A crowdsourcing framework for stakeholder engagement in funding agency call processes

A Research Dissertation submitted in fulfilment for the degree of Ph.D through the National University of Ireland, Galway

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Abstract

Public research funding agencies have sought to better involve the general public and other stakeholders in their competitive processes for the allocation of research funding. Such efforts result from the worldwide push towards open science which promotes concepts such as transparency over processes and the involvement/education of diverse stakeholders. One such means by which public research funding agencies have sought to involve diverse stakeholders is through the use of crowdsourcing. However, limited research exists into the use of crowdsourcing by public research funding agencies. Furthermore, as public sector organisations, public research funding agencies face challenges in adopting the use of processes originally designed for the use by the private sector.

Evidence shows that public research funding agencies are using commercial crowdsourcing platforms and processes which are not bespoke for their purposes. Numerous challenges are faced by public research finding agencies who seek to use crowdsourcing. First, the crowdsourcing concept has yet to reach maturity, with ambiguity as to what practices form part of the crowdsourcing phenomenon. Second, many existing crowdsourcing frameworks do not bear application to public sector organisations such as public research funding agencies. Third, challenges faced by public research funding agencies in open call processes are not fully understood. Fourth, existing crowdsourcing frameworks do not provide a practical guide for funding agencies as to how to deploy crowdsourcing processes. Last, existing research does not offer guidance for public research funding agencies in the development of science policy surrounding the use of crowdsourcing.

To address this gap in the research, an in depth examination of crowdsourcing and its constituent practices was conducted. A crowdsourcing framework was selected and adapted for the purposes of application to public research funding agency call processes. The crowdsourcing framework was applied to data provided by two groups of experts covering the domains of crowdsourcing and research funding. This was completed for the purpose of identifying new practices for use. Thereafter, the crowdsourcing framework was applied to call processes in two public research funding agencies.

This study makes several contributions to both research and practice. First, the study advances a first-of-a-kind crowdsourcing framework adapted for use in public funding agency call processes. Also, this study provides a substantial reflection on crowdsourcing and its constituent practices. The research identified new categories of practices for use by public research funding agencies in accessing crowds. The framework provides practical guidance as to why, when and how crowdsourcing practices can be used. Also, the study provides a series of recommendations for public research funding agencies in the development of science policy. Last, recommendations for future research are presented and the limitations of this research are discussed.

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Dedication

To Elizabeth,

To Ethan, William, Mollie and David

Love always

Dad

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Explanation of Terminology

Description	Definition
Call for Proposals (CFP)	Academic and commercial calls for solutions to problems (CFPs) that include submissions, external and internal funding requests (Aguilar et al., 1998; Jablonski, 1999; Mekaouche et al., 2005; Minkler et al., 2003).
Collaborative Design	Collaboration, coordination and cooperation in the design of artefacts (Arias et al., 2000; Kleinsmann, 2006; Kvan, 2000).
Collective Intelligence	Groups of individuals doing things collectively that seem intelligent (Malone et al., 2011).
Crowdsourcing	The use of IT to outsource any organisational function to a strategically defined population of human and non-human stakeholders in the form of an open call (Kietzmann, 2017)
Crowdfunding	An open call, essentially through the Internet, for the provision of financial resources either in form of donation or in exchange for some form of reward and/or voting rights in order to support initiatives for specific purposes (Schwienbacher and Larralde, 2012).
e-Government	Includes the use of all information and communication technologies.to facilitate the daily administration of government. (Fang, 2002; Moon, 2002)
Education and Public Engagement (EPE)	An activity mandated by the funders of scientific research to increase public awareness of, and engagement with science.
GLAM sector	A sector including galleries, libraries, archives, and museums
Grant Proposal	A written application submitted to a competitive process seeking funding (Connor and Upton, 2004; Graves et al., 2011; Herbert et al., 2013)
Information Systems Development (ISD)	The process (activity) whereby a work activity or a larger organizational setting is facilitated by introducing a new socio-technical information system or modifying or expanding an existing one (Luukkonen et al., 2013).
Information Systems (IS) Research	The associated research discipline examining socio-technical information systems
INPUT, PROCESS, OUTPUT (IPO)	A popular process model format used in various domains as a base in the evaluation of processes (Bushnell, 1990; Ilgen et al., 2005; Littlepage et al., 1995; Pujet et al., 2000).
Inner Source Software (ISS)	An information systems development organisation develops software in-house in a way that mimics the way in which Open Source Software is developed (Stol et al., 2014)
Iteration	A process for arriving at a decision by repeating rounds of analysis generally in a 'time-boxed' period of work.
Micro-tasking	The act of breaking a large project into tiny, well-defined tasks (Deng et al., 2016; Kittur et al., 2008a; Walsh et al., 2014).
Open Call	An open request directed to a crowd generally via an Internet platform (Alonso et al., 2008; Brabham, 2009; Chatzimilioudis et al., 2012; Hammon and Hippner, 2012; Schenk and Guittard, 2011).
Open Innovation	A paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology (Chesbrough, 2003a).
Open Source Software (OSS)	An open means of development process used in the software development industry (Ågerfalk and Fitzgerald, 2008; Von Krogh, 2003; Open Source Initiative, n.d.).
Outsourcing	The outsourcing of functions outside the business for which they have limited or no competency (Ågerfalk and Fitzgerald, 2008; Corney et al., 2009; Mullin, 1996)
Participatory Design	The techniques and methods used, namely strategies that allow for the direct participation of workers in project definition and design specification (Kensing and Blomberg, 1998)

Peer Production	A new model of economic production, different from both markets and firms, in which the creative energy of large numbers of people is coordinated (usually with the aid of the internet) into large, meaningful projects, largely without traditional hierarchical organization or financial compensation (Benkler and Nissenbaum, 2006).
Platform	The process architecture through which participants in a process interact.
Process Initiator	The initiator of the crowdsourcing activity (Estellés-Arolas and González-Ladrón-De-Guevara, 2012).
Research Funding Agency	Research funding agencies (agencies) are known by a series of terms such as research agencies, research bodies, research institutes, research councils and research hubs and are involved in selecting research to be funded and funding research (Crawley and O'Sullivan, 2016; Dragojlovic, 2013; Piore et al., 2019; Wang et al., 2012).
Research Funding	Funding obtained through a competitive process, in which potential research projects are evaluated and only the most promising receive funding (Garcia and Sanz-Menéndez, 2005).
Third Sector	Charitable, philanthropic and not for profit initiatives.
Wisdom of crowds	The collective opinion of a group of individuals rather than that of a single expert (Galton, 1907; Kittur and Kraut, 2008; Surowiecki, 2005).
Wiki	A set of linked web pages, created through the incremental development by a group of collaborating users (Leuf and Cunningham, 2001).

Declaration

I hereby declare that, except where duly acknowledged, this thesis is entirely my own work and that I have not obtained a degree in this University or elsewhere on the basis of any of this work. This point is particularly emphasised in relation to all figures and tables. Where these have been reproduced, the original sources are acknowledged. Otherwise, they represent my own work.

Eoin Cullina

List of papers to-date from this dissertation

Cullina, Eoin, Kieran Conboy, and Lorraine Morgan. "Choosing the right crowd: An iterative process for crowd specification in crowdsourcing initiatives." 49th Hawaii International Conference on System Sciences (HICSS). IEEE, 2016. Available from: http://dx.doi.org/10.1109/HICSS.2016.541

Conboy, Kieran, Eoin Cullina, and Lorraine Morgan. "A Crowdsourcing Practices Framework for Public Scientific Research Funding Agencies." Proceedings of the 12th International Symposium on Open Collaboration Companion. ACM, 2016. Available from: http://doi.acm.org/10.1145/2962132.2962134

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Chapter 1. Introduction

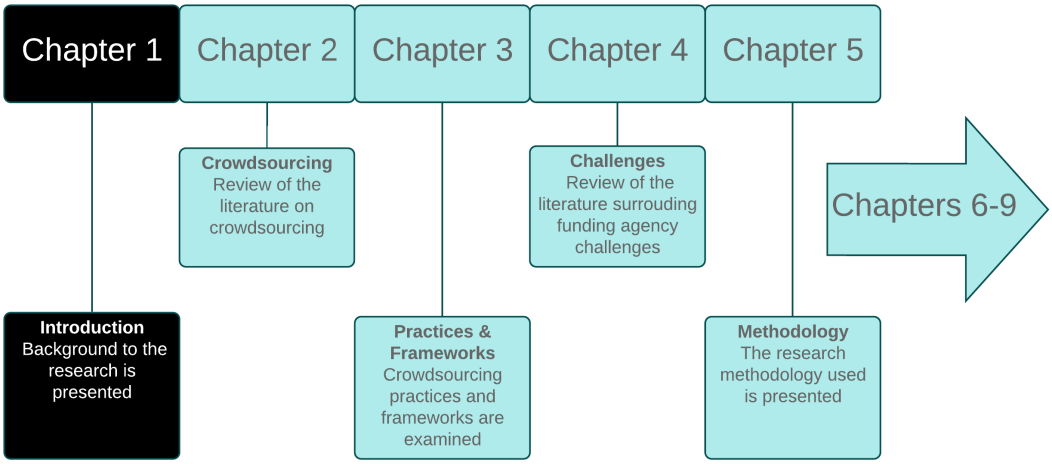


Figure 1.1 - Chapter structure – Chapter 1

1.1. Background

The purpose of this chapter is to provide the background to the study. The chapter proceeds as follows: after the background to the research is presented (Section 1.1), Next, research regarding open science is examined (Section 1.2). The funding agency call processes are examined (Section 1.3). Next, crowdsourcing as a process is introduced (Section 1.4). A practices based approach to the research is outlined (Section 1.5). The rationale for this study is then presented (Section 1.6). The chapter then presents the research objectives (Section 1.7) and a summary of the methods used (Section 1.8). Last, an overview of the layout of the chapters is presented (Section 1.9). This chapter provides the context for this study prior to the literature review on crowdsourcing in Chapters 2 and 3 (see *Fig.* 1.1 above).

This chapter outlines a process whereby a crowdsourcing framework was selected and adapted, for public research funding agency call processes. The resulting crowdsourcing practices framework presents funding agencies with a practical means by which to use crowdsourcing. Evidence shows that funding agencies are using crowdsourcing in research funding call processes in an attempt to move towards open science. Open science seeks amongst other goals to improve transparency over processes and increase diverse stakeholder participation in processes. Crowdsourcing presents as one such means to achieve these goals.

This research follows from a Science Foundation Ireland (SFI) project examining the prospective use of crowdsourcing in scientific research funding agency call processes. The project commenced in early 2014. Initially, the project investigated the potential use of a design science approach to building a crowdsourcing framework from scratch. A preliminary conceptual model was prepared (see *Fig*. 1.2 below). However, in the early stages of the research, it became evident that further empirical investigation was required where the crowdsourcing literature required further development. Also, initial investigations highlighted the existence of similar frameworks suitable for adaption thereby mitigating the need for the development of an entirely new framework. Research has posited that groups of people can provide solutions to challenges that are in some instances greater than the sum of their membership or locus of their expertise (Baumeister et al., 2016, p. 1). In a similar fashion, funding agencies are seeking new ways to benefit from the engagement of diverse stakeholders.

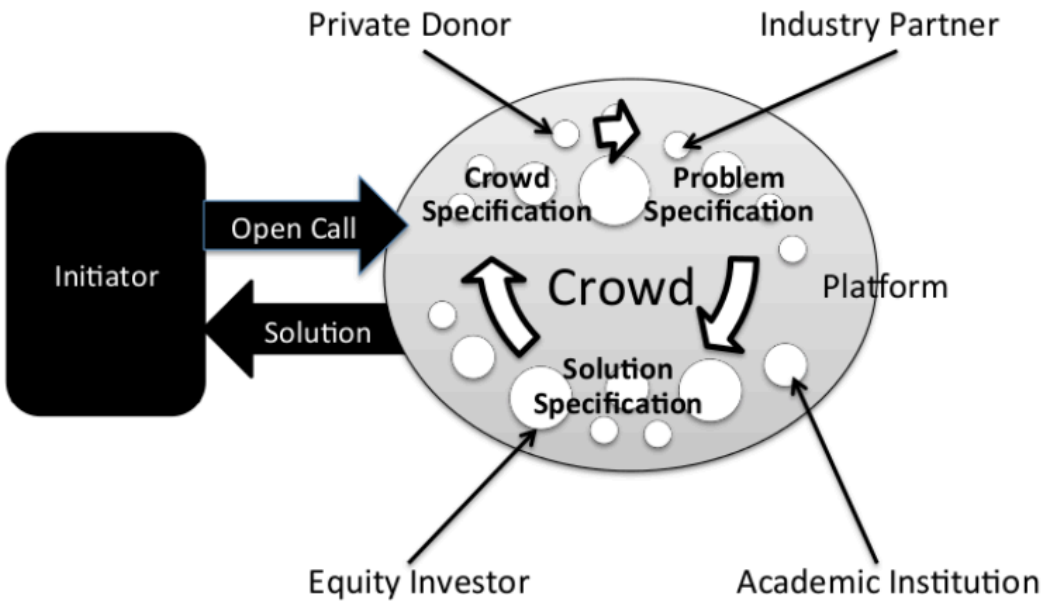


Figure 1.2 - Preliminary conceptual crowdsourcing model

The opportunities presented by the use of crowdsourcing are evident at a time when the processes surrounding the funding of research face challenges. For example, there is evidence of increased competition between researchers for funding (Kincsö Izsak and Markianidou, Ruslan Lukach, 2013). This increased competition for research funding has led to growth in proposal submissions and lower funding-success rates (Roebber and Schultz, 2011).

Some negative aspects of the existing competitive processes are also evident (for example see Fang and Casadevall, 2015). Attempts to embrace open science are commensurate with the global move towards Science of Science Policy (SoSP) (Lane and Bertuzzi, 2011; Valdez, 2008). Attempts at obtaining greater public participation stands in contrast to accusations that science is an ivory tower (vanBergeijk and Johnson, 2014) where funding agencies have been accused of living insulated from the needs of society (Mikulak, 2011). Some research has questioned whether or not it is worth the effort in engaging other types of stakeholders such as citizens in decision-making processes around policy (Irvin and Stansbury, 2004).

Although increased efficiencies through the reduction of cost and time are important considerations in research, the use of crowdsourcing by public research funding agencies is primarily driven by a need to engage the public and inform future science policy. Research has highlighted that there is a need for a reflection by funding upon appropriate science policy (Bozeman and Youtie, 2017; Lane, 2009). Jasanoff, (2019, p. 225) states that across a "*widening range of policy choices, technological cultures must learn to supplement the expert's preoccupation with measuring the costs and benefits of innovation with greater attentiveness to the politics of science and technology*".

Research has sought to understand the issues arising from the interaction of people, processes and technology within organisational structures (Davenport et al., 2009; Markus and Robey, 1988; Wade and Hulland, 2004). Research has also called for a greater examination of crowdsourcing (Pedersen et al., 2013). Research has also examined public sector management (Bretschneider, 1990; Caudle et al., 1991; Cordella and Iannacci, 2010; Goldfinch, 2007; Newcomer and Caudle, 1991). Despite this fact, there is a comparatively small body of research engaging with public sector crowdsourcing (Brabham, 2013; Liu, 2017a). Limited research has also examined systems for the management of grant processes. For example, Perbangsa et al., (2017) conducted research to determine what features are needed for the systems to function in a research grants management system. Also research has examined similar aspects of processes that form part of funding management systems such as such as problem ideation (Chan et al., 2015; Reinig et al., 2007) and peer review (Hardaway and Scamell, 2012; Harnad, 1996). There is a clear lack of guidance available for public research funding agencies on the prospective use of crowdsourcing.

This is despite the presence of research on crowdsourcing in other domains including management, economics, software engineering, healthcare and geography (cf. Heipke, 2010; Hossain, 2015; Ibrahim and Verliyantina, 2012; Stol and Fitzgerald, 2014; Swan, 2012). Various pieces of research have adopted a practices perspective in seeking to better understand information systems approaches utilised by organisations (Lacity and Willcocks, 1998; Pikkarainen et al., 2008; Thorén et al., 2014). This research adopts a similar approach in examining how practices can provide solutions to specific process challenges. A practices approach is evident in research topics such as software development, open innovation and crowdsourcing (Holmström et al., 2006; Hossain et al., 2011; Schenk and Guittard, 2011; Thorén et al., 2014).

Throughout this research it is evident that multiple terms are used to describe similar phenomena, actors and tasks. This causes a degree of confusion over the meaning of certain terms. For example, the terms 'rewards' and 'incentives' are used interchangeably across the literature, yet, in certain instances they can have different meanings applied. To provide clarity in these instances, competing terms and definitions are discussed and agreed within the body of this thesis. For example, the term 'funding agency' is used to denote public research funding agencies where such organisations are known by a series of terms such as research agencies, research institutes, research councils and research hubs amongst others (Crawley and O'Sullivan, 2016; Huang et al., 2016; Tetroe, Graham, et al., 2008; Torfing, 2013; Wang et al., 2012).

Funding agencies largely decide their own course of action in terms of enacting science policy. Braun, (1998, p. 811) argues that to a large extent funding agencies are: "*built to a considerable extent on the principle of 'self-organisation' and that scientific referees and advisors, laymen, funding administrators, and political representatives are all part of the decision process within funding agencies*". Similarly, terms such as 'call for proposals' (CFP), 'open call', 'grant processes', 'competition' or 'call processes' are used by funding agencies worldwide to describe the competitive process of evaluating research topics, or submissions seeking an award of funding (Crawley and O'Sullivan, 2016; Drummer and Bassed, 2013; Wang et al., 2012). For the purposes of this research, the term 'open call process' is used to describe the process used by funding agencies in deciding what research to fund.

1.2. Open science

In this section, open science and the associated movement for the democratisation of science is presented as a primary motivation for the use of crowdsourcing by research funding agencies. The narrative underlying this research may be found in a debate that has continued for over a century namely, should laypersons and other stakeholders be permitted to play a part in science where scientific excellence is at issue? In 1999, UNESCO concluded a '*Declaration on Science*' setting out core international objectives in relation to science including the involvement of citizens (UNESCO, 1999).

Also, the European Commission has called for a reflection upon open science and associated funding processes with Doove, (2016) stating that "*Innovative models for knowledge transfer, like citizen science and crowdsourcing, are primarily seen as 'nice to have' and are not sufficiently embedded in regional and national research and innovation strategies*". Research has supported the position that citizens and other stakeholders can play an active part in science and more broadly scientific research (Couvet et al., 2008; Lidskog, 2008; Nelkin, 1982; Woolley et al., 2016).

Wooley et al., (2016) describes contemporary terms such as "*participant-driven research*", "*crowdsourcing*" and "*citizen science*" as "*populist rhetoric*". Research has also argued that open science provides greater value to more people than is initially apparent (Cribb and Sari, 2010). However, opposition to citizen involvement in the realm of science and technology is based on the claim that laypersons are incapable of grasping the technical nuance and methodological complexity of science (Kleinman, 1998).

Challenges are evident for the involvement of laypersons in the context of peer review (Harnad, 1996; Scott, 2007). Siemsen states that "*the job of popularization should rest with science - an informed public cannot be manipulated as easily by 'pop science*" (Siemsen, 2010, p. 293). Proposals have been made in research to address this imbalance. For example, Guston, (2004, p. 26) identifies core points in the forming of an agenda towards the democratization of science namely:

"first, engage user communities and lay citizens more fully in review of funding applications. Such "extended peer review" increases the presence of public priorities without mandating research programs or diluting quality". Second, "increase support for community-initiated research at universities and other research institutions".

Scientists are also concerned with the conflicting problems of public apathy towards science arising from the overtly commercial focus of science. Small and Mallon, (2007, p. 103) state that the:

"political imperative of increasing commercialization of science is frequently viewed as contributing to a problem of public mistrust in science. One proposed solution, (favoured) in political circles, is increased public engagement and participation in the science agenda".

This debate is set against the context of an international debate as to what constitutes scientific truth and transparency in modern media. In an article in Nature in 1999, Michael Gibbons in calling for a more open science stated that "*a new contract must now ensure that scientific knowledge is 'socially robust', and that its production is seen by society to be both transparent and participative*" (Gibbons, 1999, p. 11). This statement reflects a changing view that science is no longer the preserve of an elite, but is something that is to be shared by all for the overall benefit of science and society.

Thorpe and Gregory, (2010, p. 273) state that "*the commercial exploitation of scientific knowledge and increased public participation in democratic decision-making about science and technology have emerged as the two central themes of contemporary science*". In the latter case of public participation, a challenge presents itself in the form of enabling diverse stakeholders to participate in science. This contemporary theme emerges from a movement known as the democratisation of science which seeks to empower people who hitherto had no means of sharing insights and knowledge (Oomen and Aroyo, 2011). However, Kleinman, (1998, p. 134) also advances a challenge that: "*(w)e must ask what the nature of lay involvement is. To what extent does this participation involve laypersons in activities and decision-making commonly understood to be the exclusive realm of experts?*".

The present debate also extends to public sector modernization, in providing stakeholders with a voice, service quality and value for money (Hilgers and Ihl, 2010). The European Commission adopted two main goals for science namely: (i) full open access for all publicly funded scientific publications by 2020 and (ii) open data - the sharing and re-use of data - as the standard for all publicly funded research (Doove, 2016). These goals aim to promote trust amongst citizens and place science at the core of democratic societies. However, in seeking to build open science there is a need not just to involve laypersons but a diverse basket of stakeholders.

While public partnership is well established in science (Israel et al., 1998) a move towards the involvement of crowds in science introduces new challenges and opportunities (Franzoni and Sauermann, 2014). In recent years, other types of stakeholders have been invited into the consultation process in terms of identifying opportunities in new research (Brookman et al., 2016). Evidence shows diverse public and private actors participating with funding agencies in shaping scientific research agendas. Pierce, (2007, p. 125) argues that:

"the construction of a democratic education should include the social agency of both natural objects and those produced by science, technologies that shape social life, and the agency of scientists, policy makers, social actors within industry, and the media".

For this reason, the crowdsourcing ecosystem that can be used by public research funding agencies is a broader concept than citizens alone and should provide space for other types of stakeholder to interact such as other public sector stakeholders, commercial enterprise and third sector organisations. For example, in Ireland, call processes have been operated by Science Foundation Ireland (SFI) that also feature interactions with other funding agencies such as the Irish Research Council (IRC) and other public sector organisations such as Teagasc.

1.3. Public research funding call processes

Both documentation supporting funding agency call processes and research shows that call processes have several main stakeholders and components including (i) stakeholders with a vested interest in the process, (ii) a grantor who provides funding, (iii) an advertisement via an open call of a competition, (iv) a submission, (v) a

competitive assessment process and (vi) an award or selection of a winner or winning solution (Century, 2016; Duderstadt and Augustine, 2014). The US Department of Health and Human Services define the competition process as "*a process in which applications are evaluated against established review criteria, also known as objective review, and scored and recommended for award*" (HRSA, 2017). Such processes are not without criticism. Research has examined the negative effects of similar processes which can restrict novel or risky research which can potentially produce innovative outcomes (cf. Wang et al., 2018). The process whereby applicants seek to improve their skills and success rates in such processes is referred to as 'grantsmanship' (Root-Bernstein, 1993).

Research has also examined the practices used in systems for managing funding allocation in similar call systems including: internal tracking, online registration, proposal review, relationship management, grant requirements evaluation, payments, budgeting system querying and reporting and data access (Perbangsa et al., 2017, p. 248).

Traditionally, call processes have been managed and executed within the four walls of the agencies using internal and external experts and reviewers (Berezin, 1998; Couzin-Frankel, 2013; Roebber and Schultz, 2011). Public research funding agencies are now seeking to build systems to interact with diverse stakeholders and communities such as citizens, charities and corporations amongst others. The US Government initiative of Challenge.gov presents as one such example (Challenge.gov, 2015). In so doing, a move towards open science (Cribb and Sari, 2010) is evident thereby expanding the scope of call processes. Although there is evidence of different organisational structures across funding agencies, there is an extremely large degree of similarity evident in practices used in call processes. In particular, such processes use similar practices to the peer-review and assessment practices (Roebber and Schultz, 2011; Roy, 1985; Wessely, 1998). Despite this, Van Bekkum, (2014, p. 1) states that "*little is known about how research funding bodies view public participation in research funding decisions, and how they involve the public into their strategies and practices*".

Funding agency call processes bear many structural similarities to INPUT, PROCESS, OUTPUT (IPO) models which facilitates the categorisation of different process aspects for the purposes of evaluation (Bushnell, 1990). Such models have been used in processes that feature evaluation ranging from training, departure processes, solving groups, teams, open innovation metrics (Erkens et al., 2012; Ilgen et al., 2005; Littlepage et al., 1995; Pujet et al., 2000) and crowdsourcing (Marjanovic et al., 2012).

This research examines the use of crowdsourcing by public research funding agencies in their open call processes. Crowdsourcing processes have been used in different research related contexts (Candido dos Reis et al., 2015; de Graaf et al., 2017; Khatib et al., 2010). However the idea of using citizens and other stakeholders in science is not new. Before the advent of crowdsourcing, Citizen Advisory Committees (CACs) were used in increasing numbers to provide public input into environmental policy and management decisions (Lynn and Busenberg, 1995). Evidence shows public participation in various capacities where on a scale applied by Kleinman, (2000), degrees of public participation range from acknowledging public views, to the public having an active decision-making role.

More broadly, crowdsourcing bears prospective application to scientific challenges and science research (Bücheler and Sieg, 2011; Franzoni and Sauermann, 2014; Wiggins and Crowston, 2011; Woolley et al., 2016). Research has also examined the use of crowdsourcing in formulating scientific research questions (Beck et al., 2019). Research has examined issues and alternatives in peer review processes (Hojat et al., 2003; Suls and Martin, 2009). Crowdsourcing involves tapping into the transformative nature of the crowd and the emergent nature of crowd solutions as is evident in cutting edge applications. One such example lies in tournaments and gamified crowdsourcing (Morschheuser et al., 2016; Schrier, 2020).

1.4. Crowdsourcing

Some confusion exists as to the exact origin and composition of the crowdsourcing concept. For example, the use of the term ‘crowdsourcing’ arose several years after the first evidence of similar web-enabled processes emerged (Trompette et al., 2008). Research in the domain is still regarded, as being in its infancy and parts of the domain remain unexplored (Majchrzak and Malhotra, 2013; Marjanovic et al., 2012; Rahman

et al., 2015; Shen, 2019; Tajedin and Nevo, 2013; Zahay et al., 2018). The contemporary move towards crowdsourcing represents a core change at the heart of organisational philosophy driven by the increase in open innovation and the desire to move outside the traditional boundaries of the organisation (Howe, 2006).

Open innovation as a parent domain utilises both inward and outward flows of information through the organisation in the development of new products and services (Baldwin and von Hippel, 2011; Chesbrough, 2003b; West and Gallagher, 2006). Originally, crowdsourcing was conceptualised in the commercial context (Howe, 2006). However, in recent years increasing evidence exists of governments turning towards open engagement of diverse stakeholders in processes (Brabham, 2013; Koch et al., 2011; Leydesdorff and Meyer, 2003; Mergel, 2015; Mergel and Desouza, 2013). Governments are becoming more receptive to the use of crowdsourcing for the soliciting of public opinion and shaping of public policy (Brabham, 2013; Liu, 2015, 2017b; Prpić, Taeihagh, et al., 2015).

Crowdsourcing is being used by commercial organisations to drive innovation in a number of domains, e.g. new chemical processes (Eli Lilly), toy designs (Lego), mobile phone designs (LG), and new consumer products (Procter & Gamble) (Cahalane et al., 2013). Also, several crowd intermediaries have now become household names such as Kickstarter, Rockethub, and Amazon Mechanical Turk. Crowdsourcing processes have been used in other types of challenges as diverse as software development, disaster relief, t-shirt design, neighbourhood re-gentrification, education and weapons development (Bow et al., 2013; Brabham, 2010; Gao et al., 2011; Rosner and Bean, 2013; Stol and Fitzgerald, 2014).

The crowdsourcing process largely involves finding a challenge, picking a suitable crowd to address the challenge, advertising the challenge through an open call, accepting submissions and picking a winner (Majchrzak and Malhotra, 2013; Saxton et al., 2013). Nakatsu, (2014) presents one version of process as: (1) a requestor (either an individual or organization) identifies a specific task to be performed or problem to be solved: (2) the requestor broadcasts the task or problem online: (3) the crowd performs the task or solves the problem: (4) depending on the nature of the task, the requestor either (4a) sifts through the solutions and selects the best solution (selective crowdsourcing), or (4b) aggregates/synthesizes the crowd's submissions in

a meaningful way (integrative crowdsourcing). Accordingly, the process stages and tasks bear many similarities to those of a IPO process as delineated below (see *Table* 1.1). However, some clear distinctions exist between the use of funding agency call processes and crowdsourcing processes. A comparison is presented below of a similar nature to comparator tables used in examining processes across research at *Table* 1.1 below (Chesbrough, 2003b; Felin and Zenger, 2012; Marjanovic et al., 2012; Nerur et al., 2005). The next section discusses the use of crowdsourcing by agencies in call processes.

Table 1.1 - Comparison of funding agency call processes with crowdsourcing processes synthesised from Chesbrough, 2003a; Felin and Zenger, 2012; Marjanovic et al., 2012; Nerur et al., 2005

Process Feature	Agency Call	Crowdsourcing Call
Process type	IPO	IPO
Management Style	Command and Control	Collaboration and competition
Manager Control	Vertical	Horizontal
Expertise Sought	Mostly external	Almost exclusively external
Knowledge Management	Explicit	Tacit
Participant Assignment	Administered	Self-selection
Participants Role	Determinative	Facilitative
Process Model	Waterfall like	Flexible
Process Structure	Bureaucratic and formal	Organic
Process Visibility	Secretive/restricted	Transparent
Technology	Predominantly document-based	Largely software assisted

1.5. A practices based approach

The identification of practices and the conceptualisation of associated practice frameworks has been a core pursuit within the information systems discipline (Dubé and Paré, 2003; Ewusi-Mensah and Przasnyski, 1991; Hossfeld et al., 2014; Lacity and Willcocks, 1998; Pikkarainen et al., 2008; Watson et al., 1991).

Practices present in information systems research in various formats including: best, digital, management, strategic, operational or methodological. To this end, practices reflect the values and principles through which organisations operate. The Oxford Dictionary defines the noun 'practice' as "*the actual application or use of an idea, belief, or method, as opposed to theories relating to it*" (Oxford Dictionary, 2017). Research focusing upon crowdsourcing practices are to be found across the different types of crowdsourcing initiatives operated in commercial and not-for-profit contexts (Carletti et al., 2013; Ramos, 2019; Schenk and Guittard, 2011; Sigala, 2015; Xu et

al., 2015). A plethora of conceptual and practitioner crowdsourcing frameworks show individual categories of practices that can be used in the management and operation of solution-seeking processes (Estellés-Arolas, 2016; Estellés-Arolas and González-Ladrón-De-Guevara, 2012). Crowdsourcing practices can also be contextualised from the perspective of open science where Guston, (2004, p. 25) supports the broader need for "*creating institutions and practices that fully incorporate principles of accessibility, transparency, and accountability".*

1.6. The rationale for this study

The rationale for this study is presented as follows:

The study seeks to inform the creation of new science policy surrounding the use of crowdsourcing by public research funding agencies. Agencies find themselves at the heart of a major evolution in public policy with a move towards open innovation and the desire for citizen involvement in public processes (Hilgers and Ihl, 2010; Maxwell, 2006). New processes are required to engage the public where the research funding process has faced criticism (Irwin, 2006; Rowe et al., 2005). Agencies have faced various challenges in recent years in addressing charges levied by the public and various commentators against science. Many of the arguments can be traced to a lack of connection between citizens who fund science and the scientists who avail of agency funding (Bielak et al., 2008; Burgess, 2014; Evans and Durant, 1995). Despite the presence of some limited literature concerning public research funding agencies and the creation of policy (Lavis et al., 2003; Smits and Denis, 2014), little or no research exists as to the creation of science policy for the use of crowdsourcing.

Following calls from research, the study addresses the need for theoretical reflection on crowdsourcing. In particular, where there is no one set of agreed crowdsourcing practices or definition of crowdsourcing evident from research. Challenges and limitations are evident within existing theoretical approaches to conceptualising crowdsourcing where research has explicitly called for further theoretical investigations in the area (Alam and Campbell, 2013a; Majchrzak and Malhotra, 2013; Marjanovic et al., 2012; Saxton et al., 2013; Zhao and Zhu, 2012). Also, confusion exists as to the exact definition of crowdsourcing (Estellés-Arolas and

González-Ladrón-De-Guevara, 2012). Various challenges are evident with existing crowdsourcing frameworks which are predominantly practice-led. In particular existing frameworks lack clarity in their composition, a strong theoretical foundation, evidence of cumulative tradition in their development, parsimonious construction and broad applicability of the framework.

There is a need to add to the limited body of existing research on the public sector's use of crowdsourcing. In particular, where extremely limited examples of the research relating to the public sector use of crowdsourcing are available. This study addresses the gap in the literature where there is a need for research on crowdsourcing in a public sector context. Despite the evidence of research applying open innovation concepts in public initiatives (Hilgers and Ihl, 2010; Mergel and Desouza, 2013; Stewart-Weeks and Kastelle, 2015) limited examples are available of crowdsourcing being used in the context of the public sector (Brabham, 2013; Liu, 2017a; Loukis, 2018). Many existing crowdsourcing frameworks including the framework at the root of this study are commercial in focus by virtue of the absence of availability of public sector frameworks. Funding agencies, as a public sector organization, play a critical role in driving national innovation output and accordingly, practices for the management of their call processes require closer scrutiny. Loukis and Charalabidis (2015, p. 1) states that "*there is still limited knowledge on how crowdsourcing can be efficiently and effectively performed in the special context of the public sector, much less than in the private sector*". This is further complicated by the fact that research shows public sector organisations have different attitudes to incentivisation, risk and bureaucracy (Bason, 2010; Bloch and Bugge, 2013; Bommert, 2010; Buurman et al., 2012). Conflicting research argues that crowdsourcing can transform government and the public sector despite the challenges (Clark et al., 2019; Clark and Logan, 2011).

1.7. Research objectives

The research objectives for this study are presented as follows:

RO1.1 To explore the crowdsourcing research and identify the constituent practices that form part of the crowdsourcing process. The research seeks to delineate the crowdsourcing concept from an examination of crowdsourcing frameworks and practices.

RO1.2 To select and adapt a crowdsourcing practices framework for public research funding agency call processes. The next objective of the study is to select from existing literature and adapt a crowdsourcing framework through which public research funding agencies can use crowdsourcing practices. To address this objective, twenty competing crowdsourcing frameworks from the literature are evaluated. From these, one framework is identified and adapted for use by research funding agencies.

RO2. To apply the framework as a lens to public research funding agency call processes in: the second objective of the research is to apply the framework as a lens in RO1.2, to two groups of experts and two case studies for the purposes of data collection in:

> **RO2.1 highlighting challenges faced:** funding agencies face numerous types of challenges in call processes. Examples include challenges faced in engaging the public and other stakeholders as well as keeping participants motivated. Challenges are also faced in sourcing contributions from laypersons and experts. The challenges faced by research funding agencies are examined in Chapter 4.
>
> **RO2.2 examining crowdsourcing practices used:** various types of practices are used by funding agencies. Through applying the framework to expert interviews and case studies, existing practices used by the funding agencies are examined.
>
> **RO2.3 identifying new crowdsourcing practices:** through expert interviews and case studies new crowdsourcing practices are identified. The new practices are compiled within the Marjanovic et al., (2012) framework.

1.8. Research methods

The research methods used are presented as follows: first, expert interviews were completed with two groups of experts based upon predefined expertise criteria including funding agency experts and crowdsourcing experts. The expert interviews provided confirmation of the nature and extent of crowdsourcing practices used. Also, through these interviews, new practices were identified. The practices identified were then added to the conceptual framework for application in the two subsequent case studies completed. Second, two case studies into the crowdsourcing processes used by two public research funding agencies were completed. The first case study covered the use of crowdsourcing in a national funding agency. The second case study examined contemporary efforts from a pan-national (European) funding agency to use crowdsourcing practices in call processes.

1.9. Layout of chapters

The content of the subsequent chapters as they relate to the research objectives are described as follows and summarised at the conclusion of this section (see *Table* 1.2 below).

Chapter 1: Introduction. This chapter presents the motivation for the research and outlines the core research objectives. The chapter presents an introduction to the public research funding agency call processes and crowdsourcing.

Chapter 2: Crowdsourcing. An overview of open innovation and the subdomain of crowdsourcing is presented. The chapter defines the crowdsourcing process and presents crowdsourcing practices that can be used as a basis for the framework selection process in Chapter 3.

Chapter 3: Practices & frameworks. A preliminary conceptual framework is selected and from twenty competing frameworks. It is then adapted to contain practices identified from the literature.

Chapter 4: Public research funding agencies. The preliminary conceptual framework is applied in an in-depth review of funding agency call processes and a detailed examination of the challenges faced by funding agencies are presented.

Chapter 5: Research methodology. In chapter five the theoretical and philosophical considerations in the research and choice of research methods for the qualitative research methodology/plan are presented.

Chapter 6: Expert interviews. The preliminary conceptual framework is applied to two sets of expert interviews and research findings regarding the use of crowdsourcing practices are presented. Existing practices are examined and new practices are identified.

Chapter 7: Case studies. The conceptual framework containing new practices identified in Chapter 6 is applied to two case studies.

Chapter 8: Discussion & analysis. A reflection upon the findings in line with contemporary research is completed and conclusions and are presented.

Chapter 9: Conclusion. The chapter concludes by discussing the implications of the research, examining the research limitations and presenting future avenues for research. Also, guidelines are provided for public research agencies seeking to (i0 implement the findings arising from this research and (ii) inform science policy.

Table 1.2 - Mapping of chapters to research objectives

#	Objectives			Chapters
O.1 DEVELOP	1.1 To explore the crowdsourcing research and identify the constituent practices that form part of the crowdsourcing process. 1.2 To select and adapt a crowdsourcing practices framework for public research funding agency call processes.			CH 2, 3 & 4
O.2 APPLY	2. To apply the framework as a lens to public research funding agency call processes in	2.1	highlighting challenges faced	CH 6
		2.2	examining crowdsourcing practices used	CH 7
		2.3	identifying new crowdsourcing practices	CH 8 * 9

Chapter 2. Crowdsourcing

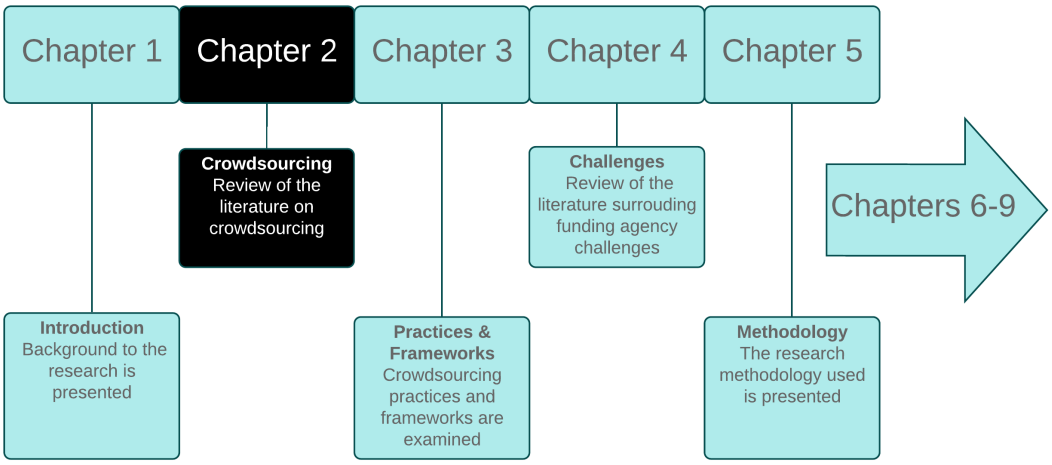


Figure 2.1 - Chapter structure – Chapter 2

2.1. Introduction

The purpose of this chapter is twofold. The first is to contextualise the origins and evolution of crowdsourcing as a form of open innovation. The second is to examine crowdsourcing practices from research in addressing research objectives RO1.1, and RO2.2. This chapter outlines the evolution of crowdsourcing prior to the selection of a framework for adaption in Chapter 3 (see *Fig.* 2.1 above). This chapter seeks to underpin the framework selection process completed in the next chapter.

The chapter proceeds as follows. After the introduction (Section 2.1) an overview of the literature review approach is presented (Section 2.2). Thereafter, the early origins of crowd collaboration are presented (Section 2.3). The concept of open innovation is discussed in detail and is presented as the parent domain of crowdsourcing (Section 2.4). Crowdsourcing is then examined (Section 2.5). The advantages of adopting a crowdsourcing practices approach to the problem space are presented (Section 2.6). A brief chapter summary is presented by way of conclusion (Section 2.7). The application of crowdsourcing to funding agency call processes faces several immediate challenges. It is unclear as to the exact definition of crowdsourcing and what practices constitute part of the process. Also, no substantial evidence is available from the research of a crowdsourcing framework best suited to the needs of funding agencies. Limited guidance is available from research to facilitate public sector organisations such as agencies in using crowdsourcing processes.

2.2. Literature review approach

The literature review process included the reflection upon literature available on crowdsourcing and on research funding agency call processes. Basket journals in information systems domain and science policy domains were examined at the start of the process. A literature review approach as advocated by vom Brocke et al., (2015) was used. Also, Webster and Watson/Levy and Ellis were referred to in the process. (Levy and Ellis, 2006; Webster and Watson, 2002). Last, observations on the literature review process from Jennex, (2015) were also considered in completing the review. The process involved three cycles of (i) searching, (ii) selecting and (iii) synthesising research.

The literature review approach adopted herein stands in contrast to other systematic approaches adopted in software engineering such as those of Kitchenham et al., (2009). Such approaches are suggested to be replicable and unbiased. Subsequent research has challenged this position, arguing instead for approaches that focus on the quality of literature interpretation over obsessive focus upon process rigor (Boell and Cecez-Kecmanovic, 2014). MacLure, (2005), states that (such); "*Systematic Literature Reviews are criticized for reducing literature reviews to formalistic literature searches thus stifling academic curiosity and threatening quality and critique in scholarship and research*".

Due to their ability to access other databases provided by publishers the Web of Science, AIS E-library and Google Scholar were used as the main search tools in the search stage of the research for literature review purposes. Materials sought included peer-reviewed journals, conference proceedings, articles and other types of high quality research publications.

For the body of information systems literature, A* journals were accessed including the; European Journal of Information Systems, Information Systems Journal, Information Systems Research, Journal of AIS, Journal of Information Technology, Journal of MIS, Journal of Strategic Information Systems and MIS Quarterly. A specific search string was constructed to search these basket journals. This core body of journals forms the "basket" or backbone of most literature review

searches within the IS discipline. The following preliminary search string was used in the examination of the term (Crowdsourcing):

> "(MIS QUARTERLY) OR (INFORMATION SYSTEMS RESEARCH) OR (INFORMATION SYSTEMS JOURNAL) OR (EUROPEAN JOURNAL OF INFORMATION SYSTEMS) OR (JOURNAL OF MANAGEMENT INFORMATION SYSTEMS) OR (JOURNAL OF THE ASSOCIATION FOR INFORMATION SYSTEMS) OR (JOURNAL OF INFORMATION TECHNOLOGY) OR (JOURNAL OF STRATEGIC INFORMATION SYSTEMS)."

Conference papers of interest included the International Conference on Information Systems (IC-IS) The European Conference on Information Systems (ECIS), The Americas Conference on Information Systems (AMCIS) and the Hawaii International Conference on System Sciences (HICSS). Furthermore, industry specific conferences relevant to the crowdsourcing domain were also examined such as OpenSym, Human Computer Interaction (CHI) and Collective Intelligence.

The diagram below (*Fig*. 2.2) presents a sample overview of research results on Web of Science from the basket of IS journals for crowdsourcing. In the initial search results were sorted both by total citations amassed and also in terms of date of publication. In using this approach, it was possible to insure that both highly cited research and contemporary research were examined at the start of the review process. References cited in the papers identified were then examined.

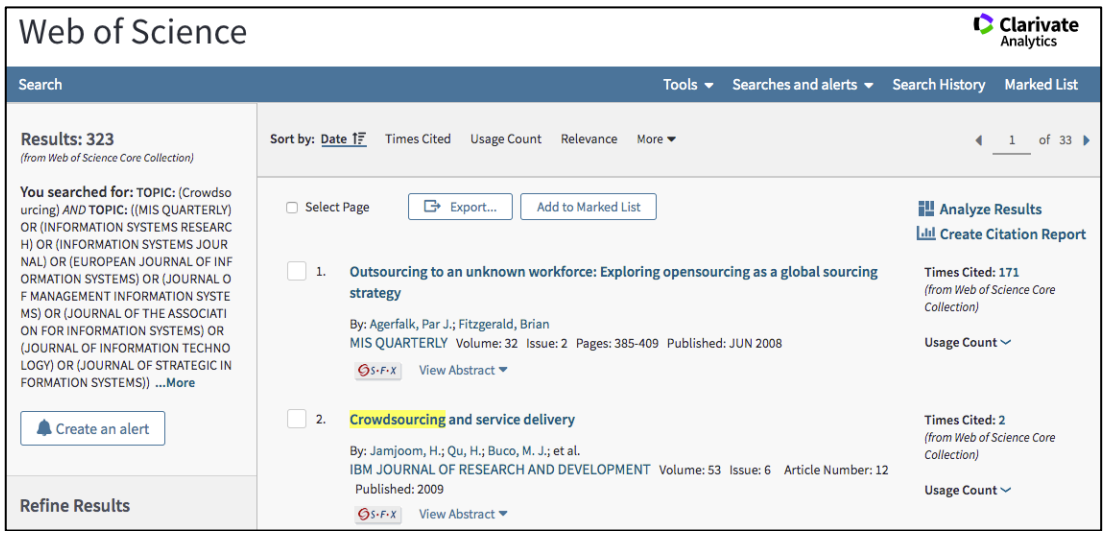


Figure 2.2 - Web of science search results on crowdsourcing from basket journals

For the science policy search, a series of leading journals within the science policy domain were identified and searched. Examples include Research Policy, Administrative Science Quarterly and Science and Public Policy. The following preliminary search string was used in the examination of terms relating to (Research funding agency):

> (RESEARCH POLICY) OR (ADMINISTRATIVE SCIENCE QUARTERLY) OR (GOVERNANCE: AN INTERNATIONAL JOURNAL OF POLICY, ADMINISTRATION AND INSTITUTIONS) OR (JOURNAL OF EUROPEAN PUBLIC POLICY) OR (JOURNAL OF POLICY ANALYSIS AND MANAGEMENT) OR (PUBLIC MANAGEMENT REVIEW) OR (QUARTERLY JOURNAL OF POLITICAL SCIENCE) OR (OMEGA: THE INTERNATIONAL JOURNAL OF MANAGEMENT SCIENCE) OR (INTERNATIONAL REVIEW OF ADMINISTRATIVE SCIENCES) OR (REVIEW OF MANAGERIAL SCIENCE) OR (SCIENCE AND SOCIETY SERIES) OR (SCIENCE AND PUBLIC POLICY) OR (SCIENCE, TECHNOLOGY AND SOCIETY) OR (JOURNAL OF SCIENCE POLICY AND GOVERNANCE) OR (INFORMATION AND MANAGEMENT)

The search cycle involved first, the completion of several tasks including searching, sorting, and refining the relevant literature. A second cycle of selecting literature including the analysis and interpretation of research identified was completed. Last the search concluded with the synthesis of the results into themes/constructs within the crowdsourcing and public research funding call process literature. This process was executed until a point of conclusion was reached where no new literature was arising in respect of a theme identified.

2.3. Early origins of crowd collaboration

Examples of organisations engaging crowds are evident throughout history addressing organisational problems include scientific challenges such as the Longitude prize (Spencer, 2012). The longitude challenge (1714), presents as one such example where a series of inducement prizes were offered by the British Government to overcome a complex navigational scientific challenge. An inventor, John Harrison, solved the problem through the development of a clock for plotting longitude. Throughout history we see other examples of the application of crowds in an effort to resolve great societal problems and challenges through the application of science (Watson, 2011).

Research has also examined the phenomenon of the "*madness of crowds*" where one frequently cited example is the Dutch Tulip bubble of the 17th Century. Panic buying of tulip bulbs by crowds drove up prices dramatically leading to a bubble and inevitable collapse (Mackay, 2012; O'Hara, 2008). In a modern context, crowds have not always provided good answers to the types of answers sought and in some instances have provided answers that have caused unwanted controversy for the solution seekers (Lane, 2016; Wilson et al., 2017). Also, the crowd can turn into online mobs as is evidenced by the work of groups such as '*Anonymous*' who are accused of digital vigilantism (Slavkovik et al., 2015). Despite the apparent challenges presented in engaging crowds, evidence exists of crowds providing solutions to complex tasks that could not be performed previously by limited numbers of experts or individuals in collaboration (Surowiecki, 2005).

2.4. Open innovation

This section, (Section 2.4) examines crowdsourcing in the open innovation context. Open innovation is a term coined by researchers to describe a phenomenon that emerged in businesses throughout the 1990's and 2000's regarding the development of internal and external innovation opportunities (Baldwin and von Hippel, 2011; Chesbrough, 2003b; Vanhaverbeke and Cloodt, 2006; West and Gallagher, 2006) Chesbrough, (2006, p. 2) defines open innovation as:

"the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology".

Traditionally, businesses innovated internally and kept new ideas internal/secret in so far as was possible. Evidence is mounting that organisations have broken this tradition and have moved outside the walls of the firm using open innovation processes in seeking new ideas (Curley, 2015; Dodgson et al., 2006).

Research highlights crowdsourcing as a particular type of open innovation (Burger-Helmchen and Penin, 2010; Nambisan and Sawhney, 2007).

However, in this regard crowdsourcing is not alone where many other types of solutions seeking process, are categorised as part of the greater open innovation family (Mladenow et al., 2014). However, research has also treated open innovation and crowdsourcing in the same context (Chanal and Caron-Fasan, 2010) where in practice they are often contextualised within the same discussions with crowdsourcing described as a particular manifestation of open innovation (McKetin, 2013, p. 3). Further research has presented them more specifically as parent and child domains (Schenk and Guittard, 2011). Crowdsourcing has also been identified as a means of implementing certain open innovation strategies (Phillips, 2010).

The open innovation process can be contextualised as the search for solutions to challenges both inside and outside the four walls of the organisation. Research suggests that those firms that search broader and deeper than other firms are more innovative (Jeppesen and Lakhani, 2010). The process was developed by firms such as Dell, IBM and Proctor and Gamble where Chesbrough described by analogy the contemporary move outside the four walls of the organisation in seeking solutions in the form of a funnel (Chesbrough, 2003b).

Modern corporations cited as adopters of open innovation also include Microsoft, Intel, Sun, Oracle, Cisco, Genentech, Amgen and Genzyme to note but a few (Baldwin and Hippel, 2010; Chesbrough, 2003b; Phillips, 2010). Many similar organisations across industries such as software development have subsequently used various types of open innovation outside of crowdsourcing such as inner source and open source software development (Stol et al., 2014).

The open innovation process is presented as a sideways funnel (see *Fig.* 2.3 below) representing the innovation process spanning from project inception all the way to the market. Evidence is presented from research, like crowdsourcing, that open innovation has extended further in scope in recent years (West et al., 2014). The walls of the open innovation funnel represent the boundaries of the organisation (Chesbrough, 2003c, p. XXIV) where opportunities are to be found by the organisation both inside and outside of the funnel walls.

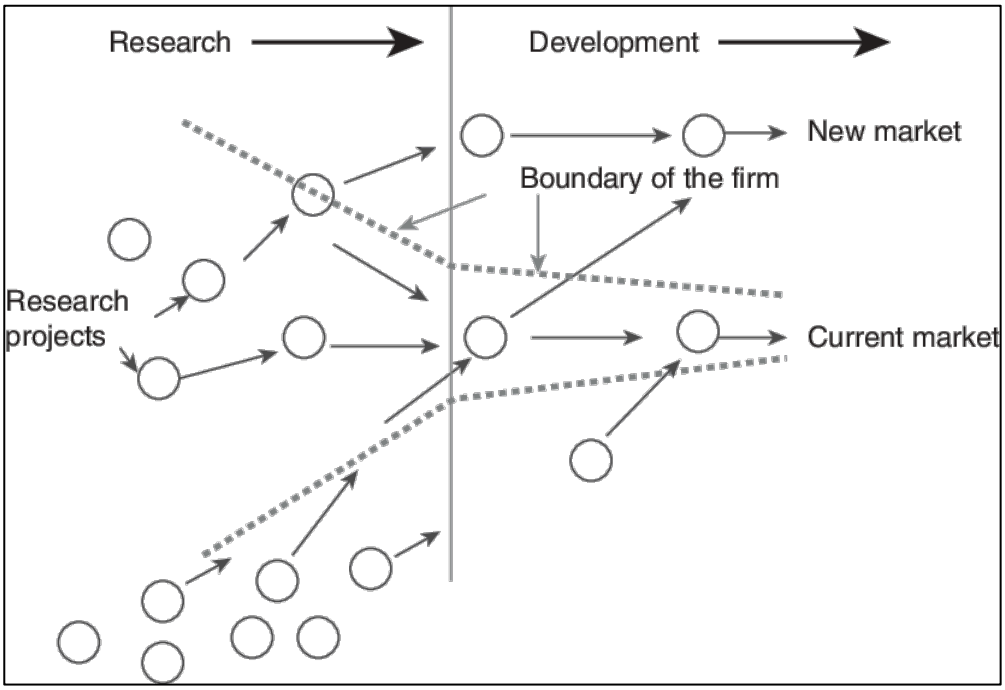


Figure 2.3 - The open innovation funnel - Chesbrough (2003, p.37)

Evidence is also presented of the increasing use of open innovation by government. Where earlier definitions including that of (West and Gallagher, 2006) have taken a commercial innovation focus, recent work has extended the use of open innovation (Hilgers and Ihl, 2010; Liu, 2017c; Mergel and Desouza, 2013; Seltzer and Mahmoudi, 2013). Government and public agencies predominantly engage with the citizen in two capacities namely participative government (Bowler and Donovan, 2000) and integrated (public services) (Dunleavy and Hood, 1994; Pollitt and Bouckaert, 2004). The focus upon the open nature of government is also reflected in discussions concerning concepts such as public value (Moore and Moore, 2005).

Funded scientific research has also moved towards the use of open innovation and crowdsourcing (Beck et al., 2019; Bücheler and Sieg, 2011; Franzoni and Sauermann, 2014; Uhlmann et al., 2019). Open innovation is not presented in research as a universal panacea to all the challenges. For example, the application of open innovation has encountered failures in some instances (West and Lakhani, 2008). Also, some critics have claimed that the open innovation process is "*old wine in new bottles*" (Trott and Hartmann, 2009). Research has further argued that there are certain projects more suited to closed forms of innovation (see for example Felin and Zenger, 2012). Despite these contradictions, evidence has shown that it is not a passing phenomenon with large corporations continuing to invest in the domain (Chesbrough and Brunswicker, 2014; Rauter et al., 2019).

2.4.1. Advantages of open innovation

Open innovation encompasses two channels for solutions namely '*outside in*' and '*inside out*'. Advantages can be obtained from using both channels of open innovation. The former channel reflects where innovative ideas are taken from outside the funnel and integrated into internal processes (Schenker-Wicki and Inauen, 2011, p. 496). The latter channel reflects upon how formative internal ideas can be taken externally and given new life (Bunce, 2006, p. 24). The latter scenario is often ignored in public open innovation. This is an important consideration with regard to the context of funding agency call processes where it is not evident that there is substantial use of '*inside out*' approaches in funding.

The use of open innovation also provides benefits from the growth of value networks/communities. Allee, (2000) describes the concept of generating economic value through complex dynamic exchanges between one or more enterprises, customers, suppliers, strategic partners and the community. The underlying ideas of value creation and value capture in information systems research encapsulate efforts to identify business models that create value for the user/customer through interactions between various types of stakeholders (Chesbrough, 2003b; Dong and Wu, 2015; West, 2007). The concepts of value creation and value capture through interactions between stakeholders leads into the research concerning the generation of/interaction with communities both online (Cullen and Sommer, 2011; Preece, 2000; Preece and Maloney-Krichmar, 2005) and offline (Näsi et al., 2011; Rosenberry, 2010).

Open innovation provides the advantage of the flexibility of application. For example, it can be used in different contexts such as online communities and virtual collaborative structures such as COINs (Gloor, 2007). Collaborative open innovation networks (COINs) are defined as "*a cyberteam of self-motivated people with a collective vision, enabled by the Web to collaborate in achieving a common goal by sharing ideas, information, and work*" (Hart, 2007). Virtual collaborative structures cover various types of online or network-based collaboration and have been taxonomised over the years from the focuses of project management, academia, functionalities, organisation and informational dimensions amongst others (Albors et al., 2008).

2.4.2. Variants of open innovation

In this section, variants of open innovation and concepts that have evolved as both antecedents to and in parallel with contemporary crowdsourcing are examined. Although research has categorised some of the concepts (see *Table* 2.2 below) as existing separately to open innovation (see Flostrand et al., 2019), based on the criteria above, this research posits they represent different forms of open innovation. Contemporary crowdsourcing practices overlap with other variants of open innovation.

Off/Near Shoring: From the outset of the 1990s many businesses started the process of moving certain aspects of their production or innovation to different countries in an attempt to reduce costs through offshoring (Svensson et al., 2010). There are various types of offshoring including nearshoring. Lower cost economies such as China and India benefited greatly from the concept where companies such as Apple, Dell, HP and IBM were keen to reduce balance sheet costs and tap into new cost-effective labour forces. Generally, with offshoring, the solution provider (contractee) satisfies a specific contract for the stakeholder (contractor) and does not have to compete with other competitors within an ecosystem. By contrast, with outsourcing, contractual obligations and licensing arrangements bind the parties so a line of obligation exists between the contractor and the outsourced worker (Glass, 2004). Although offshoring does not involve the specific use of a platform new process management tools have been developed by open organisations in seeking to address the challenges associated with offshoring (Rosenbusch et al., 2019; Sariola et al., 2015).

Outsourcing: Is where a business contracts out a process to another party (Lacity and Willcocks, 2000). In practice, it is possible to outsource work but not formally engage in offshoring. Outsourcing was one of the two main components in crowdsourcing identified by Howe in the original coining of the term ‘crowdsourcing’ (Howe, 2006). Crowdsourcing is frequently discussed in the same context as offshoring. Through moving outside the boundaries of the firm in seeking solutions to challenges it represents a pure form of open innovation. Like offshoring, outsourcing is a process guided by strong contractual obligations (Davis et al., 2006).

Commons-based peer production: The earliest known distinction drawn between crowdsourcing and similar domains was presented by comparison against commons-based peer production. Benkler and Nissenbaum, (2006) highlight this component as one that forms part of the modern crowdsourcing process. Commons-based peer production (or social production) represents a new model of socio-economic production. Large numbers of people work cooperatively in less rigid hierarchical structures (usually over the Internet) where financial remuneration is seldom an incentive for participation (Cahalane et al., 2013; Madison, 2014). Linux and SETI are examples of such models (Stol and Fitzgerald, 2014). The community involved in the project are joint stakeholders. Peer production differs from many crowdsourcing initiatives whereby competitions can be used and motivational rewards other than for intrinsic reasons are made available. Also, some crowdsourcing initiatives can have rigid organisational structures in place in the execution of an initiative.

Free/Libre Open source software development (open source): Open source is a contemporary example of collaboration in software development (Osterloh and Rota, 2007). FLOSS has frequently been used in the same contexts as crowdsourcing and finds its origins in the work of Richard Stallman in the 1980s with the foundation of the Free Software Foundation (Von Krogh, 2003). Open source works on the basis of a community working together to develop software where the participants do this mainly for personal reasons such as learning new skills, being part of a community or helping the social good (Campagnolo et al., 2018; Evangelatos et al., 2018). Open-source systems are built on potentially large diverse crowds of different stakeholders with different motives. They are distinguishable by the fact that work is not assigned and there is no explicit system-level design (Mockus et al., 2002).

Inner source: Recently, a subset of FLOSS namely inner source has gained traction (Stol and Fitzgerald, 2014) where inner source is the application of OSS principles to internal projects. Inner source teams can still make broader contributions to external communities such as with the case of organisations that use OpenStack (Sefraoui et al., 2012). Distinctions can be seen between the FLOSS and crowdsourcing in the areas of incentivization and organisational participation where with inner source the overall organisational objectives drive the ecosystem (Stol and Fitzgerald, 2014). With inner source, the organisation play a leading role in driving outcomes as is evidenced in the software development domain (Carroll et al., 2018).

Folksonomies: These group generated collections bear similarity to the features available in many contemporary crowdsourcing systems. Whilst, not every folksonomy is Internet-based, they take the form of collections of media that are either tagged or placed online / upon networks for the purposes of tagging (Hotho et al., 2006). Various factors are evident where (i) rewards, motivational factors and commercial considerations are not to the forefront in such network, (ii) they are not platform-centric and (iii) multiple types of electronic communication channels are used in such systems (Bullard, 2018; Jackson et al., 2018).

Wikis: Wikipedia as an online collaborative service has gained notoriety since its inception and expansion. Howe, (2009) cited wikis as an early example of crowdsourcing. Wikis form part of the social computing domain also occupied by blogs and online communities (Quinn and Bederson, 2011). Wikis allow the community to collectively edit and vet user-generated media and content. The term "*wiki*" is a phrase adopted from Hawaiian slang for quick. Users can add, modify content, link to other information and maintain/edit on an open basis (McFedries, 2006). Wikis are frequently cited as a clear example of crowdsourcing.

Co-creation is focused upon the generation of shared value and is described as bringing "*different parties together (for instance, a company and a group of customers), in order to jointly produce a mutually valued outcome*" (Prahalad and Ramaswamy, 2004). As a concept, it emerged in the 2000s concurrently with other forms of open innovation. Through the process, the customer brings value to the firm through their interactions (Lens, 2014; Neumann, 2014). In turn, this leads to a greater quality of service or product offered (Piller et al., 2012). Both the company and the customer are stakeholders in the process. Both benefit in different ways where some instances of crowdsourcing such as IBM Innovation Jams and Dell Idea Storm show aspects of co-creation. However, not all crowdsourcing initiatives show evidence of co-creation, where by way of example, in software testing an individual can provide the result (Stol and Fitzgerald, 2014).

Participatory development (Nelson and Wright, 1995) and participative development (Hirschheim, 1983) are evident in domains such as software engineering. Participative development is characterised by a high degree of user involvement in the development process but exists as a separate concept from prototyping (Fitzgerald et al., 2002). Not all crowdsourcing involves the development of products or innovative ideas with user involvement. Participatory development is generally conducted for reasons of extrinsic motivations and is not always centred upon a web 2.0 where conventional and electronic communication can be used instead. The variants of open innovation are compared and contrasted in the following table (*Table* 2.2).

Table 2.1 - Variants of open innovation

Variant	Description	Literature
Off Shoring	Involves moving certain aspects of their production or innovation to different countries in an attempt to reduce costs.	Venkatraman, 2004; Glass, 2004; Sariola et al., 2015; Rosenbusch et al., 2019
Outsourcing	A business contracts out a process to another party generally so save costs.	Lacity and Willcocks, 2000; Howe, 2006; Davis et al., 2006
Peer Production	Large numbers of people work cooperatively in less rigid hierarchical structures (usually over the Internet) mostly for intrinsic reasons.	Benkler and Nissenbaum, 2006; Cahalane et al., 2013; Madison, 2012; Stol and Fitzgerald, 2014; Howe, 2006
Open Source (FLOSS)	Community working together to develop software where the participants do this mainly for personal reasons	Osterloh and Rota, 2007; Von Krogh, 2003; Campagnolo et al., 2018; Evangelatos et al., 2018; Mockus et al., 2002
Inner Source	Similar to FLOSS, however, overall organisational objectives drive the ecosystem	Stol and Fitzgerald, 2014; Carroll et al., 2018
Folksonomies	Group generated collections of media that are either tagged or placed online / upon networks for the purposes of tagging	Hotho et al., 2006; Bullard, 2019; Jackson et al., 2018
Wikis	Where community can interact to generate knowledge via collectively editing and vetting user-generated media and content	Quinn and Bederson, 2011; McFedries, 2006; Howe, 2006
Co-creation	The generation of shared value between the initiator and customer	Prahalad and Ramaswamy, 2004; Piller et al., 2010; Lens, 2014; Neumann, 2017
Participatory Development	Like co-creation, it is also used to generate products and services through consumer interaction	Nelson and Wright, 1995; Hirschheim, 1983; Fitzgerald et al., 2002

Some research has sought to draw differences between open innovation and crowdsourcing where it is argued that open innovation predominantly concerns the innovation process. Also, research has argued that collaborators in the project are invariably known to each other and/or are governed by contract/rules (Schenk and Guittard, 2009; Zhao and Zhu, 2014). Some research has sought to combine the two

as separate ideas and concepts (Dolinska, 2018). However, practice examples have shown that this is not exclusively the case in all instances. Evidence exists of crowdsourcing participants also knowing each other and using types of legal agreements within crowdsourcing initiatives. Crowdsourcing as an open innovation concept possesses all of the aspects of open innovation identified (Sub-section 2.4.1). Also, crowdsourcing shares overlaps with the other variants of open innovation (see *Table* 2.2 above). In the next sections (Sub-sections 2.5.1 - 2.5.5) the conceptual foundations and various definitions of crowdsourcing, as a form of open innovation, are explored.

2.5. Crowdsourcing

In this section, crowdsourcing is examined. Crowdsourcing was defined by Howe as representing "*the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call*" (Howe, 2006). Howe presented crowdsourcing as an amalgam of outsourcing (Lacity and Hirschheim, 1993b) and the wisdom of crowds (Surowiecki, 2005). Crowdsourcing like the differing types of open innovation outlined above (*Table* 2.2) involves, for the greater part, short term or limited interactions between individual stakeholders or groups with a challenge. By contrast, Marjanovic et al., (2012, p. 13) states "*it is also interesting to ask whether solution seekers and successful solution providers establish and sustain longer-term repeated relationships?*".

Early variants of crowdsourcing such as micro-tasking, involved engaging crowds of participants, with limited skills, in the execution of simple/repetitive tasks. In recent years crowdsourcing has gained traction whereby numerous companies and organisations have developed bespoke crowdsourcing platforms such as Amazon Mechanical Turk, Mob4hire, uTest, Freelancer, eLance, UpWork, Guru, Topcoder, Trada, 99design, Innocentive, CloudCrowd, and CloudFlower amongst others (Andro, 2018; Doan et al., 2011). Moreover, science has also moved towards the crowd for innovative solutions and funding as is evidenced by projects such as Galaxy Zoo, Zooniverse, SciFundChallenge, Petridish and iCancerUk. Crowdsourcing presents as a means for organisations to obtain value from interactions with crowds (Tucci et al., 2018).

2.5.1. Origins of crowdsourcing

In this section, the origins of crowdsourcing are examined. Although crowdsourcing initiatives can feature many of the aspects of open innovation, several core components form the conceptual foundation of the domain. Concepts include (i) outsourcing, (ii) collective intelligence and (iii) the wisdom of crowds (Howe, 2006; Lacity and Hirschheim, 1993a; Surowiecki, 2005). Outsourcing as a form of open innovation is addressed above (Sub-section 2.4.2). The remainder, namely collective intelligence and the wisdom of crowds are presented hereafter.

Collective Intelligence: Collective intelligence is frequently addressed in the same contexts as crowdsourcing (André et al., 2012; Buecheler et al., 2010). Various definitions of collective intelligence have been advanced where Glenn (2015) defines collective intelligence as:

"consisting three elements namely 1) data/information/knowledge; 2) software/hardware; and 3) experts and others with insight that continually learns from feedback to produce just-in-time knowledge for better decisions than any of these elements acting alone".

In a more broad definition, the MIT Center for Collective Intelligence uses the term "*to describe very broadly groups of individuals doing things collectively that seem intelligent*" (Ellis and Ellis, 2019). The identification of collective intelligence has also been examined through the guise of a framework that focuses upon '*genes*' that go towards the identification of collective intelligence. The assessment is completed through posing questions namely: what is being accomplished, how is it being done, who is performing the task and why are they doing it? (Malone et al., 2011).

Wisdom of Crowds: Suroweicki, (2005), argues that crowds of ordinary individuals are often wise and perform better than expert individuals (wisdom of crowds). Suroweicki, (2005), lists three types of problems suitable for crowdsourcing including; (1) cognition problems, (2) coordination problems and (3) cooperation problems. Whilst these types of problems do match prominent crowdsourcing examples, they are not a comprehensive list of all problem types suitable for crowdsourcing. Varying amounts of cognition, cooperation and coordination are present within the same process and do not stand-alone (Surowiecki, 2005).

The research cites examples from prediction markets ranging from election polls to Oscar predictions. In one particular instance, he discusses a noted British scientist Francis Galton, describing a competition in which contestants guessed the weight of "*a fat ox*" at an agricultural event in England. The ox was measured as weighing 1,198 pounds. Some 787 contestants provided an average guess of 1,197 pounds. Suroweicki further states that a crowd must satisfy three conditions namely diversity, independence and it must bear a "*particular kind of decentralization*".

Research has also sought to distinguish crowdsourcing from the wisdom of crowds based upon the use of web technologies and the non-reliance upon outsourcing (Saxton et al., 2013). Also, there have been criticisms of the concept where Tammet, (2007), has noted the potential for problems in systems which have less well-defined means of pooling knowledge. Subject matter experts can be overruled and even wrongly punished by less knowledgeable persons e.g. (in systems like Wikipedia). From the conceptual perspective, a difference must also be drawn between wisdom of the crowd and soliciting different types of wisdom in the crowd. Landemore and Elster, (2012) addresses the contrasting domain of collective wisdom and notes that it differs where, wisdom of crowds primarily focuses on information markets, polling and voting. By contrast, collective wisdom is reflected in a process of preference aggregation. In the next section contemporary attempts to define crowdsourcing are examined.

2.5.2. Defining crowdsourcing

In this section attempts from research to define crowdsourcing are examined. Despite Howe's initial definition of crowdsourcing advanced in 2006, (see Sub-section 2.5.1) above and a revised definition presented in 2011, no unified definition of '*a crowd*' or '*crowdsourcing*' has been unanimously accepted by research where numerous competing definitions are presented. Much of the definitional challenges with crowdsourcing are also apparent in attempts to distinguish between different types of open innovation (Sub-section 2.4.2) where various pieces of research have considered the differences (Marjanovic et al., 2012; Schenk and Guittard, 2011). To this end crowdsourcing has been called an "*ill-defined term referring to a set of distributed production models*" (Wiggins and Crowston, 2011, p. 1) and "*an umbrella term*" by others (Erickson, Petrick, Trauth, et al., 2012; Geiger, Seedorf, et al., 2011;

Marjanovic et al., 2012). In other examples, it has been defined as a "*trend*" (Anastasiou and Gupta, 2011). Crowdsourcing crosses boundaries with other parts of open innovation (Bonfanti and Brunetti, 2015).

Definitions of crowdsourcing exist that are also specific to certain industries such as software development (Stol and Fitzgerald, 2014). Also, diverse platform definitions exist for engaging a crowd to complete small tasks for a reward such as '*micro-tasking*' sites and '*Witkeys*' (Heer and Bostock, 2010; Kaganer et al., 2013; Kittur et al., 2011; Meier, 2013; Yang et al., 2008). IBM's innovation jam has been described by some authors as an '*ideas contest*' (Ebner et al., 2009) and by others in the context of the crowd (Diasio and Bakici, 2010). Kietzmann, (2017, p. 2) revisited and updated Howe's definition of crowdsourcing to "*the use of IT to outsource any organisational function to a strategically defined population of human and non-human actors in the form of an open call*". This updated the definition of crowdsourcing took a broader focus than the previous examples. However, for the purposes of discussion, the broad definition advanced by Estellés-Arolas and González-Landrón-de-Guevara (2012) attempted to create an all-encompassing, integrated crowdsourcing definition. The widely-used definition advanced by Estelles-Arolas describes crowdsourcing as

"(*c)rowdsourcing is a type of participative online activity in which an individual, an institution, a non-profit organization, or company proposes to a group of individuals of varying knowledge, heterogeneity, and number, via a flexible open call, the voluntary undertaking of a task. The undertaking of the task, of variable complexity and modularity, and in which the crowd should participate bringing their work, money, knowledge and/or experience, always entails mutual benefit. The user will receive the satisfaction of a given type of need, be it economic, social recognition, self-esteem, or the development of individual skills, while the crowdsourcer will obtain and utilize to their advantage what the user has brought to the venture, whose form will depend on the type of activity undertaken*"

(Estellés-Arolas and González-Ladrón-De-Guevara, 2012, p. 197).

For the purposes of examining crowdsourcing, the headings available under this definition are used in the next section (Sub-section 2.5.3). This is due to the breadth of components included. However, this research supports the use of definitional components closer to that of Kietzmann, (2017). He defined 'crowdsourcing' as: "*the use of IT to outsource any organizational function to a strategically defined population of human and non-human actors in the form of an open call.*'' It is suggested in this research that, in the funding agency context, a similar definition can be used, with some minor changes namely: "*outsourcing any public research funding agency task via an open call to a strategically defined population of stakeholders*". This research by contrast rejects the idea that a mandatory IT component is required for the completion of crowdsourcing. It follows from the same definition that the 'crowd', in the context of public research funding agencies, can be defined as: "a diverse group of human or non-human stakeholders who participate in the provision of solutions to public research funding challenges".

2.5.3. Components of crowdsourcing

The definitional components advanced by Estellés-Arolas, (2012) are now discussed:

Participative; crowdsourcing is described in the first instance as participative, where at its minimum, active user participation is a minimum requirement for crowds to function. Brabham, (2013) cited Google Flu Trends as an example of an initiative lacking sufficient interaction to truly be considered crowdsourcing. Research has also examined how to attain sufficient participation (Sharma, 2010). **Online activity;** some debate exists as to whether or not crowdsourcing is an exclusively online activity, where evidence shows that earlier forms of crowd engagement used paper-based systems (Harnad, 1996; Spencer, 2012). Estellés-Arolas, (2012) describes crowdsourcing as an online activity where this component is backed up in other online-only definitions (Saxton et al., 2013). In practice, evidence exists of crowdsourcing initiatives where no Web 2.0 platform is used. Various crowdsourcing activities relating to folksonomies are evident in practice where no Web 2.0 portal is utilised (Hotho et al., 2006). Also, additional evidence is available of GSM platforms being utilised in crowdsourcing initiatives without the presence of Web 2.0 / Online portals (Gupta et al., 2012). Accordingly, crowdsourcing is not necessarily an online activity. **Initiator;** Several different terms are used to describe this actor including

"*crowdsourcer*", "*task initiator*" and "*solution seeker*". Various similar terms such as "*crowd user"* and "*requestor"* are used in other definitions to describe the crowdsourcer/process initiator (Blohm et al., 2013; McKiou and Sankisa, 2011; Vuković, 2009). This revised definition includes several types of process initiator such as individuals, companies etc. Earlier definitions of crowdsourcing, such as that proposed by Howe, (2006) were mostly commercial in focus and did not feature government or third sector stakeholders until later iterations.

Group of individuals; for much of the research it is presented that the crowd is human or composed of individuals. Also, from practice, evidence is presented of team collaboration or a type of "*groupsourcing*" in crowdsourcing initiatives (Jackson et al., 2018; Rokicki et al., 2015; De Vreede et al., 2013) as opposed to crowds of individuals. Several definitions of crowdsourcing have presented the crowd as generally a large group of people, however, other definitions have described the crowd using other distinguishing criteria such as "*human*" (Doan et al., 2011). Some research has theorized that the crowd might in the future be digital with some online platforms for communities using artificially intelligent agents or actors (Kietzmann, 2017).

Knowledge; evidence is presented from the research of solution seekers seeking both skilled participants and participants of limited skills (Staffelbach et al., 2015). Several examples exist of crowdsourcing initiatives only utilising highly skilled or knowledgeable crowd members such as in the software testing domain (Stol and Fitzgerald, 2014). **Heterogeneity;** some crowdsourcing challenges have specifically sought crowds of heterogeneity, as opposed to niche crowds (see for example De Boer et al., 2012), where diversity of skills in the crowd can in some instances lead to novel results (Boudreau et al., 2012). **Number;** none of the definitions has placed an explicit number as to how large or how small a crowd must be. Crowds are presented as "*a group of individuals of varying knowledge heterogeneity and number*", (Estellés-Arolas and González-Ladrón-De-Guevara, 2012). Broad terminology is evident in the description of crowds such as a "*diverse and large network of individuals*" (Stewart et al., 2009), a "*group of people or community*" (Govindaraj et al. 2011), or a "*large and open crowd of people*" (Geiger, Seedorf, et al., 2011). Recent research has also shown that bigger crowds are not always better (Scoles, 2015). In one such test against a simulated crowd, a sample using half the maximum crowd size returned better results

over a larger crowd (Guazzini et al., 2016). It is concluded that crowd sizes can be finite or unrestricted as to size.

Flexible open call; the definition also describes the process of communication with the crowd as vis–à–vis a "*flexible open call*". Although Estellés-Arolas, (2012) does not provide substantial discussion around this point, the research shows varying degrees of flexibility in the openness of calls. Some calls being closed to select groups of individuals with limited flexibility in terms of scope and high definition in terms of the task in need of resolution (Bonazzi et al., 2017; Brabham, 2009; Digout et al., 2013). Evidence exists of restrictions being placed in calls made to crowds for more expert based forms of crowdsourcing such as in the software testing domain (Stol and Fitzgerald, 2014). Wexler, (2011) states that the term open call can be somewhat misleading where "*open*" does not necessarily imply that the broadcast to the crowd is not targeted at a particular demographic or subject to certain restrictions. Wexler, (2011) describes a call process as targeting either "*an undifferentiated mass; or narrow, for instance calling on those who debug computer viruses*". The definition of open cannot be regarded as truly 'open' in nature when all examples of crowdsourcing are taken into account.

Voluntary undertaking of a task: although the vast majority of crowdsourcing solicits voluntary contributions from a crowd, some types of organisation compel crowd engagement as part of their employment. Where internal crowdsourcing (Zuchowski et al., 2016) is used, employees as part of the job description can be assigned to complete crowdsourcing tasks. Accordingly, the question arises as to whether or not they are voluntarily completing the task requested. **Variable complexity and modularity:** contemporary crowdsourcing systems feature the ability to bound problems in different levels of granularity to make tasks more accessible (Hoßfeld et al., 2014). Research has addressed the practice and the means by which the complexity of a task is set (Nakatsu et al., 2014). **Always entails mutual benefit:** evidence is available of crowdsourcers and participants engaging with challenges for a plethora of reasons that are not always extrinsic, such as in the case of helping with disaster relief (Gao et al., 2011; Mazzola and Distefano, 2010). **User will receive the satisfaction of a given type:** the definition also suggests that rewards for participation crowdsourcing need not always be monetary.

Table 2.2 - Issues in defining contemporary crowdsourcing

Definitional issue	Description	References
Participative	The process requires a minimum level of engagement to proceed and be countenanced as crowdsourcing. Some research has also addressed the need for sufficient participation	Brabham; 2013; Sharma, 2010
Online activity	Where research has sought to characterise crowdsourcing as purely online a reflection on the research across domains shows evidence of offline crowdsourcing	Harnad, 1996; Spencer, 2012; Saxton et al., 2013; Hotho et al., 2006; Gupta et al., 2012
Initiator	Evidence shows the actor who starts the process is called by a variety of names which encompasses the same role. For this research the term solution seekers is chosen	Blohm et al., 2013; Govindaraj et al., 2011; Vuković, 2009
Group of individuals	The research has highlighted that along with individuals providing solutions, groups and diverse stakeholders can make contributions. There is even a prospect that artificial intelligence might one day assist crowdsourcing	De Vreede et al., 2013; Jackson et al., 2018; Rokicki et al., 2015; Doan et al., 2011; Kietzmann, 2017
Knowledge	Contemporary examples of crowdsourcing feature the ability to leverage the knowledge of skilled and unskilled crowds in addressing tasks of varying complexity	Staffelbach et al., 2015; Stol and Fitzgerald, 2014
Heterogeneity	Research has examined how diverse crowds containing stakeholders from different domains can provide novel solutions. For various reasons, including political ones, solution seekers seek to increase crowd diversity	Boudreau et al., 2012; De Boer et al., 2012
Number	No clear mandatory or minimum crowd size is defined under research	Stewart et al., 2009; Govindaraj et al. 2011; Geiger et al., 2011; Sumit, 2015; Guazzini et al., 2016
Flexible open call	Most definitions of crowdsourcing address the idea of an open call however examples have been presented of crowdsourcing with narrow and restricted call criteria	Stol and Fitzgerald, 2014; Wexler, 2011; Kietzmann, 2017; Bonazzi et al., 2017; Digout et al., 2013; Whitla, 2009)
Voluntary undertaking of a task	In the vast majority of cases crowdsourcing participation involves a crowd self-selecting to participate. In theory participation might not be truly voluntary if completed as part of employment	Zuchowski et al., 2016
Variable complexity and modularity	More advanced forms of crowdsourcing feature the ability to set the granularity of tasks to best suit the crowd	Hoßfeld et al., 2014
Benefit / satisfaction of a given type	Contemporary crowdsourcing initiatives, unlike micro-tasking and turking challenges, can feature various types of intrinsic and extrinsic incentives and motivational factors / reasons for participation	Gao et al., 2011; Mazzola and Distefano, 2010; Rogstadius et al., 2011; Govindaraj et al., 2011

Practice has influenced the structure of contemporary crowdsourcing processes where there is evidence that the scope of the concept has further evolved (see *Table* 2.2 above). Evolving definitions have been advanced for the concept (Estellés-Arolas and González-Ladrón-De-Guevara, 2012; Saxton et al., 2013). This research posits that from a conceptual perspective, the crowdsourcing process has pre-existed the coining of the term in 2006 (see Section 2.5.1 above). Goldcorp, Threadless and iStockphoto took formation circa 2000 with Innocentive and Topcoder launching in 2001 (Brabham et al., 2013). The initial definition of crowdsourcing advanced by Howe, (2006) focused upon commercial activities of such companies but crowdsourcing concepts subsequently extended to include government and other applications (Brabham, 2009; Wazny, 2017). Subsequently, the definition was extended by Jeff Howe to include other types of organisation outside of pure commercial enterprise.

2.5.4. Crowdsourcing for complex and critical challenges

In this section, the prospective application of crowdsourcing to large or complicated tasks is discussed. Crowdsourcing as a concept has evolved (see *Table* 2.3 below), where more recent evolutions in the crowdsourcing concept have featured the use of bespoke crowds for complex challenges (Chandler et al., 2013). In micro-tasking, problems can be easily defined and readily solved where such problems can be contextualised as "*tame*" problems (Kreuter et al., 2004). Such challenges are evident in widespread low complexity crowdsourcing. By contrast, there is evidence of using the crowd to address more complex or "*wicked problems*" (Mesnard, 2018; Modaresnezhad et al., 2020). The challenge of overcoming complex or wicked problems through crowdsourcing remains a contemporary challenge (Bozzon et al., 2015; Staffelbach et al., 2015). Crowdsourcing approaches allow collective intelligence to be leveraged to solve complex problems when resources or expertise are otherwise lacking (Mergel and Desouza, 2013). In a modern context, it is noted that managing volume and scale remain key challenges in modern crowdsourcing systems (Candido dos Reis et al., 2015; Hillen and Höfle, 2015). In respect of issues concerning time, examples exist of crowds been used to solve urgent or time-dependent challenges (Mazzola and Distefano, 2010). For example, in Haiti and Nepal crowdsourcing systems were used to provide live and real-time mapping solutions in disaster environments where time was a critical factor for rescuers (Gao et al., 2011).

Table 2.3 - Timeline of the use of crowdsourcing

Timeframe	Sectors	Concepts	References
Late 1990's to 2005	-SMEs	The earliest contemporary examples of crowdsourcing processes were predominantly narrow in scope and embraced ideas such as micro-tasking (Kaganer et al., 2013) whereby simple or repetitive work is broken into parcels requiring minimal skill levels on the part of the crowd for completion (Walsh et al., 2014). Examples included Threadless and iStockphoto	Laity and Willcocks, 2000; Surowiecki, 2004; Grossman and Helpman, 2002; Brabham et al., 2013; Kaganer et al., 2013; Walsh et al., 2014
2005 to 2010	-SME's -Corporations -Government	Evidence emerged in the 2000s of new forms of crowdsourcing being used by large corporations as well as SMEs. In addition to micro-tasking, crowds were taking on larger more complex parcels of work as platform technology evolved. Examples include Dell Idea Storm	Howe 2006; Kittur et al, 2008; Brabham, 2008; Yang 2008, Brito, 2008; Leimeister et al, 2009; Whitla, 2009; Vukovic, 2009; Zook et al, 2010
2010 to 2020	-SME's -Corporations -Government -Third Sector -Internal	A major evolution in the crowdsourcing concept has been the move towards using bespoke crowds for complex challenges such as software testing and advanced use types such as gamification (Morschheuser et al., 2016). Evidence shows the use of crowdsourcing processes to address wicked problems such as disaster relief (Gao et al., 2011) or gamified protein folding (Khatib et al., 2010) where the problem space is continually changing	Khatib et al., 2011 Afuah & Tucci, 2012;; Doan et al, 2011; Estelles-Arolas, 2012; Gao et al, 2011; Poetz & Schreier, 2012; Schenk & Guittard, 2011, Chandler et al., 2013; Saxton et al, 2013; Zuchowski et al, 2016; Morschheuser et al., 2016
2020 onwards	-Multi-stakeholder environments and advanced technology platforms	Research posits that in the future that crowdsourcing will be used for advanced scientific challenges and that the crowd might not be entirely human (Kietzmann, 2017). Crowds will be used more to address wicked problems (Mesnard, 2018). Research also suggests crowdsourcing platforms may leverage advanced technologies such as artificial intelligence, machine learning and quantum computing (Dellermann et al., 2018; Kamar et al., 2012; Kulkarni, 2011). Through Web 3.0 crowds are also seen to be used as sensors (Vukovic et al., 2013)	Kietzmann, 2017; Mesnard, 2018; Kamar et al., 2012; Kulkarni, 2011; Dellermann, 2018; Vukovic et al., 2013

2.5.5. Variants of crowdsourcing

This section examines the distinctions between the different variants of crowdsourcing evident from practice. The variants are presented hereafter.

Crowdfunding: Like crowdsourcing, the term crowdfunding is also known by other terms such as 'microfinance' (Riedl, 2013). Many of the reasons for the explosion in crowdfunding came from the previous global recession (Grossman, 2012). Entrepreneurs and communities found it harder to access finance and the lending procedures of banks became much more restricted and time-consuming. To combat these challenges, a number of crowdfunding sites were established such as ArtistShare, Kickstarter and Rockethub (Freedman and Nutting, 2015).

Crowdfunding is described as "*an open call, essentially through the Internet, for the provision of financial resources either in form of donation or in exchange for some form of reward and/or voting rights in order to support initiatives for specific purposes*" (Belleflamme et al., 2010; Kleemann et al., 2008). There are various types including an equity-based model, profit-sharing scheme, lending and outright donations (Belleflamme et al., 2014). In the early evolution of the modern instantiations of crowdsourcing and crowdfunding the two processes were largely viewed as being one in the same process (Belleflamme et al., 2014; Schwienbacher and Larralde, 2012)**.** However, other examples exist in research of purported differences between the two areas where according to Brabham, crowdfunding does not fit the strict definition of crowdsourcing as "*Crowdsourcing is a blend of top-down managed processes and bottom-up processes with the locus of control over production residing with both the organisation and the crowd in a shared give-and-take way* " (Brabham et al., 2013, p. 38).

Citizen science (crowd science): presents as a growing area within the domain of crowdsourcing. It is also referred to as 'crowd science' in certain contexts. Noted examples include citizens participating in the mass classification of celestial anomalies (Madison, 2014), shared processing power for scientific research and biological classifications (Nov et al., 2010). Examples include the search for a cure for M-PVM on Foldit which used crowd technologies to process large amounts of data (Khatib et al., 2010). The Royal Society of Chemistry also ran a competition addressing the

"*Mpemba effect*" and crowdsourced 22,000 submissions to an established scientific problem (Royal Society of Chemistry, 2014).

Crowdvoting: by contrast was one of the initial forms of crowdsourcing identified by Howe, (2006). Crowdvoting leverages the community's judgment to organize, filter and stack-rank content such as newspaper articles, music and movies and is an extremely popular form of crowdsourcing (Araman and Caldentey, 2016; Kirkels and Post, 2013). However, it can be argued that rather than existing as a separate type of crowdsourcing, crowdvoting has become a practice within crowdsourcing and is present in sectors such as crowdfunding or crowd science initiatives. Many crowdsourcing competitions and challenges feature voting facilities. Other platform interaction features can be classified in a similar context such as "*likes*" or "*shares*". Toyota, for example, has used crowdvoting in selecting the names of a new car for production (Stoner et al., 2018).

Micro-tasking: One of the most widely used and earliest forms of crowdsourcing rests in *micro-tasking*. Large scale platforms such as Amazon Mechanical Turk are used to distribute vast numbers of small tasks requiring completion (Ipeirotis et al., 2010). The use of micro-tasking by many large corporations has not gone without controversy. As with offshoring and outsourcing, micro-tasking has been seen as exploitative where workers in developing countries perform masses of small tasks for a small payment (Ross et al., 2010). Mechanical Turk has also become noted as a source of crowdsourced research projects where participants are paid to engage in surveys and related tasks (Chen et al., 2011).

Internal crowdsourcing: represents one of the most recent evolutions in the crowdsourcing domain. Many of the definitions of crowdsourcing advanced have exclusively an external focus and do not account for scenarios whereby internal crowd engagement processes can be used. Despite this fact, many examples exist globally of organisations engaging both internal and external crowds. In certain instances, both internal and external participants engage within the same initiative such as with IBM innovation Jams events (Anthony, 2012; IBM, 2015). In another example of purely internal crowdsourcing, the New York Lord Mayor's office uses an internal platform (Simplicity) for employees to provide ideas (Mergel, 2015). A vast plethora of organisations now use internal crowdsourcing to source solutions to challenges

(Zuchowski et al., 2016). Where existing definitions and frameworks are to be examined phenomena such as internal crowdsourcing do not meet many of the existing crowdsourcing definitions.

Other forms of crowd collaboration: exist such as 'crowdstorming' and 'crowdwriting' whereby a crowd collaborate to brainstorm ideas through a platform or participate in the collective writing of documents online in a crowd process (Burov et al., 2011). However, such categorisations are small, where compared to the larger domains of crowd science and crowdfunding. Estellés-Arolas et al., (2016) highlighted five categories of crowdsourcing types which in addition to the above included crowdcasting, crowd collaboration, crowd support, crowd content, crowd production, crowd searching, crowd analysing and crowd opinion. However, it is posited that these forms of crowdsourcing task dimensions are not strongly evident in practice and are arguably present in many more popular forms of crowdsourcing which are presented in the next chapter.

2.6. Advantages of using crowdsourcing

The purpose of this section is to examine the prospective benefits for an organisation in using crowdsourcing. Benefits are presented in addition to broader advantages of open innovation presented above (see Sub-section 2.4.1). As presented in Chapter 1, (Section 1.2), evidence exists of the public sector using crowdsourcing and other similar open innovation approaches in practice (Brabham, 2012a; Charalabidis et al., 2012; Clark et al., 2019; de Graaf et al., 2017). In light of this, and in considering the above (Section 2.5), this section now presents examples of how crowdsourcing can be of similar benefit to government research funding agencies where crowdsourcing:

- **can produce better results over and above existing processes.** Poetz and Schreier (2012) highlight that crowdsourcing initiatives can outperform professional in-house activities for the generation of new product ideas. Also, the use of crowdsourcing practices has been shown to facilitate both novelty and diversity in terms of participation and solutions obtained (Boudreau et al., 2012; Lakhani, 2006). Research also shows that crowdsourcing and open innovation systems feature the use of practices that facilitate efficient participant interactions (Antikainen et al., 2010; Cavallo and Jain, 2012; Tran-

Thanh et al., 2013; Zheng et al., 2011). Also, crowdsourcing processes can also facilitate the completion of many tasks in parallel through one process rather than a series of fragmented projects (Dow et al., 2012; Lee et al., 2018).

- **can be used to engage and retain new types of stakeholders.** From existing crowdsourcing and open innovation research, evidence shows that stakeholders can produce both novel and innovative results through processes (Ford, 2013; Masters et al., 2015). Crowdsourcing and open innovation processes can be used to retain and foster new types of talent within the ecosystem (Brown and Hagel, 2006; Difallah et al., 2014; Füller et al., 2012; Paroutis and Heracleous, 2013; Wu et al., 2013). Incentivisation strategies can also be used to encourage participants to remain within the ecosystem and participate (Blanchard, 2008; Zhang and Van Der Schaar, 2012).

- **systems can deal with large, complex and time-critical challenges.** Call processes can be scaled to solve challenges that are large complex or time-critical. Leading examples include disaster relief, mapping disaster zones, searches for missing aircraft and complex medical challenges. (Candido dos Reis et al., 2015; Gao et al., 2011; Hillen and Höfle, 2015; Staffelbach et al., 2015; Yang et al., 2014). With the advent of new technologies, managers can harness the compute and scale options available under cloud computing to scale to meet the needs of a challenge (Bernstein, Brandt, et al., 2011; Boimabeau, 2009) or facilitate rapid acquisition (Wu et al., 2013).

- **can facilitate transparency and trust.** Research has shown that there is more likely to be better support for process outputs derived from an open and transparent process (Landis et al., 2012) and that transparency is important (Bertot et al., 2010; Hardaway and Scamell, 2012; Iordanou, 2019). Various levels and types of openness can be required in initiatives where various crowdsourcing practices exist for setting visibility over different stages in challenges (Ågerfalk and Fitzgerald, 2008; Brito, 2011).

- **can facilitate learning.** The open innovation and crowdsourcing literature address the organisational and cultural changes required in moving towards open environments (Herzog, 2008; Martins and Terblanche, 2003; Mortara and

Minshall, 2011). Crowdsourcing and open innovation systems have been used in the active and passive informing of participants in tournaments. Also, evidence is available of crowdsourcing being used for passively educating or training participants (Chesbrough and Spohrer, 2006; Frey et al., 2011; de Graaf et al., 2017; Wu et al., 2013).

- **presents a means to gain publicity for challenges.** Evidence shows that even where processes produce unexpected results advertising and mass publicity can easily be attained through crowd participation (Lane, 2016). From the ecosystem perspective, such approaches improve the prospective retention of crowds within ecosystems (Coday et al., 2005; Difallah et al., 2014).

2.7. Summary

In this chapter, the origins and evolution of the crowdsourcing concept as a form of open innovation was examined. Crowdsourcing components were identified from theory that are considered in the framework selection process completed in the next chapter, (Chapter 3). This research presents crowdsourcing, as offering solutions to challenges similar to those faced by public research funding agencies. Crowdsourcing presents organisations with numerous prospective advantages (see Section 2.6 above). In the next chapter various competing crowdsourcing frameworks and taxonomies are compared and contrasted from research and a framework is selected for use in the study .

Chapter 3. Practices & frameworks

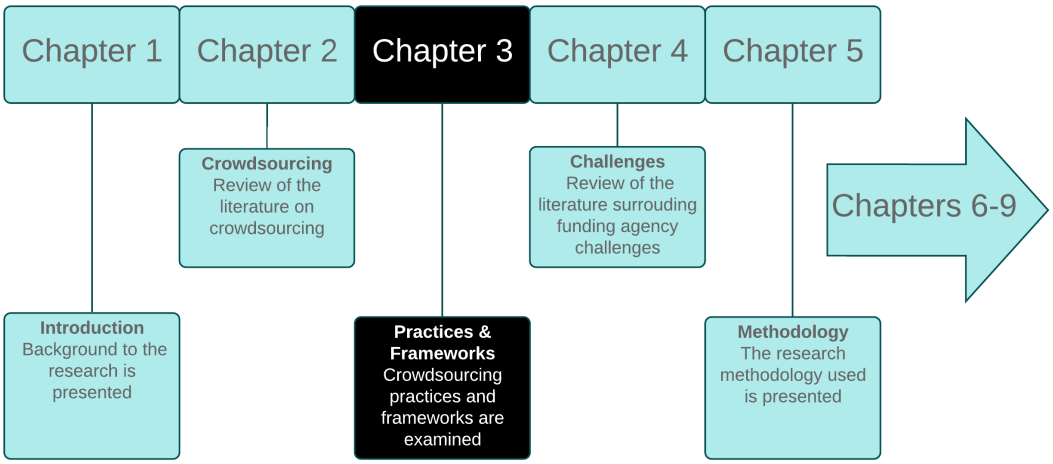


Figure 3.1 - Chapter structure – Chapter 3

3.1. Introduction

The overall purpose of this chapter is to compare, contrast and select a crowdsourcing framework from existing research that will be adapted to contain practices identified from the literature in addressing research objectives RO1.1, RO1.2 and RO2.2. The framework is identified and selected so as to guide funding agency call processes. Practices that form part of the crowdsourcing process are contextualised within the framework. After this introduction (Section 3.1), competing crowdsourcing frameworks are compared/contrasted for the purpose of selecting a framework for adaption (Section 3.2). Second, research is examined to establish evaluation criteria for selecting a crowdsourcing framework for use (Section 3.3). Third, the Marjanovic et al., (2012) framework is examined for its suitability based upon the evaluation criteria (Section 3.4). Fourth, the process of compiling practices is outlined (Section 3.5). Fifth, the framework stages and associated practices are examined (Sections 3.6, 3A - 3I). Last, a chapter summary and preliminary conceptual framework are presented (Section 3.7). This chapter outlines the process of examining and selecting a crowdsourcing framework for adaption prior to the examination of funding agency processes and challenges in Chapter 4 (see *Fig.* 3.1 above).

Research has addressed the need for theoretical reflection in crowdsourcing work (Erickson, 2011; Geiger et al., 2012; Geiger, Rosemann, et al., 2011; Marjanovic et al., 2012; Saxton et al., 2013; Zhao and Zhu, 2014). Various approaches have been used in advancing taxonomies and typologies within the crowdsourcing domain and

advance new frameworks (Estellés-Arolas, 2016; Estellés-Arolas and González-Ladrón-De-Guevara, 2012; Liu, 2017c; Nguyen et al., 2013; Zuchowski et al., 2016).

As outlined in Chapter 2, (Sub-section 2.4.3), a challenge is presented in selecting a crowdsourcing framework for application to funding agency call processes. In particular where existing research has advanced conflicting and confusing definitions of what constitutes crowdsourcing (Estellés-Arolas and González-Ladrón-De-Guevara, 2012; Hetmank, 2013; Majchrzak and Malhotra, 2013). Research has advanced either limited, domain-specific or piecemeal crowdsourcing frameworks (De Boer et al., 2012; Chan et al., 2015; Estellés-Arolas and González-Ladrón-De-Guevara, 2012; Saxton et al., 2013; Sun et al., 2015). Slivkins and Vaughan (2014, p. 4) state that, "*it appears very difficult to capture all of the pertinent aspects of crowdsourcing in a coherent model. As a result, many of the existing theoretical papers on crowdsourcing propose their own new mode*."

Challenges are faced in building frameworks and models, where the selection of an appropriate level of abstraction, which is central to the imparting of strong theory (Whetten, 1989), becomes a difficult exercise. By way of example, whereas motivations (Kaufmann et al., 2011), value propositions and member retention (Torres, 2011) are factors in crowdsourcing, from a theoretical perspective they are not mandatory components for the operation of all types of crowdsourcing. To date, a predominantly practice-oriented approach has led the evolution of crowdsourcing frameworks and in the inclusion of certain crowdsourcing process components. This is evidenced from the variety of different models in use in practice that have been identified from research (Estellés-Arolas, 2016; Geiger et al., 2012; Saxton et al., 2013). This research argues that in synthesis processes, excess components often become part of frameworks/models. A more parsimonious theoretical reflection would dictate that surplus components be disregarded or removed. By way of contrast to the construction of frameworks that are too broad in scope and application, some contemporary crowdsourcing frameworks also serve to unduly limit and constrain the application of crowdsourcing within certain sectors e.g. software engineering, disaster relief or GLAM processes. It follows that new theory is required. In particular where contemporary crowdsourcing processes are required to support complex decision making in organisations where Bonazzi et al., (2017, p. 646) states that crowdsourcing can:

"provide different types of support to the decision making process, especially in the design phase, through idea generation and co-creation, in the choice phase, through voting, as well as in the intelligence phase to explore or exploit information about the issue to be investigated."

In the next section, an overview of competing crowdsourcing frameworks is presented. A list of twenty frameworks are examined. Whilst the list examined does not purport to encompass all frameworks, it is presented with a view to comparing and contrasting core aspects of tasks and practices evident across crowdsourcing research.

3.2. Comparing/contrasting crowdsourcing frameworks

Inconsistencies exist between crowdsourcing frameworks and taxonomies as outlined above. Accordingly, in this section (Section 3.2), competing crowdsourcing frameworks are compared and contrasted for the purpose of selecting a framework for adaption. Attempts to taxonomise crowdsourcing and create frameworks have increased in recent years and are discussed as follows where research has sought to categorise crowdsourcing based upon the types of process used and types of process dimensions. For example, Brabham, (2008) divided the crowdsourcing domain into four predominant "*types"* namely, (1) knowledge discovery and management, (2) broadcast search, (3) peer-vetted creative productions and (4) distributed human intelligence tasking. The basis for such categorisations rests as a general level of abstraction, where distinctions are drawn based on the types of crowdsourcing used in practice. Frameworks relating to specific variants of crowdsourcing do not bear application in the context of this study where the desired outcomes within the process do not relate to the primary mission objectives of funding agencies. For example, a framework advanced by Standing and Standing, (2018) relates to ethical considerations within the crowdsourcing process and while it does bear application in other funding contexts, it does not provide a mechanism by which funding applications can be assessed by crowds. Several contemporary frameworks also seek to discriminate between crowdsourcing processes based upon varying process dimensions (Corney et al., 2010; Doan et al., 2011; Rouse, 2010; Schenk and Guittard, 2011; Vukovic et al., 2010). These frameworks focus on "*dimensions*" for classification purposes. For example, Vuković, (2009) categorises crowdsourcing

based upon a series of interaction between the requestor, business owner, candidate provider, system administrator and providers.

Schenk and Guittard, (2011) subsequently categorised crowdsourcing based upon two dimensions: (1) the nature of the process and (2) the nature of the task. Such distinctions do not offer sufficient boundaries through which new or existing practices can be categorised for crowdsourcing within research funding call processes. At a broad level of abstraction, most crowdsourcing processes can be divided between these two dimensions. However, this classification provides little guidance as to the operational intricacies, tasks or practices required for research funding agency crowdsourcing.

The progression of research shows crowdsourcing has moved from taxonomies/typologies towards frameworks and distinctions based upon concepts such as dependencies, benefits and motivations. For example, Rouse, (2010) presents (1) nature of the task, (2) distribution of benefits and (3) forms of motivation, as core dimensions of crowdsourcing. This categorisation represented a departure from previous categorisations where motivations for participation were examined as in many of the previous frameworks, participation for payment was disregarded.

Also, Corney et al., (2010) addressed similar issues where the research examined the relationships between the (1) nature of the task, (2) nature of the crowd and (3) nature of the payment. The third criteria identified by both Corney et al., (2010) and Rouse, (2010) focused upon new categorisation criteria missing from many earlier investigations of the area. It follows that the type of remuneration or recompense offered in competitions can have a direct effect on outcomes. In initiatives where no recompense is on offer, the third criteria can be substituted by intrinsic reasons for participation such as those highlighted by Rogstadius et al., (2011).

As the crowdsourcing concept expanded in practice and new types of organisations adopted the process, further and more complex frameworks emerged. Geiger et al., (2011) identified four core '*characteristics*' that form part of the process namely the: (1) pre-selection of contributors (qualification-based, context specific or none), (2) accessibility of peer contributions (modify, assess, view), (3) aggregation of contributions (integrative vs. selective) and (4) remuneration for contribution (fixed, success-based, none). This type of categorisation presented a different perspective of

the crowdsourcing process over and above previous attempts. Earlier frameworks were focused on simple tasks for payments where more advanced frameworks featured different perspectives including the type and nature of contributions made. Doan et al., (2011) also expanded the assessment criteria within crowdsourcing and advanced some nine dimensions namely: (1) the nature of collaboration, (2) the type of target problem, (3) how to recruit and retain users, (4) what users can do, (5) how to combine crowd inputs, (6) how to evaluate crowd inputs, (7) degree of manual effort, (8) role of human users and (9) architecture. The categorisations advanced by Doan et al., (2011) differ from other taxonomies where it also encompasses systems design and process implementation. Previous taxonomies had sought to classify based on process user or process outcome. By contrast, Doan et al., (2011) addressed more complex considerations such as user retention and the evaluation of crowd inputs. Subsequent research provided a review of the types of contemporary crowdsourcing in use in practice where Saxton et al., (2013) advanced a list comparing crowdsourcing types. Nakatsu et al., (2014, p. 829) also adopted a different approach by categorising via four quadrants based upon varying degrees of complexity (see *Fig. 3.2* below). The challenge in characterising crowdsourcing is presented by Nakatsu et al., (2014, p. 824) as follows:

"As crowdsourcing becomes more pervasive and takes on so many different meanings, it becomes progressively more difficult to keep track of all the different approaches, much less to discern how individuals and organizations might best choose among them".

	Independent Tasks (Individuals)	**Interdependent Tasks** (Virtual Communities)
Well-structured Tasks (The solution to the problem is well-defined.)	**I. Contractual Hiring** *Low Commitment:* • Human intelligence tasks • Crowdsharing marketplaces *High Commitment:* • Online employment platforms	**II. Distributed Problem-solving (Additive/Pooled Coordination)** *Low Commitment:* • Geo-located data collection • Distributed knowledge gathering • Crowdfunding
Unstructured Tasks (There is no known or well-defined solution to the problem.)	**III. New Idea Generation – Solo** *Low Commitment:* • Consumer-driven innovation *High Commitment:* • Online problem-solving platforms • Contests	**IV. Collaboration (Reciprocal Coordination)** *Low Commitment:* • Real-time idea jams *High Commitment:* • Open source software development • Open source design of hardware • Open content projects

Figure 3.2 - A taxonomy of crowdsourcing based on task characteristics - (Nakatsu, 2014)

Through quadrants, tasks are categorised as [axis 1] (1) well structured, (2) Unstructured versus [axis 2] (3) Independent and (4) Interdependent. Such distinctions provide a different level of classification over some of the earlier taxonomies in the field. Distinctions are drawn based upon a reflection as to the level of complexity and the types of relationships that exist inside the crowdsourcing process. This approach allows their relative interdependencies or differences to be examined. More recent attempts to categorise crowdsourcing in context have reflected upon concepts such as gamification Morschheuser et al., (2016) and game theory in crowdsourcing Estellés-Arolas., (2018).

Last, frameworks for the application of crowdsourcing in the public sector have been also presented, where in recent research Liu et al., (2017c) identified components in facilitating the government in engaging with public crowds namely: (1) purpose (2) crowd (3) motivations (4) process designs and (5) outcomes. From the above categorisations of crowdsourcing presented, evidence exists of the repetition or duplication of process components across frameworks with little by way of evidence provided in the literature as to what constitutes a robust crowdsourcing process. The next section (Section 3.3) addresses this challenge through (i) setting evaluation criteria and (ii) evaluating frameworks through these criteria.

3.3. Framework evaluation criteria

To select a crowdsourcing framework for the purposes of funding agency call processes, it must hold evidence, upon evaluation, of possessing certain core qualities such as (i) strong evidence of theoretical considerations in its construction and (ii) suitability to research funding agency call processes. To this end a classification scheme is synthesised from the research literature through which competing crowdsourcing frameworks can be compared and contrasted. Classification schemes can provide clarity in areas of complexity (Lambert, 2006). Bailey, (1994) identifies ten advantages of a good classification scheme which contain amongst others the opportunity to "*reduce complexity and achieve parsimony, identify similarities among objects and allows a group of objects to be analysed at the exclusion of other, more diverse objects, Identify differences so that dissimilar objects can be separated for analysis*". To this end several criteria are advanced through which competing frameworks are examined.

This research seeks to use good theory to inform a framework selection process. To this end, key aspects of good theory outlined by Whetten, (1989) Sutton, (1995), Weick, (1989) and Dubin, (1978) are used as evaluation criteria which are then applied across the crowdsourcing literature for the purposes of selecting a framework for adaption to contain practices. Where the key components of good theory are presented above and contextualized in other work in decision support systems (Durand et al., 2008), agile software development (Conboy, 2009) and cloud computing (Urquhart, 2009). The following themes as evaluation criteria are identified namely; (i) clarity of composition, (ii) a strong theoretical foundation, (iii) evidence of cumulative tradition, (iv) parsimonious construction and last, (v) the broad applicability of the framework. Accordingly, these components synthesized from the aforementioned literature are used as a guide in the evaluation of competing frameworks. In order to compare and contrast competing frameworks a classification approach entitled "Classification Design Steps" is used (Lambert, 2006). The steps are presented as follows;

- Step 1- State the objectives of the classification: The objectives of the classification are to facilitate the comparing. contrasting and selection of a crowdsourcing framework for use by public research funding agencies from the body of existing frameworks available in research.
- Step 2- Identify the necessary functions and characteristics of the classification: To evaluate competing crowdsourcing frameworks (i) as to the strength of the theoretical considerations underpinning the framework (robustness) and (ii) for their suitability to public research funding agencies.
- Step 3- Select the classification philosophy that delivers the required functions and characteristics: That the framework selected meets with the criteria for good theory as established by Whetten, (1989) Sutton, (1995), Weick, (1989) and Dubin, (1978) and meets the process considerations for public research funding agencies (IPO)
- Step 4- Identify the classification principles that flow from the theoretical basis (i) clarity of composition, (ii) a strong theoretical foundation, (iii) evidence of cumulative tradition, (iv) parsimonious construction and last, (v) the broad applicability of the framework.

- Step 5- Choose a procedure that is consistent with the principles: Each framework/model is compared and contrasted based upon the criteria above. A selection is made that best meets with the criteria under examination.
- Step 6- Decide the rules to operationalise the procedure: The rules regarding the review process are now presented (Sub-sections 3.3.1 – 3.3.5).

3.3.1. Clarity of composition

Nakatsu, (2014) states that a common criticism of crowdsourcing is that it can mean almost anything involving a crowd, or anything generated on the Internet. As presented in Chapter 2, both research and practice posit that various misconceptions exist as to what parts of a crowdsourcing process are mandatory or optional. It follows that a lack of clarity is manifest in numerous crowdsourcing frameworks and taxonomies presented (Kucherbaev et al., 2016). Also, the meaning of the term "*crowdsourcing*" has been confused by the numerous definitions that have been advanced and is subject to a lack of clarity (Mesnard, 2018). Kaganer et al., (2013) notes that crowdsourcing examples such as micro-tasking pre-exist the phrase coined by Howe in 2006. At its origins, crowdsourcing portals were known by a variety of other phrases until crowdsourcing was accepted as the overarching term.

Also, numerous definitions of crowdsourcing use unclear or non-committal terminology in their description. Terms such as "*generally*", "*largely*", "*usually*" and "*typically*" are used in definitions advanced pointing towards a lack of clear boundaries in the components that form part of the process (Howe, 2006; Thuan et al., 2016). Anastasiou and Gupta, (2011) describe crowdsourcing as a "*trend*". Estelles-Arolas and Gonzalez-Ladron-de-Guevara, (2012) note that numerous conflicting definitions that have been put forward for crowdsourcing. By way of further example, Geiger et al., (2011) present one such definition, which shows, signs of transformation from the original definition advanced by Howe in 2006.

Last, as previously discussed in Chapter 2, (Sub-section 2.4.2) it has become harder to distinguish crowdsourcing from other forms of open innovation due to similarities in definitions put forward (Benbya and Van Alstyne, 2011; Liu, 2017c), where Roman, (2009) also makes specific observations with respect to this problem by stating that the term crowdsourcing is often improperly used to describe other types

of open innovation where in the past, many crowdsourcing initiatives have emerged with similar characteristics. Ali-Hassan., (2016, p. 318) describes a similar conceptual problem with crowdsourcing arising from a lack of clarity where the:

"number of emerging crowdsourcing initiatives and the number of tasks the crowd can perform has led to naming conventions and practices that have allowed many studies to mistakenly treat some crowdsourcing sites as noncrowdsourcing practices and vice versa".

It is posited that the framework selected for adaption must be clear in its composition and show no ambiguity in its construction and constituent components.

3.3.2. A strong theoretical foundation

A clear lack of theoretical foundation exists in examples presented on the crowdsourcing concept both in research and practice. According to Whetten, (1989) a good concept or theory should have strong underlying logic and rationale. Houser, (1988) also notes a connection between the use of theory and discipline's academic maturity. To this end, the topic of theory within the development of crowdsourcing frameworks and taxonomies remains an important issue. Evidence is presented from the research that an extension of theory in crowdsourcing is required (Erickson, Petrick and Trauth, 2012). It has also been argued that crowdsourcing literature requires further theoretical maturity before stronger contributions can be made to research in the area (Alam and Campbell, 2013b; Marjanovic et al., 2012; Zhao and Zhu, 2014). Saxton et al., (2013) also argue that the crowdsourcing literature would benefit greatly from taxonomic theory. There have also been calls for specific theoretical reflections on niche-crowdsourcing areas such as motivation, governance and decision-making in crowdsourcing (Alam and Campbell, 2013b; Slivkins and Vaughan, 2014; Zogaj and Bretschneider, 2014).

It follows from calls in the crowdsourcing literature that the framework selected for the purposes of this study must show evidence of strong theoretical foundation in its construction.

3.3.3. Evidence of cumulative tradition

This research seeks to build upon existing frameworks where a significant challenge with contemporary frameworks is the lack of evidence in displaying cumulative tradition in their development. While there is a continuous proliferation of proposed models and frameworks, few are specifically building upon or improving upon each other. One would expect that studies of crowdsourcing would build foundations from bodies of related knowledge such as open innovation (Chesbrough, 2003b), collective intelligence (Malone et al., 2010; Mulgan, 2014), outsourcing (Lacity and Hirschheim, 1993a), human computation (Quinn and Bederson, 2011) and wisdom of crowds (Surowiecki, 2005) where such concepts originated, matured, and have been applied and tested thoroughly over time. However, there is evidence of a lack of cumulative tradition in the formation of the crowdsourcing concept.

Dubin, (1978) states that a good concept or theory should cumulatively build on existing research. It is not clear from the existing body of crowdsourcing knowledge "*which parameters or features matter most when designing new platforms or algorithms*" (Slivkins and Vaughan, 2014, p. 5). Where existing research has not presented itself in a cumulative manner, practitioners must amalgamate independent fragments in an attempt to present a coherent model. Brabham, (2008) for example outlined how crowdsourcing can be explained through a theory of crowd wisdom and an exercise of collective intelligence. Other examples from research advance models without explanation as to the cumulative origins of the nascent process components.

It follows that a framework selected for adaption purposes should show strong evidence of having been subject to cumulative development based from the existing body of crowdsourcing research.

3.3.4. Parsimonious construction

Models and frameworks display evidence of feature duplication and a lack of parsimonious development not only in crowdsourcing but also across the open innovation domain. Parsimony involves removing any factors that provide little additional value to our understanding (Whetten, 1989). Parsimonious construction is an important feature in framework development and the creation of theory (Gregor, 2006). Crowdsourcing models display features borrowed from other types of

processes that are in excess to the underlying theory and as such provide no additional value to the models. Nakatsu, (2014) in forming a framework describes the difficulty caused by feature repetition across frameworks.

Many crowdsourcing taxonomies presented in current research contain feature overlap whereby they present the same constituent components as other taxonomies, thereby rendering one taxonomy indistinguishable from the next as to their utility. Some attempts to categorise crowdsourcing have sought to provide an all-encompassing definition to account for all the variances evident across definitions and taxonomies (Estellés-Arolas and González-Ladrón-De-Guevara, 2012). An analysis of existing crowdsourcing frameworks indicates the presence of feature redundancy and duplication where for example, many frameworks mandate the inclusion of a web 2.0 element or platform (Saxton et al., 2013). By contrast, albeit from a historical perspective, examples exist of crowdsourcing without the use of web 2.0 platforms (cf. McKiou and Sankisa, 2011).

It follows that such requirements are surplus and unnecessary in contemporary crowdsourcing frameworks where a parsimonious reflection would dictate that such components be amended or removed where no value is added.

3.3.5. Broad applicability of the framework

Doan et al., (2011), notes that defining crowdsourcing systems can be surprisingly tricky and in some instances, its definitions can be too restricted. Metcalf (2004) and Weick (1989) notes the range of applications of a concept is a key criterion for judging its quality. Felin et al., (2017, p. 132) has argued for a broader approach to understanding open crowd-type approaches and the underlying theory stating:

"Overall, talk about openness broadly, in the abstract, misses the more fine-grained, analytic nuance that is needed to specify when certain forms or governance structures make sense, and when not—and what an organization should be open to and why".

The limited applicability of existing crowdsourcing frameworks presents a challenge in certain sectors (Grewal-Carr and Bates, 2016). Present crowdsourcing models fall short with evidence in some domains of the narrowing of interpretation

and application of the concept (Behrend et al., 2011; Oliveira et al., 2010; Peng and Ruoyu, 2011). Whereas crowdsourcing is not ideally suited to every type of challenge (Brabham, 2009), by comparison, there is evidence of organisations failing to capture value. For example, such failures can include problems arising from messy unfocused core interactions, too much vertical integration and too little orchestration, too much social waste and a failure to leverage network effects (cf. Van Alstyne et al., 2017). Certain taxonomies are focused upon the categorisation of initiatives based upon one viewpoint alone such as complexity, quality or problem types (Nakatsu et al., 2014) and as such are not suited to all the types of crowdsourcing task or application. Doan et al., (2011, p. 87) in providing categorisations, seek to not limit the model applied by confirming that they "*do not restrict the type of collaboration nor the target problem (and) view CS as a general-purpose problem-solving method*". Heer, (Heer and Bostock, 2010) notes that some studies, particularly those dependent on physical or environmental context, are simply ill-suited to using the web. In this context, we see that the inclusion of certain mandatory criteria within models and frameworks would reduce the applicability of crowdsourcing. Govindaraj, (2011) confirms this point in another context in confirming that contemporary web 2.0 enabled crowdsourcing processes do not access people in emerging markets due to a lack of sufficient mobile Internet access. Also, crowdsourcing models developed for the private sector display limited applicability where applied in charitable contexts. In this regard, where the application of crowdsourcing and crowdfunding to the Zooniverse crowd succeeded in the first instance it failed in the latter case (Lintott, 2014). Constraints can serve to limit the applicability of crowdsourcing where a knowledge entry threshold is too high for participants.

It follows that the framework selected should be unduly prevented from application due to an overly narrow interpretation of the core concepts underlying the framework.

Such challenges serve to motivate the approach adopted in this research of taking an existing robust framework and adapting it to the needs of the agencies. In *Table* 3.1 below, a comparison of crowdsourcing processes and research is completed for the purposes of evaluation. This research argues that even where no model/framework/process presented reaches the threshold of all the evaluation criteria (see Section 3.3 above), some are suitable for use by funding agencies.

Table 3.1 - Comparison of crowdsourcing processes and research

n	Authors	Title	Focus	Components	Applicability	Limitations	Evaluation criteria
1	Oomen & Arroyo (2011)	Crowdsourcing in the Cultural Heritage Domain: Opportunities and Challenges	Tasks	(1) correction/transcription, (2) contextualisation, (3) complementing collections, (4) classifications, (5) co-curation and (6) crowdfunding.	Covers non-for-profit projects and as such is suitable to public applications. Also, the framework encompasses extrinsic motivations which bear similarity to public needs	Classification is limited to GLAM/Heritage organisations, Focuses upon tasks/process outputs. Predominantly focuses on outcomes. Framework is limited to a typology	Builds on existing theory in combining constructs with the Digital Content Lifecycle for application purposes. The framework is grounded in public participation literature
2	Aris, (2107)	Current state of crowdsourcing taxonomy Research: A systematic review	Task, crowd, rewards	(1) crowdsourcer (2) crowd (3) task (4) process (5) content (6) platform (7) theme (8) reward	No guidance as to the stages of the process or overarching tasks is presented. The review does not feature a process framework that can be applied	Broad high-level classification is employed. Provides a review of taxonomic approaches but does not address the types of lower level processes and sub processes pertinent to funding agencies	A comprehensive review was performed to identify the current state of crowdsourcing classification or taxonomy research to date. 23 studies were examined
3	Brussee, Rovers et al, (2013)	Crowdsourcing Classification, costs, benefits, and usage	Tasks	(1) produce something, (2) rate or value something, (3) facilitate: help make something possible, (4) publicise: draw attention by crowdsourcing something.	The classifications cover aspects of the objectives funding agencies are seeking to achieve. Also, the categorisations introduce the idea of cost savings which is relevant to the research focus	Focuses upon process outcomes and cost benefits in assessment. Distinctions do not fully extend to cover all types of crowdsourcing that might be used by the funding agencies	Strong evidence of cumulative development where building on the existing paper and categorisations of Oomen and Arroyo, (2011)
4	Doan et al, (2011)	Crowdsourcing Systems on the World-Wide Web	Tasks, outputs	(1) the nature of collaboration, (2) the type of target problem, (3) how to recruit and retain users, (4) what users can do, (5) how to combine crowd inputs, (6) how to evaluate crowd inputs, (7) degree of manual effort, (8) role of human users and (9) architecture.	In examining what users do and the target problems, the categorisations in the study advance a means by which agencies could evaluate the tasks they are seeking to complete through crowdsourcing. The categorisations also allow for work covering simple to complex tasks	Classification focuses upon system types and both behavioural and structural considerations. However, model does not entirely extend to cover the procedural or sequential nature of tasks/crowd interactions that would be used by funding agencies	The research is novel in adopting a challenges-based approach addressing key areas such as recruitment, combination, management and openness, where concepts are all grounded in leading research examples

n	Authors	Title	Focus	Components	Applicability	Limitations	Evaluation criteria
5	Brabham, (2013)	Using crowdsourcing in Government	Tasks, platform models	(1) knowledge discovery and management, (2) broadcast search, (3) peer-vetted creative productions and (4) distributed human intelligence tasking	The classifications are relevant for RFAs as the apply to a public case scenario. The categorisations are focused upon kinds of problems best suited for crowdsourcing, which is applicable in a funding agency context	Classifications cover broad core areas of crowdsourcing at a high level of abstraction without examining relationships between all types of process components relevant to funding agencies.	The model is comprehensive citing both previous crowdsourcing literature from earlier research and real-world case examples in its construction
6	Marjanovic et al, (2012)	Crowdsourcing based business models: In search of evidence for innovation 2.0	Tasks	(1) input, process, (2) output, (3) outcome, (4) broker organisations, (5) solution seekers, (6) solution providers	Paper contextualises crowdsourcing into a process with stage tasks. Framework encompasses similar innovation stakeholders (companies, government bodies, third sector and research institutions) that are comparable to agencies	Classification explains process stakeholders and process stages without accounting for all different crowdsourcing model types that may apply to funding agencies. Also focuses upon a type of crowdsourcing with financial rewards. Paper presents a clear hierarchical structure of ownership and control, in crowdsourcing	Paper advances a process as theory in response to a theoretical gap. It contextualises crowdsourcing within open innovation domain by comparison to other types of crowdsourcing. The paper is strong in also offering broad applicability through staged construction
7	Vukovic et al., (2010)	Crowdsourcing for Enterprises	Platform models	(1) crowdsourced function (e.g. design, development and testing, marketing and sales) and (2) crowdsourced mode (competition vs. marketplace)	Paper adopts a process, tasks and features based approach which can be applied to similar IPO processes. Also, the framework seeks to categorise on modes and functions rather than by taxonomic approaches	Paper provides a process example only. The distinctions based upon function and mode do not incorporate combinations of both components. Also, the framework is solely an enterprise-based approach and provides more support from practice than literature	Although predominantly practice led, the framework uses leading practice examples in highlighting process features including MTurk, Innocentive, iStockphoto and Threadless
8	Schenk and Guittard, (2011)	Towards a characterization of crowdsourcing practices	Tasks, rewards	(1) cognitive dimension of the tasks – (2) nature of incentives – (3) benefits of crowdsourcing	Framework incorporates a practices-based perspective. Also study covers both commercial and non for profit approaches and advances a definition	Classification sets crowdsourcing as separate from open innovation. Limited analysis applied as to the nature of the crowd or problem types that could apply in a funding agency context. Study limited to taxonomic focus	The study provides a scale of simplicity to creativity in crowdsourcing tasks unlike other studies that have theorised only one or limited types of crowdsourcing such as microtasking

n	Authors	Title	Focus	Components	Applicability	Limitations	Evaluation criteria
10	Nakatsu, (2014)	A taxonomy of crowdsourcing based on task complexity	Task complexity	[A] (1) well structured, (2) unstructured versus [B] (3) independent and (4) interdependent	Seeks to classify based upon characteristics, dimensions and and types. Also advances a classification system by which initiatives can be classified	Research in based upon the perspective of complexity as it relates to task characteristics rather than the process. Also, the framework is based upon an anonymous crowd which may not apply to all funding call processes	The research attempts to build a theoretical foundation by comparison against related areas and incorporates taxonomic approaches in advancing conclusions
11	Geiger et al.,, (2011)	Managing the Crowd: Towards a Taxonomy of Crowdsourcing Processes	Tasks, rewards	(1) pre-selection of contributors (qualification-based, context specific or none), (2) accessibility of peer contributions (modify, assess, view), (3) aggregation of contributions (integrative vs. selective) (4) remuneration for contribution (fixed, success-based, none)	Framework covers a process approach as opposed to mere typologies. Also examines both motivations and dimensions to crowdsourcing	Taxonomy built from examples of specific organizations applying a crowdsourcing approach rather than individual constructs. As such, framework is practice led and may not suit all types of public sector funding call processes	The paper uses the theory surrounding taxonomy development which is well founded. Also, paper cites a broad body of crowdsourcing literature in framework construction
12	Gomes et al, (2012)	Crowdsourcing for Music: Survey and Taxonomy	Outputs	(1) music co-creation, (2) decision support, (3) crowdsourced music collection and management, (4) marketplace, release, and (5) crowdfunding.	The study does cover all aspects of funding agencies' work, however, the components do bear similarity to tasks completed by funding agencies	Classifications are limited to the music industry and do not delve into relationships with other crowdsourcing models and accordingly are hard to apply in a funding agency context	The research approach combines both a survey and taxonomic theory. Work arises from a study of the investigated applications and also from the review of the literature in the field
13	Saxton et al, (2013)	Rules of Crowdsourcing: Models, Issues, and Systems of Control	Platform models	Models; intermediary, citizen media production, collaborative software development, digital goods sales, product design, peer-to-peer social financing model, consumer report model, knowledge base building model, collaborative science project model	The research is sufficiently broad to encompass government or public applications such as funding agencies	Taxonomy focuses upon the various model types rather than a task or motivation centric viewpoint. The study is reliant upon a web 2.0 definition which does not apply to all funding agency cases	The study encapsulated 103 well-known crowdsourcing web sites and deployed content analysis methods. Also, substantial context is offered through comparisons with outsourcing and advanced internet technologies. Last, also the research featured a substantial literature review
14	Allahbakhsh et al, (2013)	Quality Control in Crowdsourcing Systems	Tasks, Worker profiles	(A) workers profile, (2) reputation, (3) expertise (B) task design, (1) definition, (2) user interagency (3) granularity (4) compensation policy	The systems taxonomy incorporates aspects of reputation, expertise and granularity, all relevant to the work of funding agencies	Classification from process procedural perspective. Framework is limited to characterizing various dimensions of quality control in crowdsourcing systems	The taxonomy is based entirely on examples from practice and provides little by way of theoretical guidance from literature

n	Authors	Title	Focus	Components	Applicability	Limitations	Evaluation criteria
15	Erickson et al, (2012)	Hanging with the right crowd: Matching crowdsourcing need to crowd characteristics	Tasks, platform models	(1) ideal crowd knowledge, (2) Desired crowd value, (3) preferred crowd location – marketing/branding, productivity, product service innovation and knowledge capture	Two aspects of the framework including marketing and knowledge capture are of strong relevance to the funding agencies	Framework fails to advance a the process that could be used by funding agencies and has insufficient number of models to cover all types of crowdsourcing. The authors state that additional empirical data and review by researchers are required as the study is early in the domain	The work provides, an organizing framework, categorizing crowdsourced tasks based on organizational need in response to frameworks that were too broad in nature. It adopts a qualitative, interpretivist approach in using grounded theory to build a framework
16	Liu et al, (2017)	Crowdsourcing Designs: A Synthesis of Literatures	Process design	(1) Innovation driven (2) service driven crowdsourcing divided into five core parts namely: crowds, outsourcers, motivation, process design, and outcomes.	The framework envisages public sector applications and also adopts a process-based approach in the application of crowdsourcing which is relevant to funding agencies	Framework by its own admission is based upon a narrow body of literature. Also, the framework does not expressly build from previous frameworks in a manner that could be utilised by funding agencies	The research examined selected crowdsourcing projects classified by service and innovation purpose. In so doing literature relevant to each of the service types was compared and contrasted
17	(Mazzola and Distefano, 2010)	Crowdsourcing and the participation process for problem solving: the case of BP	Closed Crowdsourcing, Open Crowdsourcing	(1) Internal research (2) external research, (3) boundaries of the firm, (4) user solutions	The framework provides little by way of application to funding agency processes with no tasks or stages presented	The framework discussed does not provide explicit stages or tasks that can be readily adopted by research funding call processes	Develops a theoretical grounding for an enriched version of crowdsourcing from literature. Features a literature study into fields related to CS, including OI and OS. Also, a case from practice is examined
18	Felin and Lakhani (2017)	Firms, crowds, and innovation	Strategy, organizations, and innovation	(1) the functions of sociality, (2) the forms of sociality, and (3) the failures of sociality	The study also contextualises crowdsourcing by comparison to similar features from domains close to crowdsourcing, such as crowdfunding	Framework is not exclusively related to crowdsourcing and is anchored to a theory of the firm and sociality. The research is not advanced as a comprehensive catalogue of the varied organizational forms that relate to crowds and innovation Also, no staged process is provided	Research provides a theoretical angle to view crowdsourcing strongly supported by literature in the area of sociality
20	Vianna (2019)	Crowdsourcing Platforms: Objective, Activities and Motivation	Types, Characteristics	(1) Content Development, (2) Development of products and/or services, (3) Crowdfunding, (4) Provision of geographic information, (5)Provision of services, (6) Complex Projects, (7) Information exchange	The study seeks to contextualise the types of activities and motivation factors as a function of the platform's objective which bears similarity to funding agency objectives	Framework also focuses upon products and geographic information which are not current concerns of the funding agencies. Also the analysis is not contingent on process stages	Paper is comprehensive from both the practical and theoretical perspectives in both using a theoretical lens and reviewing 136 platforms

3.4. Selection of the Marjanovic et al., (2012) crowdsourcing framework

The framework of Marjanovic et al., (2012) presents a process framework, meeting many of the above evaluation criteria with the reasons for its selection presented below (see Sub-section 3.4.1 above). In this section, the framework components are compared against existing research and theory presented in Chapter 2, by way of evaluating the framework based upon the criteria presented above (see Section 3.3)

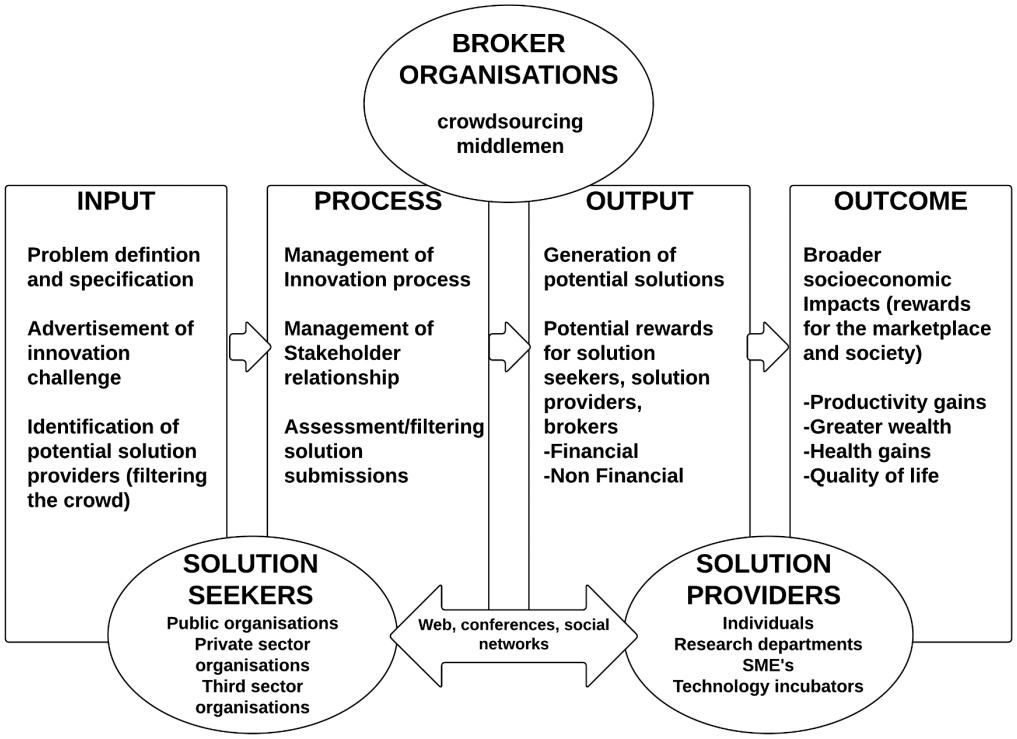


Figure 3.3 - Marjanovic et al., 2012: Stages in the crowdsourcing process and key players

This framework (see *Fig.* 3.3 above) presents a suitable lens from which to examine data for several reasons. First, many existing frameworks do not specify the stakeholders involved, the sequential stages of the processes or both. The framework by contrast address this through the presentation of a three categories of key players and four process stages namely: [key players] (1) Broker Organisations, (2) Solution Seekers, (3) Solution Providers and [stages] (1) Input, (2) Process (3) Output and (4) Outcome. This approach to framework generation views the problem space from the process perspective rather than upon dimensions or problem type (for example see Pedersen et al., 2013).

This approach runs in contrast to many existing examples, which seek to map the crowdsourcing landscape based upon typologies or taxonomies (cf. Ali-Hassan and Allam, 2016; Rouse, 2010; Vuković, 2009; Wiggins and Crowston, 2011).

3.4.1. Evaluation of the Marjanovic et al., (2012) framework

In respect of the evaluation criteria identified above (Section 3.3), the framework is evaluated under the headings identified as follows.

Clarity of composition: although crowdsourcing can be regarded as an umbrella term, the authors contextualise crowdsourcing as a child domain of open innovation (2012, p. 2). Other research has failed to show clarity in this regard, where definitions have over generalised in terms of the core crowdsourcing components (Estellés-Arolas and González-Ladrón-De-Guevara, 2012).

The research draws distinctions between crowdsourcing and other types of open innovation based upon key criteria such as reward and incentives structures, IP, structures of ownership and control as well as examining the types of crowdsourcing (2012, p. 3). Such clarity as to definition and constructs is identified as supportive of a strong theory development process (Dubin, 1978; Metcalfe, 2004; Weick, 1989) which is addressed in the next section.

A strong theoretical foundation: The framework is presented subject to the author's specific call for theoretical investigations, where the framework is based upon a clear and unambiguous presentation of the concepts central to crowdsourcing. The research underlying the framework is based upon observations of the need for theory and the fragmented nature of crowdsourcing literature (Alam and Campbell, 2013a, p. 2). It addresses not only the theory underlying stakeholders involved, but also the process involved. In particular, the authors addressed key theoretical components from the research including; the roles of both seekers and solvers (including the pool of potential solvers used), reward and incentives structures, risks and risk management (Marjanovic et al., 2012, p. 11).

Evidence of cumulative tradition: The framework (see *Fig* 3.3) shows clear evidence of cumulative tradition, having been developed not only from the existing body of open innovation literature (Chesbrough, 2003b) but also from reflection upon

other choice crowdsourcing definitions, taxonomies and frameworks (Brabham, 2008; Geiger, Seedorf, et al., 2011; Lakhani, 2006). The framework components presented (see *Fig.* 3.3 above) show evidence of reflection on existing process components developed in previous research. This research also established process types similar to those identified herein (see Section 3.5) below. The framework does not seek to '*reinvent the wheel'* and draws upon a rigorous body of literature and existing knowledge in its construction.

Parsimonious construction: The authors in building on existing research, sought to remove any factors that provided little additional value to the understanding of crowdsourcing. Whetten, (1989) also discusses how theory where advanced should add additional value to the understanding of a concept. It is evident that surplus or unnecessary components have not been subsumed. Also, the definition of crowdsourcing used and applied to the case studies contained only the core components considered central to the concept including: the pool of people approached to be the problem-solvers, reward/incentive for the problem solver, risk management strategies, role of the seeker in the innovation process and intellectual property rights (2012, p. 7). The framework does not contain features from other crowdsourcing models that are surplus to these core tasks.

Broad applicability of the framework: The research partially addresses the challenge of the range of applications of the concept as addressed by (Metcalfe, 2004; Weick, 1989). Whereas the authors identified that their reflection primarily focused upon crowdsourcing where tasks were completed for monetary reward, the research also addressed the applicability of crowdsourcing models across sectors. Examples included the private, public and not-for-profit sectors (2012, p. 12) as well as across task/types such as knowledge discovery and management and broadcast search (2012, p. 4). The research also shows strong applicability to practice where the constructs identified in the literature are confirmed through application to leading case examples within the research including, Innocentive, Goldcorp, Philoptima and NESTA (2012, pp. 8–11). Last, the work has been citied in numerous other research papers supporting the applicability of the framework in other contexts.

By way of summary, it is presented that the framework:

- is clear in its construction with all the correct process stages and stakeholders represented;
- is widely cited across the literature and is examined in the crowdsourcing context (Ghezzi et al., 2018; Hossain and Kauranen, 2015; Simula and Vuori, 2012; Thuan et al., 2016);
- is well-founded in theory, having been formulated in response to a need for better theory in crowdsourcing processes as identified by the authors;
- shows evidence of cumulative tradition, having been constructed from a reflection on both crowdsourcing practice and with consideration for the originating body of open innovation literature;
- is of parsimonious construction, not containing superfluous features evident in other crowdsourcing frameworks that are not borne solely of a kernel or foundational theory;
- bears a strong degree of applicability to funding agencies, where it envisages application to other sectors and envisages other types of rewards outside of pure commercial focus.

However, the framework selected is faced with specific limitations as discussed in the this chapter (see Section 3.4.4 below). One notable challenge rests in the fact that the framework is not instantiated from the funding agencies perspective. Framework components

The process described by Marjanovic et al., (2012) identifies three categories of stakeholders who interact in the seeking and providing of solutions through a platform. All the key examples of stakeholders present within the contemporary crowdsourcing ecosystem are evident from the framework and also apply to the funding agency context. Accordingly, no adaption is required.

Broker Organisations: or a crowdsourcing intermediary (middleman) is a third-party service provider who facilitates the crowdsourcing process by providing a platform. Crowdsourcing and crowdfunding initiatives worldwide are supported by numerous types of platforms and third-party intermediaries. Although business models of the various broker organisations worldwide differ, there is a substantial similarity evident between the operational models. Contemporary crowdsourcing features

different types of brokers organisations and entities within initiatives (Adams, 2014). Brokers can share information and interact across different platforms within challenges (Zhang et al., 2016). The role of such intermediaries has been examined in specific domains such as software testing (Haas et al., 2014). Further examples of public and private brokers from practice include Amazon Mechanical Turk, Indiegogo, SciFund Challenge, RocketHub, PetriDish, Galaxy Zoo, Zooniverse, Challenge.gov and the Natural Environment Research Council. Such entities exist independent of the requestor/initiator and the crowd and act as a go-between in various capacities. The framework does not exclusively rely upon Internet or information technologies and also lists offline interactions such as conferences and social networks as a means of interaction (Marjanovic et al., 2012).

Solution seekers: perform various tasks including in some instances shaping the scope of the challenge, interacting with the crowdsourcing middlemen and rewarding solution providers. This is commensurate with the works completed by similar roles described in research as outlined in Chapter 2, (Section 2.5.3) where contemporary literature has predominantly addressed the type of solution seekers available or the types of tasks they complete. The entity who starts the crowdsourcing process is addressed by other similar terms such as initiator, requestor and crowdsourcer (Blohm et al., 2013; Estellés-Arolas and González-Ladrón-De-Guevara, 2012; McKiou and Sankisa, 2011; Vuković, 2009). As per the framework, these process initiators are seeking solutions to challenges and can be public, private and third sector organisations. Some call processes facilitate interactions between all three types of solution seekers such as in public patient collaborations in funded healthcare research (Hogg, 2015; Truitt et al., 2018).

Marjanovic lists several types of ***solution providers*** including individuals, research departments, SME's and technology incubators. In the first instance the crowd present as a solution provider. Zhu defines the crowd as "*human*" and notes that the tasks advanced in the process "*are usually hard or even impossible for automatic computer systems*" (Zhu et al., 2012). Despite this fact, there have been significant advances in decision-making systems that one day might lead to artificial intelligence playing a part in crowdsourcing. The use of automation and bots are evident in software testing and wikis (Beschastnikh et al., 2017; Strohmann et al., 2017). There have been significant advances in decision making/assistance systems, which could

lead to artificial intelligence playing a part in crowdsourcing in the future (Kietzmann, 2017). Also, Slavkovik and Fisher (2015, p. 4) address the digital crowd which contains agents that can be represented by *"individual people, organisations, other web-based services, etc*". This division of work between humans and machines has been referred to in some quarters as 'heteromation' (Ekbia and Nardi, 2014). One such example is where robots can make decisions based upon human cooperation with the assistance of crowdsourcing (Ma, 2014). Also, patents exhibit new systems that recommend either human or computer based crowd solutions (Dai, 2015; Dai et al., 2015). In its present definitional context the crowd is a human crowd. Research has also examined the combination of collective and artificial intelligence for decision support in crowdsourcing (Rhyn and Blohm, 2017).

Contemporary versions of crowdsourcing also involve the engagement of other stakeholders including SME's and incubators. Companies such as Intel and Hyve AG use incubators and other forms of crowd engagement in crowd innovation projects (Koch et al., 2011; Mrass et al., 2018). Some stakeholders within the ecosystem can fulfil dual roles as solution seeker and solution provider. For example, Felin et al., (2017), contextualises the crowd and broker in the same instance, where organizations and different types of crowds, (are) essentially a vehicle or mechanism for the extension and amplification of rationality. The relationship between SMEs and crowdsourcing has not only been addressed in research as solution providers, but also as organisations that can leverage benefits from participating (Maiolini and Naggi, 2011; Oliveira et al., 2010; Ramos et al., 2012). It is posited that the present framework facilitates for a similar dual role. In many crowdsourcing frameworks presented the solution seeker has always been described as contacting a crowd external to the organisation. Stol and Fitzgerald, (2014) describe crowdsourcing as engaging "*external people with the requisite specialist knowledge through an open call*". By contrast internal and intra-corporate crowdsourcing are examples of crowdsourcing taking place inside the organisation (Byrén, 2013; Villarroel and Reis, 2010; Zuchowski et al., 2016). A summary of the literature relating to the framework components is presented below (*see Table* 3.2 below).

Table 3.2 - Framework components

Components	Examples	Supporting Literature
Broker Organisations	Amazon Mechanical Turk, Indiegogo, SciFund Challenge, RocketHub, PetriDish, Galaxy Zoo, Zooniverse, Challenge.gov	Leicht et al., 2016; Adams, 2014; Zhang et al., 2016
Solution Seekers	Public, private and third sector organisations along with various combinations of all three categories	Blohm et al., 2013; Estelles-Arolas and Gonzalez-Ladron-de-Guevara, 2012; Govindaraj et al., 2011; Vuković, 2009
Solution Providers	Individuals, research departments, SMEs, incubators, artificial intelligence, teams, internal crowds	Mrass et al., 2018; Maiolini and Naggi, 2011; Oliveira et al., 2010; Ramos et al., 2012; Byrén, 2013; Villarroel and Reis, 2010; Zuchowski et al., 2016
Web, conferences, social networks	Web 2.0 platforms, mobile platforms, innovation jams, wikis, social network interactions	West and O'Mahony, 2008; Fuchs-Kittowski & Faust, 2014; Majchrzak & Malhotra, 2013

In the framework, the ***web, conferences and social networks*** are used for interactions between solution seekers and solution providers. The process is completed by a crowd through a platform or participation architecture. Evidence is available from research of similar interactions facilitated by middlemen, through online and offline platforms (Fuchs-Kittowski and Faust, 2014; Hildebrand et al., 2013; Majchrzak and Malhotra, 2013; West and O'Mahony, 2008).

3.4.2. Process stages

The INPUT *stage* of the process features three main tasks. First, the Input stage of the process involves *Problem Definition and Specification*. The process initiator sets out the problem specification through task design and more specifically the shaping of the details of the challenge to be addressed. Although Marjanovic et al., (2012) discusses this in a general capacity, this research posits that adaption is required for the purposes of the agencies.

Second, Marjanovic et al., (2012) present the task of the *Advertisement of scientific challenge or goal*. This part of the process encompasses advertising the challenge to either a broad generic or specialist crowds. Evidence of new types of advertising practices exists from the literature which can be adapted into the framework to address these challenges.

The third task outlined in the input stage addresses the *Identification of potential solution providers*. The process also describes this process as *(filtering the crowd)*. From the two case studies presented (see Chapter 7) the research identifies initiatives that either communicate with a broad undifferentiated crowd or specialist bespoke skill sets. In this regard, the framework is adapted to encompass the specific practices that are used in this process of shaping the crowd to match the needs of the challenge.

At the PROCESS stage, Marjanovic et al., (2012) identify three core categories of tasks completed in the process. First, the research describes the task of the *Management of the Innovation process* where the traditional innovation process is managed by internal management or with the use of specialist external consultants. However, the move towards different management approaches in open innovation is contextualised within the framework later in Chapter 6

Second, this stage also encompasses the task of the *Management of stakeholder relationship*. The management of stakeholder relationships central to the crowdsourcing process and becomes more complex depending on the number and type of stakeholders added to the process over and above a generic crowd. The framework is adapted to encompass practices that are used to regulate stakeholder relationships.

A core activity in most crowdsourcing initiatives is how crowds complete the tasks of filtering and assessing submissions. Third, Marjanovic et al., (2012) describe the process of the *Assessment/filtering solution submissions* at a high level of abstraction**.** Crowdsourcing initiatives use a range of practices in facilitating crowds in sorting through submissions received over and above those identified from the cases. The framework is adapted to include contemporary filtering practices.

The OUTPUT stage of the process involves two tasks. First, the task of *the Generation of 'potential' solutions* is described. This task differs from the previous stage of filtering whereby the submissions are amalgamated or sorted into a result. This task features the generation or selection of solutions by the crowd and features a range of practices. The framework is subsequently adapted to include contemporary practices used by the crowd in selecting solutions.

Second, *Potential rewards for solution seekers, solution providers, brokers* are presented. Marjanovic et al, (2012) have identified both financial and non-financial rewards as been pertinent to crowdsourcing initiatives at the output stage of the process. Substantial evidence exists from practice of initiatives both using different types of motivations for participation as well as utilising rewards at different stages of the process. The framework is adapted to reflect the use of these practices in crafting rewards to maximise participation.

Last, at the OUTCOME stage of the process, Marjanovic et al., (2012) present *Broader socioeconomic Impacts* "*(rewards for the marketplace and society) (such as) productivity gains, greater wealth, health gains and quality of life*". The strategic objectives of funding agencies and the investment of governments in scientific research overlap explicitly with these objectives.

3.4.3. Limitations of the framework

In seeking to apply the framework to funding agency processes, the framework identified is not without limitations. Several competing frameworks such as those of Mazzola and Distefano, (2010) and Geiger et al., (2011) bear potential applicability to the funding agency call processes. Apart from not holding an (IPO) format very limited factors separate these two framework from applicability. Accordingly, this limitation may be addressed in future research. In the first instance, the framework is primarily focused on commercial innovation. Also, the framework primarily deals with the broadcast search aspect of crowdsourcing, one type out of several prospective types that could be utilised. This creates some prospective limitations in the application of the framework in its present format. Also, some time has passed since the framework was first advanced in 2012 and several recent evolutions in the crowdsourcing concept need to be accounted for in the adapted framework where

practical problems are faced in platform and crowd construction that underpin communities. The framework does not provide guidance on certain contemporary problems.

Examples include choosing who starts the process, deciding upon who gets to join the crowd, finding an appropriately skilled crowd, setting rewards for participation and finding out what parts of the crowdsourcing process to measure, such as are evidence in other studies (Bozzon, 2014; Chawla et al., 2019; Kosinski et al., 2012; Vuković, 2009). Other types of challenges include obtaining a sufficient level of crowd diversity, growing and retaining crowd membership, crowd communication and decision making, dividing up tasks (disaggregation) and strategic crowd performance evaluation (Mladenow et al., 2014; Prpić and Shukla, 2014; Schlagwein and Bjorn-Andersen, 2014; Yuen et al., 2011).

The framework is primarily concerned with challenges where "*financial incentives*" are on offer. This does not cover every type of agency engagement where some tasks can be completed for both intrinsic and extrinsic motives. The non-financial element is partly acknowledged in the research at the OUTPUT stage of the framework. However, the scope of the underlying research remains largely focused on financially rewarded innovation challenges. From the funding agency perspective, other types of crowdsourcing highlighted by Brabham, (2010) such as "*distributed human intelligence*" and "*knowledge discovery and management'*" also bear consideration for agencies. The framework where adapted for agencies requires an extension to cover such related practices.

The process OUTPUT stage in its present format does not feature return iterations or process learnings to the INPUT and PROCESS stages. Such cycles are evident in methodologies such as agile software development (Highsmith, 2002) and design science research (Hevner et al., 2004; Peffers et al., 2007) where only limited evidence is available, by contrast, in crowdsourcing and crowdfunding research of iterative process development and refinement (cf. Balamurugan et al., 2014).

The framework presented does not, in its present format, account for practices for accessing internal and external crowds. Such practices are evident in other research addressing internal crowdsourcing (Byrén, 2013; Villarroel and Reis, 2010; Zuchowski et al., 2016). Based on this research, crowd membership can be sourced

from both inside the agency and outside the four walls of the organisation where the platform upon which the framework operates. This presents a means of interaction between the crowd and stakeholders at the process stages. Crowdsourcing platforms shape how contributors generate contributions and how they interact with other contributors and contributions (Blohm et al., 2013). The framework components identified by Marjanovic et al, (2012) are compared against the present body of crowdsourcing literature in the subsequent sections hereafter (Sections 3.5 and 3.6).

By way of summary it can be concluded that the framework is potentially limited for agency use by:

- a commercial focus;
- holding focus on broadcast search (one type of crowdsourcing);
- failing to encompass contemporary crowdsourcing practices that have arisen;
- not providing iterative stages or feedback loops;
- failing to integrate both internal and external crowds;
- not encompassing the voice of the citizen, laypersons, diverse stakeholders;
- providing a platform for harnessing both online and offline contributions.

3.5. Compiling practices within the framework

Rather than adopting an approach based upon dimensions or tasks to the framework adaption process (see Section 3.2 above), this research utilises an approach based upon practices. Within this research, the framework of Marjanovic et al., (2012) is now used for the purposes of compiling crowdsourcing practices under the nine framework tasks identified (see Section 3.6, 3A - 3I below). Felin et al., (2017) states that the various crowd-type practices, when appropriately designed, might help firms move data to information and eventually wisdom. Noveck (2009, p. 19) states that to "*enable collaboration at scale requires designing the practices to make participation manageable and useful and then enabling those practices by means of technology*".

This research adopts a similar perspective in examining funding agencies. Research has addressed the use practices in different contexts where amongst examples the domain has looked at (i) best practices, (ii) requirements engineering practices, (iii) organisational practices and (iv) implementational practices in different contexts (Dubé and Paré, 2003; El Emam and Madhavji, 1995; Kalev et al., 2006;

Mansor et al., 2018; Shepherd, 2018; Thorén et al., 2014; Watson et al., 1991). Practices represent real-world instantiations of knowledge to facilitate or guide practitioners in their works where Schatzki, (2012) who published leading works in the domain of 'practice theory' contextualised practices as "*orchestrated arrangements in particular cultural-discursive, material-economic and socio political arrangements*". Schatzki further states that practices crystalize where "*the sayings doings and relating that hang together in a project that gives the practice meaning and coherence*" (Schatzki, 2012; Schatzki et al., 2005).

Kemmis et al., (2013) states that clusters of arrangements preconfigure the social world for those who come to inhabit a practice of a kind. Research has also addressed other types of practices that relate to the operation of research where by way of example Dubé and Paré, (2003) addressed the use of practices in information systems research including research method practices. Other examples of practices in research are presented by Mays and Pope, (1995), who identify a number of practices that journals could explore to address space constraints. From research, categories of practices are identified below (Section 3.6) and examples are presented from the literature.

3.6. The preliminary conceptual framework

In the following sections, (Sections 3.6, 3A – 3I) the tasks identified under the crowdsourcing framework of Marjanovic et al., (2012) are examined and the associated crowdsourcing practices are compiled within the framework in-line with the tasks contained therein.

In section 3A, practices for problem definition and specification are discussed where the problem at the root of the call process is defined. In Section 3B practices for advertising the innovation challenge are presented whereby the challenge in need of resolution is advertised to the crowd. In Section 3C practices used for identifying solution providers are presented whereby crowds are selected on prerequisite criteria such as skill, location etc. In Section 3D practices used for the management of the innovation process are presented where solution seekers manage aspects of the process. In Section 3E practices used for managing the stakeholder relationships are presented where solution seekers manage the involvement and interactions of

participants. In Section 3F practices for filtering solutions received in the process are presented where the crowd categorise the submissions received. In Section 3G practices for generating solutions are outlined where the crowd select a winning or best solution/s. In Section 3H the potential rewards are presented where the crowd are rewarded for participating. Last, in Section 3I the broader socio-economic impacts are examined where practices for evaluating the impacts of crowdsourcing are presented.

3A. Problem definition and specification

Practices associated with the task of problem definition and specification are evident throughout the crowdsourcing literature (Brabham, 2013; Marjanovic et al., 2012). This task can be categorised into practices for; (i) restricting submissions (Section 3A-I), (ii) scoping problems (Section 3A-II) and (iii) selecting problems (Section 3A-III). In traditional crowdsourcing, the solution seeker plays a leading role in selecting and defining the problems in need of resolution (Brabham, 2013). Brabham states that in this scenario, the role of the crowd is to complete simple tasks (Brabham et al., 2013, p. 9). This stands in contrast to newer forms of crowdsourcing where the crowd plays a significant role in defining problems such as with IBM innovation Jams and Dell idea storms (Bayus, 2013). In these instances, complex tasks are broken up into easier sub-tasks for completion (Mehta, 2014). In the next sections (Sections A-I – A-III) three categories of practices identified from the literature are outlined and a summary is presented (see *Table* 3.3 below).

3A - I. Restricting submissions

The literature presents examples of solution seekers limiting or restricting the types of submissions that can be made by the crowd so as to provide better quality results (Deng et al., 2016). This practice is distinct from scoping the problem (Section 3A-II), where submissions are refined and categorized ex-post. This practice of restricting submissions is identifiable from similar types of practices described in the literature (Finnerty et al., 2013; Kittur et al., 2008b; Schenk and Guittard, 2011). Ghezzi et al., (2012) states in citing (Siegler et al. 2010) that in restricting or limiting the solution space, that the problem statement should be general enough to avoid any partiality towards a particular solution path. The literature addresses the restricting of the types or extent of submissions the crowd can make where the scope of inputs that can be provided is set or restricted from the start of the process.

One example of a restriction is described by Brabham, (2013, p. 9) who states that in crowdsourcing "*often the only permissible input is a simple rating or vote*". Evidence of a similar general practice of 'defensive design', is evident in research (Chen et al., 2011). This practice of restricting inputs or submission types stands juxtaposed to certain crowdsourcing processes such as those that feature free text input options (c.f. Papoutsaki et al., 2011). Through using this practice, solution seekers attempt to reduce the potential complexity arising from receiving a vast number of varied inputs from the crowd.

3A - II. Scoping problems

Practices are available by which the nature and extent of the problem in need of resolution can be defined, namely the practice of scoping problems. This category of practice is addressed in the literature with some discussion of scoping problems (Allahbakhsh et al., 2013; Kittur et al., 2011; Pedersen et al., 2013). The practice of scoping is also referred to by different names with Malhotra et al., (2017) describing the practice as "*framing*". This practice can be completed by the solution seeker and/or the crowd. There is evidence in the literature of practices used by solution seekers to set the scope of a challenge in need of resolution where Allahbakhsh et al., (2013) identifies two separate functions completed by crowds at this stage namely: a) task definition, the information the requester gives potential workers regarding the crowdsourced task and b) task design, which is a model under which the requester describes his or her task. Such practices are suited to addressing complex challenges where technology enabled capabilities can also be used to address complex problems (Pedersen et al., 2013).

Adar describes disaggregation as "*breaking up the task into something that is both rewarding, doable, and that the activity produces some kind of interesting and/or useful product*" (Adar, 2011). Zhao and Zhu (2012) also point out that "*task granularity positively moderates the relationship between external motivation and participation effort*". Either the entire crowd or parts, can form part of an incremental or radical problem specification process (Majchrzak and Malhotra, 2013). This type of practice is particularly evident in the case of disaster scenarios where the crowd's response to fluid or evolving problems (Goodchild and Glennon, 2010; Heinzelman and Waters, 2010; Yang et al., 2014).

3A - III. Selecting problems

The literature shows that crowds require a means by which a decision can be reached as to the problem or definition of the problem to be resolved by the challenge. Simple examples of the practice of Selecting problems include majority voting or random selection (Brabham et al., 2013; Cheng et al., 2013; Karger et al., 2011; Long et al., 2013; Vuurens et al., 2011). Strong support for this practice is evident in the literature. Voting systems can incorporate the use of scales to give the solution seeker a more refined picture of the crowd's preference (Luon et al., 2011; Mehta, 2014). More complex examples of the practice include weighted voting, expert selection and iterative selection (Ho et al., 2013; Hsueh et al., 2009; Tang and Lease, 2011; Zhang et al., 2015). These methods of decision making are evident in more advanced crowdsourcing systems designed to address complexity such as those used in: complex coding, regression and acceptance testing, and detail design documents etc. (Mehta, 2014). In such systems, crowds can provide more complex text, visual or audio submissions such as commenting, coding, testing and designs (Hoßfeld et al., 2011; Soleymani and Larson, 2010). In the next section (Section 3B), practices that relate to the advertisement of the innovation challenge are discussed.

Table 3.3 - Summary of practices for problem definition and specification

Stage	Task	Practices	Description
INPUT	**Problem definition and specification** **Section 3A**	**Restricting submissions** **3A-I**	Practices for limiting or restricting the types of submissions that can be made by the crowd
		Scoping problems **3A-II**	Practices through which the nature and extent of the problem in need of resolution can be defined
		Selecting problems **3A-III**	Practices through which a decision can be reached as to the problem or definition of the problem to be resolved

3B. Advertisement of innovation challenge

A practice associated with the task of the advertisement of the innovation challenge namely targeting participants is identified (Section B-I). Research has discussed strategic considerations in asking the crowds for solutions to challenges. Aten et al., (2016) argues that the intersection of strategy, communication, and technology is largely understudied in the business communication literature and deserves more

attention. To this end, how the crowd are informed of the challenge presents as an important consideration for call process managers. This task can be categorised into the practice of targeting participant categories. In the next section (section 3B-I) the practice is outlined and a summary is presented (see *Table* 3.4 below).

3B - I. Targeting participants

Evidence exists across the crowdsourcing literature of the practice of targeting participants with specific advertising. To this end, solution seekers target specific types of desired participants**.** Challenges are faced in advertising new crowdsourcing systems with motivations other than pay (Bernstein, Hartmann, et al., 2011). To benefit from crowdsourcing, solution seekers need to reach crowds that are appropriate for the task at hand. Earliest examples of crowdsourcing used the process of contacting a broad unknown crowd. However, within this task, numerous practices are evident from the research of contacting crowds by using different types of advertising. As presented in Chapter 1, (Section 1.3), an '*open call*' is a term used to describe the means of broadcast or advertisement to the crowd. The term can be somewhat misleading where the term "*open"* does not necessarily imply that the broadcast to the crowd is not targeted at a demographic, skill or subject to certain restrictions.

For example, Wexler, (2011) describes a call process as targeting either "*an undifferentiated mass; or narrow, for instance calling on those who debug computer viruses*". For example, in micro tasks placed upon Mechanical Turk, crowdsourcing contests can be restricted to "*Turkers*" of a demographic such as nationality or skill-set in the initial call or task description. Such calls are not truly 'open' in nature whereby restrictions are in place as to who can participate (Horton and Chilton, 2010). Contemporary crowdsourcing practice can inform public research funding agency call processes where different types of advertising can be used to engage potential solution providers. A specific example is the initial advertising of crowdsourcing initiatives to various age groups or people of specific socio-economic backgrounds. Also, the distance of the crowd from the problem can be an important factor. Jeppesen and Lakhani, (2010), found that problem solvers who were further away from the field from which the problem came were more likely to solve the problem. In the next sections (Sections 3CI – 3C-II) practices for the Identification of potential solution providers (filtering the crowd) are outlined.

Table 3.4 - Summary of practice for advertisement of innovation challenge

Stage	Task	Practices	Description
INPUT	**Advertisement of innovation challenge** **Section 3B**	**Targeting participants** **3B-I**	Practice for advertising the challenge to participants of a desired category

3C. Identification of potential solution providers (filtering the crowd)

Practices associated with the task of the identification of potential solution providers (filtering crowds) are evident throughout the crowdsourcing literature This task can be categorised into practices for: (i) identifying participants (Section 3C-I) and (ii) facilitating self-selection (Section 3C-II). One of the core aspects of many crowdsourcing systems is the desire to connect the correct solution seekers with the correct solution providers (Erickson, Petrick, Trauth, et al., 2012). This task stands apart from targeting participant categories (Section 3B-I). By contrast, in this instance, the call process managers must assign crowds based upon data obtained about crowd members. In the next sections (Sections 3C-I, 3C-II) two categories of practices identified from the literature are outlined and a summary is presented (see *Table* 3.5 below).

3C - I. Identifying participant categories

Crowdsourcing research addresses the practice of the identification of potential solution providers (filtering the crowd). From research, there is evidence of the use of various practices for filtering crowds with attributes necessary to solve a challenge. Crowds can be picked according to various demographic considerations (age, nationality, gender), skill criteria or randomly based upon no prerequisite criteria (Zheng et al., 2011). By way of example, in Amazon Mechanical Turk, users have the option of selecting specific criteria as to their desired crowd such as skill or country of location (Chen et al., 2011). Accordingly, in all examples of crowd engagement, the first stage in the process incorporates the process of the specification of the crowd. Practices for filtering the crowd.

For crowdsourcing software testing portals specific members of the crowd can be chosen based upon certain criteria such as knowledge of programming languages. Yet at the other extremity of the process, a general unbounded crowd of menial or inexpert skillsets can be called upon for the completion of low-intensity tasks, such as

in the case of micro-tasking (Shaw et al., 2011; Walsh et al., 2014). Schenk, (2011) states that "*a crowd can be defined as a large set of anonymous individuals*". In some initiatives, crowd participants are clearly identifiable either through their admin level or rankings if not by personal details. By way of example, to participate in Dell IdeaStorm, individuals joined the IdeaStorm community (at no cost) by selecting a username (Bayus, 2013; Dong and Wu, 2015). User reputation can facilitate the identification of quality of users where Adler, (2011) states that the "*reputation of users is computed according to the quality and quantity of contributions they make*". In third party websites such as uTest members of the crowd have profiles or avatars that identify personal ratings. By contrast, in many crowdsourcing platforms, the crowd remain completely unknown and anonymous (c.f. Varshney, 2012). Examples also exist of crowdsourcing initiatives where members of the crowd openly identify themselves in support of a particular business, charitable or philanthropic cause (Brown and Mawson, 2015).

3C - II. Facilitating self-selection

Apart from literature identifying the practice, limited discussion exists of the implications arising from the use of this practice. The practice of facilitating self-selection has long been evident in crowdsourcing research (Afuah and Tucci, 2012; Piller and Walcher, 2006).

Table 3.5 - Summary of practices for identification of potential solution providers

Stage	Task	Practices	Description
INPUT	**Identification of potential solution providers (filtering the crowd)** **Section 3C**	**Identifying participants** **3C-I**	Practices for filtering crowds with attributes necessary to solve a challenge
		Facilitating self-selection **3C-II**	Practices through which the crowd can self-select or choose problems they wish to solve

Some definitions of crowdsourcing identify this practice as a mandatory element in the definition of crowdsourcing. Some research has suggested that the practice is intrinsically linked to incentives (Barnes et al., 2015). Competence-based pre-selection is evident in aspects of crowdsourcing such as micro-tasking (Gadiraju et al., 2017).

Although, by contrast, some research has argued the self-selection aspect of crowdsourcing is not important in the overall concept (cf. Buettner, 2015). It is also argued, that non-expert yet self-selected crowds, where trained, are as reliable and accurate as trained researchers (Conley and Tosti-Kharas, 2014). Another related consideration in this practice is that low-quality users self-select to drop out of crowdsourcing initiatives (Ipeirotis and Gabrilovich, 2014). Whilst, in theory, this might not be possible where participants compete as part of their employment, such as with internal crowdsourcing, it is evident across disciplines that many crowd participants can freely choose to reject challenges as well as compete (Roy et al., 2013; Slivkins and Vaughan, 2014). In the next section (Section 3D), practices for the management of the innovation process are examined.

3D. Management of innovation process

Practices associated with the task of managing the innovation process are evident in the literature. This task can be categorised into practices for: (i) managing risk (Section 3D-I), (ii) training (Section 3D-II) and (iii) creating a feedback loop (Section 3D-III). Managing the crowdsourcing process and platform presents a complex task with both call process managers and the crowd managing various aspects of the process (Blohm et al., 2018). In the next Sections (3D-I – 3D-III) the practices are outlined and a summary is also presented (see *Table* 3.6 below).

3D - I. Managing risk

Evidence is available from research that organisations are engaging in practice of managing risk as it relates to crowdsourcing. Risk in itself can be a reason to crowdsource where Marjanovic et al., (2012) states that firms can crowdsource where the prospect of addressing the challenge in-house is perceived to be too high-risk. Risk is an important consideration in crowdsourcing (Rouse, 2010; Thuan et al., 2016).

Although crowdsourcing presents an organization with potential negative risks, the process can also provide innovative upside risk. Schenk and Guittard (2009) highlight that "*the firm that uses Crowdsourcing faces risks of unlearning and brain drain. But Crowdsourcing also generates a competitive risk to the client firm*". Hammom and Hippner, (2012) compare the associated positive and negative risks associated with crowdsourcing covering areas relating to managing costs, control, know-how and legal requirements. Increasingly, risk management is apparent within

information systems governance research. Also, crowdsourcing systems bring with their presence increased risk to the organization. Some evidence has been presented from research to examine risk as it relates to the crowdsourcing process from the business perspective (Kamoun et al., 2015; Nirosh Kannangara and Uguccioni, 2013).

3D - II. Training

With increased complexity in crowdsourcing systems, new forms of management are evident within initiatives. A large body of evidence surrounds the practice of training participants where crowdsourcing presents as a new process model requiring new forms of management to facilitate innovation. Evidence is presented from the research of crowdsourcing participants receiving training to better execute tasks within crowds (Gadiraju et al., 2015). Malhotra et al., (2017) highlights that in guiding participants in the process collaboration can be promoted over contention. Training forms an important part of obtaining success in call processes where Carvalho et al., (2011) observes that the quality of worker judgments in crowdsourcing is supplemented by "*an initial training period and subsequent sporadic insertion of predefined gold standard data*." Also, more broadly, in open innovation training as a requirement has been addressed in research (Abulrub and Lee, 2012). The attitudes of management to open innovation has been shown as important (Burcharth et al., 2014).

Also, crowdsourcing can be used in training participants. Crowdsourcing seeks to engage as diverse a group of stakeholders as is possible in facilitating processes where one major obstacle comes in the form of facilitating process learning. Self-selected crowds, after training, are as reliable and accurate as trained researchers (Conley and Tosti-Kharas, 2014). Accordingly, firms are investing in providing training for management and participants (Doroudi et al., 2016; Gadiraju et al., 2015).

3D - III. Creating a feedback loop

There is some limited discussion in the research of process designers creating a feedback loop where Marjanovic et al, (2012, p. 7) states that as crowdsourcing evolves, there can be feedback to the input stage, in terms of the revision. Some evidence exists from research that iterative practices are used within certain crowdsourcing initiatives. Contemporary crowdsourcing, like other aspects of information systems research, shows evidence of the use of new processes in the

generation of solutions. Crowdsourcing research has called for the presence of feedback loops for informing participants (Hammon and Hippner, 2012). In information systems research, hardening sprints are commonplace in agile software development and aim to facilitate the generation of optimal solutions (Fitzgerald et al., 2013). In similar crowdsourcing based examples, Park et al., (2013) discuss large scale cooperative design and reflects upon the iterative nature of the design process. This research describes evidence of increasing maturity over process stages and gradual refinement leading towards the potential solution stage.

The concept of the use of iterations or fixed cycles has also been addressed in the crowdsourcing literature with examples of this presented (Little, 2009; Little et al., 2010). The decision to freeze or iterate a tournament cycle is also evident in other domains such as software development and supply chain management since the 1950s (Fitzgerald et al., 2013; Larman and Basili, 2003). In the next sections (Sections 3E-I – 3E-III), the practices surrounding the management of the stakeholder relationship are examined.

Table 3.6 - Summary of practices for management of innovation process

Stage	Task	Practices	Description
PROCESS	**Management of innovation process** **Section 3D**	**Managing risk** **3D-I**	Practices for managing positive and negative risks associated with the use of crowdsourcing
		Training **3D-II**	Practices for training stakeholders in the crowdsourcing process
		Creating a feedback loop **3D-III**	Practices for iterating problems, solutions and communication within the crowdsourcing process

3E. Management of stakeholder relationship

Marjanovic et al., (2012) identifies several types of stakeholder in the crowdsourcing process. The literature shows evidence of the use of practices in the management of the stakeholder relationship. This task can be categorised into practices for: (i) moderating participation (Section 3E-I), (ii) facilitating communication (Section 3E-II) and (iii) compelling participation (Section 3E-III). Research shows that depending on the type of initiative, varying degrees of stakeholder management is evident in practice (Geiger, Seedorf, et al., 2011). Within innovation processes, stakeholders can include companies, individuals, research centres, universities, SMEs and even

extending as far as consumers (Agafonovas and Alonderienė, 2013; Perkmann and Walsh, 2007). In the next sections (3E-I – 3E-III) the practices used in the management of the stakeholder relationship are outlined and a summary is presented (see *Table* 3.7 below).

3E - I. Moderating participation

The management of innovation processes within crowdsourcing can be completed by both internal and external management and moderators as in the case of many crowdsourcing initiatives. The practice of moderating participation is evident across numerous initiatives in the management of the stakeholder's participation. Moderators are evident on platforms such as Dell and Lego Ideas (Bayus, 2013; Schoultz, 2014) where they assist in the administration of the crowdsourcing process. From a management perspective Anastasiou., (2011) notes that crowd control can be very time-consuming and cost-intensive, accordingly, the engagement of external managers and communities provides an added resource to solution-seeking initiatives. Many examples of crowdsourcing which adopt an exclusively internal management approach fail to take account of the potential of self-managed crowds and participant moderated environments which are evident in communities such as Lego Ideas. Some sectors managers are prone to moderate all content such as in the case of healthcare crowdsourcing. Adams, (2014) states that managers "*may feel compelled to edit texts and reserve the right to refuse to post texts. This means that all information submitted to a site may not be posted*".

3E - II. Facilitating communication

Various types of communication are required amongst stakeholders in crowdsourcing processes. The research speaks of the importance of facilitating various types of communication with the crowd. Schäfer et al., (2017, p. 33) states that "*opportunities to connect with challenge sponsors to discuss approaches, opinions, and suggestions can make solvers feel valued*". The solution seekers need to communicate with the crowd in terms of defining and specifying the problem or task design where such work presents significant overheads in cost and time (Kittur et al., 2012). This communication is often completed through an online platform.

In communities that use crowdsourcing, the crowd interacts and communicates online in scoping and selecting problems and solutions (Mladenow et al., 2014). Although rare, evidence is also available of crowdsourcing initiatives technology being used in the mediation of both online and offline communication amongst managers and participants as highlighted by Prpić et al., (2015, p. 78). In some instances, this work involves no digital platform. By contrast, in other instances, offline crowdsourcing is treated as work that in coordinated online but facilitated offline such as moving furniture or rentals (c.f. Morris, 2011). The distinctions between offline and online communication between crowds are categorised by Stage, (2013, p. 211) who identifies: "*the traditional body-to-body crowd based on physical co-presence; the mediated crowd, which has a strong offline dimension but uses media technologies as tools or communication environments; and the online crowd, as the affective unification and relative synchronization of a public in relation to a specific online site*".

3E - III. Compelling participation

The practice of compelling crowds to participate, although subject to limited reference, is evident in the literature. Whereas the crowdsourcing has raised issues of forced labour (Felstiner, 2011; Schmidt, 2013), other examples exist of forcing or compelling participants to complete tasks.

Table 3.7 - Summary of practices for management of stakeholder relationship

Stage	Task	Practices	Description
PROCESS	**Management of Stakeholder relationship** **Section 3E**	**Moderating participation** **3E-I**	Practices for managing the permissions and interactions of participants
		Facilitating communication **3E-II**	Practices for facilitating communication amongst participants
		Compelling participation **3E-III**	Practices for compelling participants to complete mandatory tasks or tasks in a prescribed manner

Evidence is presented of participants been compelled to do tasks such as walk or complete tasks slowly or at a required speed in various crowdsourcing processes (Liu et al., 2012; Vaish et al., 2014). The participation of the candidate in the challenge is subject to the completion of mandatory or compelled tasks. This practice stands

juxtaposed to the concepts surrounding self-selection and free participation discussed in crowdsourcing earlier (Barnes et al., 2015; c.f. Rogstadius et al., 2011). In the next section (Section 3F) practices for the assessment/filtering of solution submissions are examined.

3F. Assessment/filtering solution submissions

Practices associated with the task of assessment filtering of solution submissions are evident from the research. This task can be categorised into practices for: (i) filtering with electronic tools (Section 3F-I) and (ii) managing scale (Section 3F-II). Research has identified that crowds require a means to filter and sort through submissions. In particular, where evidence is also presented that crowdsourcing websites can be flooded with submissions. One term presented in the literature for this phenomenon is 'crowding' (Piezunka and Dahlander, 2015). Modern cloud hosting technologies offer crowdsourcing platforms the potential ability to scale and cope with high demand. In the next sections (Sections 3F-I, 3F-II) the practices are outlined and a summary is presented (see *Table* 3.8 below).

3F - I. Filtering with electronic tools

Research has examined the use of tools for filtering submissions (Piezunka and Dahlander, 2015). Within this practice, categorising tools are used in online initiatives that facilitate the filtering of submissions received, as is evident in the literature surrounding practices used in crowdsourced software testing (Hossfeld et al., 2014). Gao et al., (2011), note that crowds are seen to engage in the activity of filtering and state that "*to some degree, crowdsourcing can automatically filter reports through photos, videos, and comments from other reports*". In crowdsourcing initiatives, varying degrees of complexity are evident. For example, in the FoldIt science challenge Adar notes that "*Zero/marginal-intelligence agents can still complete complex tasks*" (Adar, 2011). By contrast, extremely complex submissions can be examined such as the vetting of submissions received in the Netflix algorithm challenge (Villarroel et al., 2013). The process of filtering is reflected in many initiatives in the processes of (A) disaggregation and (B) setting granularity. Allahbakhsh et al., (2013) explain the process of setting granularity whereby crowds "*can divide tasks into two broad types: simple and complex*".

There is also some evidence in crowds that numerous filtering processes in challenges can proceed in parallel (Baldwin and Hippel, 2010) thereby providing advantages over other types of solution-seeking methods. The modular element of such systems is important for collaboration in design. Separate modules can be worked on independently and in parallel, without the requirement for intense on-going communication across modules (Little et al., 2010).

3F - II. Managing scale

Research describes the IT challenges faced in managing call processes with high volumes of submissions, complexity, or within demanding time constraints. Kohler, (2018, p. 107) warns that in crowdsourcing, scaling can rapidly turn into diseconomies of scale. Call processes present as complex from the administrative perspective with managers completing several online and offline activities in the management of the call. Similarly, crowdsourcing initiatives can be subject to crowding as outlined (Section 3F-I). Platforms such as Amazon Mechanical Turk, which is based upon cloud hosting, allows workers to operate at scale, even where geographically distributed (Wang et al., 2017)**.** With the advent of cloud computing, traditional crowdsourcing processes can be completed in shorter timeframes with the availability of platform access 24/7 to participants. Also, cloud systems can scale extra resources such as compute at the click of a button. Such technologies can be used in crowdsourcing withe the evidence available of the use of such practices. In particular, evidence is available from the software development domain of the use of cloud technologies to support crowdsourcing (Li et al., 2016; Tsai et al., 2014). By contrast, research has also examined how the use of cloud technologies has created issues in crowdsourcing systems in the software testing domain (Riungu et al., 2010). In the next section (Section 3G), practices for the generation of potential solutions are examined.

Table 3.8 - Summary of practices for assessment/filtering solution submissions

Stage	Task	Practices	Description
PROCESS	**Assessment / filtering solution submissions** **Section 3F**	**Filtering with electronic tools 3F-I**	Practices for enabling the crowd to filter solutions received
		Managing scale 3F-II	Practices for facilitating scale in the crowdsourcing process through the use of cloud technologies

3G. Generation of potential solutions

Practices associated with the generation of potential solutions are presented in the research. Both practices presented bear similarity to similar practices at the INPUT stage of the process. This task can be categorised into practices for: (i) scoping the solution (Section 3G-I) and (ii) selecting solutions (Section 3G-II). Research has identified that crowds require a means to scope and select solutions. In the next sections (Sections 3G-I, 3G-II), the practices are outlined and a summary is presented (see *Table* 3.9 below).

3G - I. Scoping the solution

The crowdsourcing practices for scoping the solution bear large similarity to practices used at the start of the process for scoping the problem (see 3A-II above). However, at this stage of the process, submissions have already been filtered by the crowd (see Section 3F above). Crowds at this stage of the process can either break up or combine solutions that have come from the filtering stage of the process. By comparison, previous research has examined the ability of experts to abstract principles in problem-solving (Chi et al., 1981). This practice bears similarity to the process of amalgamating or breaking up submissions to find problems and solutions of a desired level of granularity. Also, research has examined how from multiple selections, a means is necessary by which submissions can be combined (Karger et al., 2011). Crowdsourcing research had previously addressed the practices of aggregation and disaggregation where submissions are either added together or broken apart into more digestible or micro tasks (Hung et al., 2013; Turner et al., 2012). Research has established that aggregated contributions from unskilled crowds can follow close to submissions from experts (Luther et al., 2015).

3G - II. Selecting solutions

The practice of selecting solutions bears similarity to the practice of selecting problems earlier in the process (Section 3A-III). Practices are evident within crowdsourcing initiatives that facilitate the selection of various types of solutions provided. In traditional crowdsourcing such as micro-tasking crowds provide simple solutions to menial tasks and challenges (Alkhatib, 2009; Walsh et al., 2014).

Crowds are presented with various means by which they can score contributions or vote (Brabham, 2013). Bullinger and Moeslein, (2010) describe this process as the need to determine the ranking of submissions. Some interactions allow the crowd to rate or grade ideas or submissions where other practices facilitate random distribution or sampling of ideas (Whiting et al., 2017) such as in worker feedback systems. Amongst the best available examples of contribution types from the research are crowdvoting where crowds can upvote or like contributions (Kirkels and Post, 2013).

Current crowdsourcing initiatives, by contrast, show more complex interactions in crowds such as through gamification in the generation of potential solutions to complex challenges (c.f. Morschheuser et al., 2016; Schrier, 2020). Similar to the practice for selecting problems at the input stage of the process, solution/ can be achieved through either voting or moderated participation processes (Diener and Piller, 2009; Leimeister et al., 2009). Examples from the literature also identify random types of crowd selection and distribution within systems such as reCAPTCHA where the system randomises segments of print text for conversion to type text by crowds. The system allows the random distribution of micro tasks to crowd members through web 2.0 technologies (Hillen and Höfle, 2015). Random selection suggestions can also be utilised by crowds where an impasse is reached in respect of the selection of certain solutions to challenges or submissions (Sakamoto and Bao, 2011). In the next section, (Section 3H), practices concerning potential rewards for solution seekers, solutions providers and brokers are outlined.

Table 3.9 - Summary of practices for generation of potential solutions

Stage	Task	Practices	Description
OUTPUT	**Generation of potential solutions** **Section 3G**	**Scoping the solution 3G-I**	Practices for scoping solutions through the crowd
		Selecting solutions 3G-II	Practices through which a decision can be reached as to the solution to be used

3H. Potential rewards for solution seekers, solutions providers, brokers

Practices associated with the provision of Potential rewards for solution seekers, solutions providers and brokers are evident in the research. This task can be categorised into practices for: (i) providing extrinsic incentives (Section 3H-I) and (ii) appealing to intrinsic motivations (Section 3H-II).

In practice, contemporary crowdsourcing features the use of both intrinsic and extrinsic rewards/motivations for participation at differing stages of the crowdsourcing process. The research discusses the importance of both intrinsic and extrinsic motivations (Shaw et al., 2011). Chen et al., (2011) note that "*compensation is a significant factor within the relationship between Requesters and Workers"*. The research also established that for many workers, the monetary reward is their primary motivation and their approval rating is secondary showing that participants can have multiple motivations for participation. In the next sections (Section 3H-I, 3H-II) the practices are outlined and a summary is presented (see *Table* 3.10 below).

3H - I. Providing extrinsic incentives

An area of crowdsourcing research that receives significant interest is the effect of monetary incentives upon participation (Borst, 2010; Shaw et al., 2011). Research has examined the effects of motivation and rewards upon participation and performance along with the difficulty in setting rewards for inexpert human raters (Shaw et al., 2011). In a study of the crowd at iStockphoto, Brabham (2008) found that the opportunity to earn money (the bounty) and the opportunity to develop one's creative skills trumped the desire to network with friends and other creative people, and it out-ranked other altruistic motivations (Brabham, 2010).

Contemporary research shows that task compensation continues to shape participants continued participation in platforms such as Amazon Mechanical Turk (Alkhatib, 2009). Research has examined the relationship between extrinsic motivation and successful participants (Mack and Landau, 2015)**.** Research has also examined the positive relationship between incentivisation, trust and the solver's efforts within a platform (Ye and Kankanhalli, 2017)**.** Government platforms face a challenge in providing extrinsic incentives where public procurement rules can prevent the offering of monetary rewards.

3H - II. Appealing to intrinsic motivations

For the greater part, public sector crowdsourcing initiatives *are appealing to intrinsic motivations.* Research into the third sector (Brabham, 2013; Heinzelman and Waters, 2010; Hilgers and Ihl, 2010; Koch et al., 2011; Zook et al., 2010) presents evidence of use of the practice (Section H-II).

This corresponds with research that shows much of the support received in crowdsourced scientific initiatives is based upon contributions from citizen scientists where no extrinsic rewards are available (Shirk et al., 2012; Wiggins and Crowston, 2011). Over and above extrinsic motivations held by the citizen crowd, call process designers in many public crowdsourcing engagements seek to appeal to the altruistic nature of diverse stakeholders. Research has suggested that for public sector initiatives intrinsic motivation and intangible rewards seem to be enough to motivate many participants (Royo and Yetano, 2015)**.** Research has identified the individual motivations, including intrinsic, held by participants within crowdsourcing platforms such as Amazon Mechanical Turk (Deng et al., 2016)**.** It is posited that similar values can be assessed in crowdsourcing initiatives. Research has shown for many types of initiatives where philanthropy and charity are the main project focus the crowds do not feature monetary payment (Sauermann and Franzoni, 2013). In the next section, (Section I) the broader socio-economic impacts arising from crowdsourcing are examined.

Table 3.10 - Summary of practices for potential rewards for solution seekers, solution providers, brokers

Stage	Task	Practices	Description
OUTPUT	**Potential rewards for solution seekers, solutions providers, brokers** **Section 3H**	**Providing extrinsic incentives 3H-I**	Practices for incentivising crowds through extrinsic means of motivation
		Appealing to intrinsic motivations 3H-II	Practices through which stakeholders appeal to the intrinsic motivations of participants

3I. Broader socioeconomic Impacts (rewards for the marketplace and society)

Practices associated with the measurement of broader socioeconomic impacts are evident in the research. To this end, there is evidence of solution seekers attempting to measure the impact and rewards arising from the use of crowdsourcing. This task can be categorised into a practice of using web and social media metrics (Section 3I-I). Scientific research, like crowdsourcing, presents the ability to provide impactful results to society. These include productivity gains, greater wealth, health gains and quality of life. Guston, (2004) describes societal impact where "*it means considering the societal outcomes of research at least as attentively as the scientific and technological outputs. It means insisting that in addition to being rigorous, science be*

popular, relevant, and participatory". In the next Section (Section 3I-I) the practice is outlined and a summary is presented (see *Table* 3.11 below).

3I - I. Using web and social media metrics

Evidence exists of crowdsourcing initiatives using web and social media in an attempt to measure the success of campaigns and overall impact (Blanchard, 2008; Ho and Ting, 2016). Research has also advanced that it is possible to measure crowdsourcing results using quantitative and qualitative indicators (Lenart-Gansiniec, 2017). Within the crowdsourcing domain, research has been completed into what should be measured where it is posited by Prpić and Shukla, (2016), that measurements should include "*crowd participation/contribution count variables, count variables of the number of problems solved, and count variables of text accumulated, all qualify as meaningful measures of the Crowd Capital generated*". Existing metrics used in web-based projects include: the amount of traffic in which the scheme exploits its current knowledge about the items, the project's ability of identifying the optimal item (or a good item) to exploit and the cost of exploration (a calculation made against click-through rates (CTR) (Agarwal et al., 2009). Other metrics used in contemporary online advertising and social media can also be used including Cost Per Click (CPC) and Cost Per Action (CPA) (Hu et al., 2010). Various metrics for government and business have been advanced for the measurement of openness with metrics such as a transparency index and ten core transparency/openness indicators advanced (Chvalkovská and Skuhrovec, 2010; Coronel, 2015; Hollyer et al., 2014).

Table 3.11 - Summary of practices for broader socioeconomic impacts

Stage	Task	Practices	Description
OUTCOME	**Broader socioeconomic Impacts (rewards for the marketplace and society)** **Section 3I**	Using web and social media metrics 3I-I	Practices for using web and social media metrics in measuring platform performance and process impact

3.7. Summary

In the previous sections, competing crowdsourcing frameworks were evaluated (see Sections 3.2, 3.3) and the Marjanovic et al, (2012) framework was selected as a preliminary conceptual framework for the purposes of adaption (see Section 3.4). From the review of the crowdsourcing literature, various categories of practices (see Section 3.6, 3A – 3I) were identified through the application of the Marjanovic et al, (2012) framework. The purpose of the preliminary conceptual framework below (see *Fig.* 3.4) is to guide the process of examining funding agency challenges in the next chapter (Chapter 4).

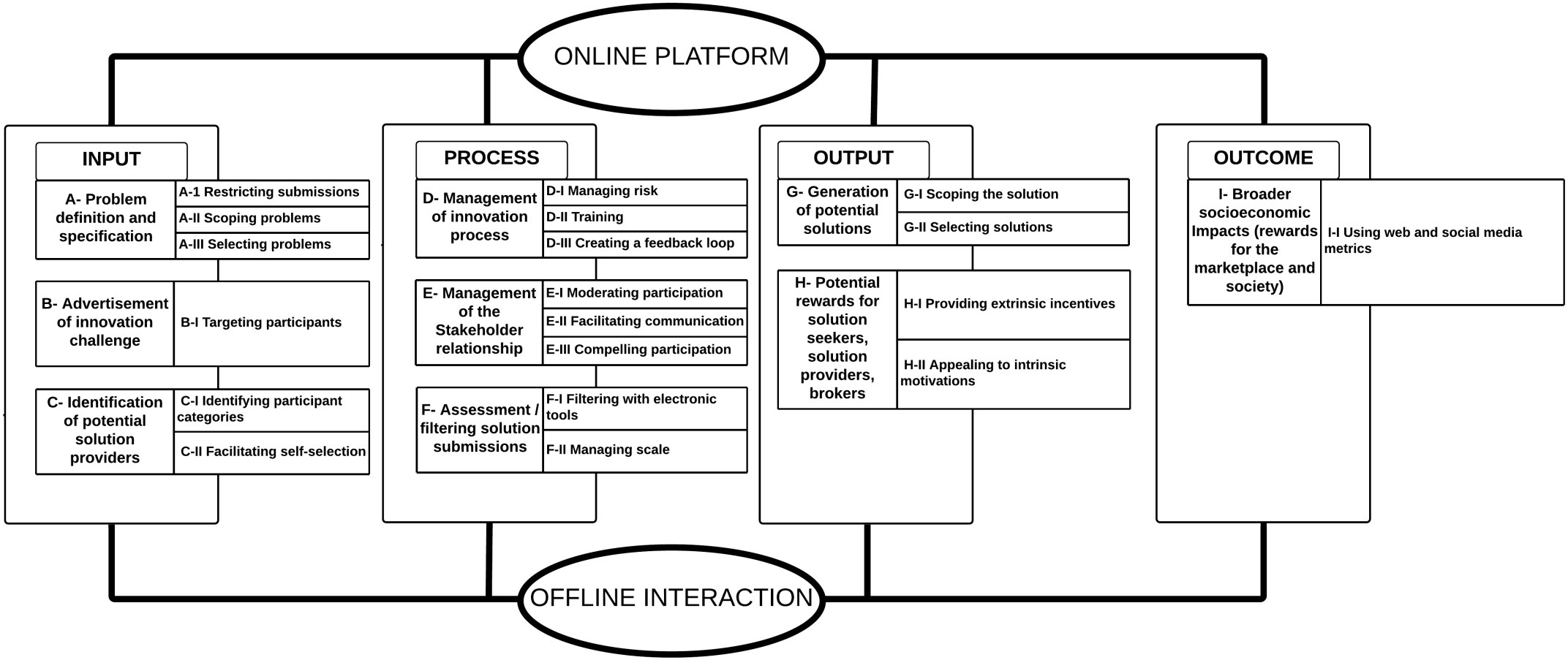


Figure 3.4 - Preliminary conceptual framework - Adapted from Marjanovic et al., (2012)

Chapter 4. Public research funding agencies

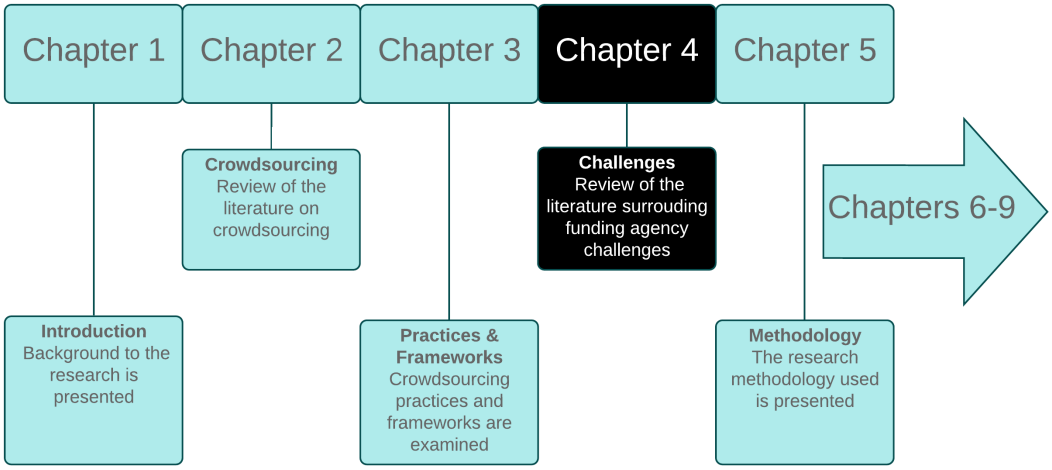


Figure 4.1 - Chapter structure - Chapter 4

4.1. Introduction

The purpose of this chapter is to (i) examine the literature relating to public research funding agencies, (ii) examine public research funding call processes through the guise of the Marjanovic et al., (2012) framework and (iii) and examine the types of challenges faced by funding agencies in addressing RO1.2 and RO2.1. This is completed for the purpose of identifying what types of public research funding agency challenges crowdsourcing can address. In Chapter 3, competing crowdsourcing frameworks were examined. The crowdsourcing framework of Marjanovic et al., (2012) was selected as a lens for data collection and categorisation. The framework was chosen as it presented as having strong foundations and was readily applicable to funding agency call processes. In Chapter 3, it was presented that the framework is suitable for examining tasks in funding agency call processes. In this chapter, the preliminary conceptual framework (See Chapter 3, *Fig.* 3.4) is applied as a lens in examining challenges faced by funding agencies in call processes. This is completed with a view to understanding the types of challenges crowdsourcing processes can address. Also, this chapter is followed by a reflection on the research methodology used (see *Fig.* 4.1 above).

The chapter proceeds as follows. First, after this introduction (Section 4.1) the background literature concerning public research funding agencies is examined

(Section 4.2). Second, funding agency open call processes are examined (Section 4.3). Third, funding agency challenges are examined where the Marjanovic et al., (2012) framework is applied to public research funding agency call processes (Section 4.4, 4A - 4I). Last, a chapter summary is presented (Section 4.5).

Over the past century new processes were created for the allocation of the scarce resource of public funds (Century, 2016). Leading figures in the scientific community such as Vannevar Bush the head of the U.S. Office of Scientific Research and Development (OSRD) and Alan Waterman the first head of the U.S. National Science Foundation (NSF) were involved in the crafting of processes and procedures in the post-war years for deciding upon who was to receive funding (Bush, 1945; Chubin et al., 1990; Zachary, 1999). Byerly Jr., (1995, p. 1531) in reflecting upon the development of scientific talent describes the:

"*interaction between science and the rest of society as a "social contract" where; in return for federal support and relative autonomy, the researcher was obligated to produce and share knowledge freely to benefit-- in mostly unspecified and long-term ways--the public good*"

4.2. Funding agencies

There are many types of funding agencies and call processes worldwide. It is simply not possible due to the diverse nature of call processes to develop a crowdsourcing framework that is pertinent to all types of call process. Accordingly, for the purposes of this research, the focus of the call processes used by public research funding agencies has been narrowed to only include agencies and processes that are: (i) wholly public in structure and funding (such as research councils), (ii) feature call processes where panels of reviewers and not individuals are responsible for making decisions in respect of funding, (iii) consider impact and excellence criteria in the evaluation of applications. Accordingly, this research excludes from consideration (i) privately funded foundations, (ii) millitary research funding and (iii) private company research grant processes.

Also, the call processes subject to examination exclude 'solicited' research programmes where the specifics of the problem to be addressed is decided exclusively in advance by the funding agency. Furthermore, commercialisation call processes are

excluded from consideration. Last, funding allocation that is random in nature and not subject to evaluation criteria has been excluded from consideration. The processes used by funding bodies such as DARPA, Bill and Melinda Gates Foundation and Chan Zuckerberg Initiative, amongst other similar bodies, are excluded from consideration.

In recent years there is evidence of public research funding agencies experimenting with different types of work processes in an effort to (i) make awards easier and faster to obtain and (ii) facilitate greater transparency in award processes (Capano et al., 2016; Palmer and Schibeci, 2014). Funding agencies invest government funding "*through competitive mechanisms..on the basis of the past performance of the applicants and the 'excellence' of the proposal*" (Geuna, 2001). In such processes, a goal exists that high-quality proposals and competent researchers are funded with experts appointed as a judge of these criteria (Huffman and Just, 1994). The competitive awarding of funding to grantees is a process fraught with strategic and political challenges (Genis and Reisman, 2010). For decades, the call processes developed in the United States by the NSF were the bedrock for many subsequent systems utilized worldwide. In this regard, it was noted that "*the pluralism of the US research system is widely admired in other countries for fostering a diversity of scientific approaches and insuring against errors of judgement in resource allocation*" (Boesman, 1997). However, there is evidence that research has provided limited engagement with public funding agencies (Van Bekkum and Hilton, 2014). This is at a time when research funding is increasingly scarce. Similarly, refereeing capacities present as a limited resource in scientific publishing and quality assurance (Pöschl, 2010).

Governments are placing increased resources into public research funding agencies in driving societal impact from science and in promoting excellence in scientific research (Bornmann, 2012; Britt Holbrook and Frodeman, 2011; Walter et al., 2007). Achieving societal impact through funded research and the assessment of its excellence forms a major part of the work of research funding agencies (Bornmann, 2013; Bornmann and Marx, 2014; Derrick, 2018; MacLean, Davies, et al., 1998). Funding agencies are involved in a cycle of soliciting stakeholder opinion, shaping funding policy and funding research. This process is explained by Braun (1998, p. 808), who states that if funding agencies are strategic, then "*funding agencies are in a good position to balance demands from both the political and scientific sides.*"

Governments fund science to drive social impact through both the hard sciences and the soft sciences (Bornmann, 2012, 2013). Russia, Japan, USA, Germany, Australia, France and Canada all spend significant sums on Science and Technology (BEIS, 2016). International examples of public research funding agencies include the United States; the National Science Foundation (NSF), National Institutes of Health (NIH), in Europe; the European Research Council (ERC), European Commission Horizon 2020, In Germany; Deutsche Forschungsgemeinschaft (DFG), In the UK; Research Councils UK, in China; the National Natural Science Foundation of China (NSFC) and in Australia; the Australian Research Council. It is from the perspective of such public agencies that open call processes are examined**.**

Research has sought to examine the review processes utilised by funding agencies (Bloch et al., 2014; Gallo et al., 2016; Pier et al., 2018), for example topics related to call processes such as research infrastructure, (Ribes and Polk, 2014), peer review (Bergquist et al., 2001; Cole et al., 1978; Roy, 1985) and government IT policy/implementation (Pang, 2017). Research in the domain of crowdsourcing and open innovation has, by contrast, examined similar competitive and collaborative processes (c.f. Boudreau et al., 2011; Glaeser et al., 2016; Majchrzak and Malhotra, 2013). Accordingly, insights from the crowdsourcing domain can be applied in the context of public call processes as will be discussed in this chapter in the examination of funding agency challenges. In the following (Section 4.3) the current structure and types of contemporary open call processes used in public research funding agencies are examined.

4.3. Open call processes

In this section, a review of the extant literature on open call processes is completed. From the perspective of a commercial firm, Hilger and Ihl., (2010, p. 71) define the open call as a call "*for participation in a non-restricted network of participants enables the firms to overcome the "local search bias" and to tap into new knowledge sources, which are as yet unknown*". Whilst public research funding agencies are not commercial in nature it is posited that they can face a similar kind of local search biases in the formulation of funding evaluation processes. Different terms are used worldwide to describe the process of the 'grantor' attributing funding to the 'grantee'. These processes are described as 'grant award processes' (Grønbjerg et al., 2000) as

well as ‘call processes’ (Crawley and O’Sullivan, 2016). Several agencies expressly refer to the competitive processes utilized as call processes such as ESA, ERC, SFI and EU Cost amongst others. Research has examined the public sector use of competitive processes (Foley, 1999). The process of improving skills in seeking funding is called ‘grantsmanship’. Peer review as one part of call processes, has long been the subject of scientific investigation (Cole et al., 1978, 1981). Peer review methods have long been the source of assessment and in some instances, criticism (Horrobin, 1990; Lebel and McLean, 2018; Roy, 1985; Ware, 2005).

Evidence shows that many of the open call process tasks are either completed entirely inside the initiating agency or with the input from external consultants or panels of reviewers (Genis and Reisman, 2010; Hodgson, 1995; Mayo et al., 2006). In Chapter 1, the main overarching components in the open call process were identified including (i) a grantor who provides funding, (ii) an advertisement via an open call of a competition and (iii) an award or grant to the grantee or winner (Century, 2016; Duderstadt and Augustine, 2014). On closer examination, further tasks bear consideration which are discussed later in this chapter (see Section 4.4 below).

Peer review processes across public research funding initiatives show similarity (Fitzpatrick, 2017). Funding agency open call processes are similar in certain aspects to university performance-based research funding systems (PRFSs) which are conducted ex-post. Evaluations of research proposals seeking project or programme funding, are also evident (c.f. Hicks, 2012). Similar peer review systems are used in the review of funding applications, conference and journal papers (Smith, 2006b; Snell, 2015). Notwithstanding the similarities, there have been calls from research for greater scrutiny over specific aspects of how these processes are operated and the effects of same (Molinié and Bodenhausen, 2013). For example, ambiguity exists as to whether individual or committee review produces better results (Bornmann et al., 2008). Also, hybrid peer review processes are evident from research. By way of example, a combination of bibliometric data and peer review processes are used in certain higher education review processes called ‘informed peer review’ processes (Geuna and Martin, 2003). The literature concerning process stages and tools in such systems are examined in addition to funding agency open call processes.

From the above research, evidence shows that although differences exist between the sequence of stages in open call processes across the agencies, the process tasks, participants and peer review approaches bear similarities. Many funding agencies use similar core features and competitive mechanisms in call processes to those developed by the NSF and its sister agencies such as the NIH (Piore et al., 2019). Evidence also shows that despite current advances in processes and technology, the features present in open call processes have remained largely unchanged for decades (Century, 2016). Traditional call systems have failed to address many complex challenges faced by funding agencies (Muscio et al., 2013). Research has also posited that certain parts of traditional call processes, such as ideation and peer review, have exacerbated problems in the building and funding of scientific research projects (Cicchetti, 1991; Roy, 1985). This is coupled with the vast amounts of paperwork and data received by funding agencies. As Vovoreanu et al., (2015, p. 140) states that for federal funding agencies:

"*the data deluge comes from the growing body of historical and continuously incoming funding documents - including funding solicitations, submitted proposals, awarded project information, published papers, project evaluations, etc.*".

In the next section, (Sub-section 4.3.1) the management of call processes in funding agencies is examined.

4.3.1. Call process management

In this section, the processes, people and systems used in the management of call processes are examined. There is evidence of funding agencies using diverse stakeholders in managing calls such as a combination of individual reviewers and panels of reviewers (Bornmann et al., 2008; Graves et al., 2011). In this section, several international examples of open call process management are presented below. Peer review forms a core part of many open call processes (Roy, 1985; Smith, 2006b; Tennant, 2018).

In the United States, the NSF retains 'program directors' with particular expertise in the chosen discipline subject to funding (Genis and Reisman, 2010). Program directors assemble a panel of reviewers which contains a mix of faculty, experts and others in any given field. They conduct confidential reviews of applications for funding (Cooper et al., 2008). The reviewers provide reviews to the

programme director who is then a position to make a case to the division director for an individual submission that she/he believes to be worthy of funding (National Science Foundation, 2014).

By contrast to the above examples, the Danish National Research Foundation uses international reviewers and experts in the evaluation of new applications for funding and the evaluation of existing foundation activities. The foundation assesses funding calls, including for example (1) centres of excellence and (2) Neils Bohr professors (Danish National Research Foundation, 2016). The foundation gives a broader mandate to 'personal investigators' in the completion of research. The foundation evaluation processes feature individual panels operating with a high level of transparency that uses a double peer review process.

The Netherlands Organisation for Scientific Research (NWO) also utilises processes that features numerous stages transitioning from individual reviewers to committees of reviewers (NWO, 2017). NWO processes feature very early feedback to researchers in the form of a pre-proposal. A short proposal is submitted which can give applicants feedback before the preparation of a substantial proposal. The application for funding moves through various stages of review leading up to a full committee review of the proposal. The process also features an ability for applicants to appeal a decision. In certain cases the NWO works with a jury where members assess the proposal individually (NWO, 2019).

Management information systems are used by call managers in advertising calls, accepting submissions, assigning reviewers, receiving reviews/scores and allocating awards. By way of example, patents have been filed outlining electronic systems for managing funding processes (Kanefsky, 2005). Funding agencies also use various online and offline management information systems to manage the call process. The merit review process provided by the NSF contains many features that are in systems used by funding agencies worldwide. The submission process is managed through the NSF '*FastLane'* System (NSF, 2009). Applicants must pre-register for the award management system for a '*DUNS'* number to allow them to apply online. Other international systems provide different levels of functionality. For example, the ISAAC system operated by the NWO in the Netherlands serves two purposes. Applicants can (i) monitor their application process and (ii) submit ongoing

project reporting (NWO, 2017). Similarly, in Ireland, SFI allow participants to monitor their application process or submit ongoing project reporting through an online system called SESAME.

Evidence exists of different types of peer review mechanisms across open call processes. For example, quality and value are sought out in review processes (Jennings, 2006). Peer review processes also seek to remove unfair and unmerited biases (Lee et al., 2013). Suresh, (2012, p. 337) sums up concerns about the present attempts by agencies to improve the peer review process where the:

"*patchwork of review processes currently in use in different countries is hindering scientific progress. Consequently, there is growing enthusiasm about, and commitment to, coordinating efforts to improve peer review from many science-funding agencies and other organizations in government, education, and the charitable and private sectors, in both developing and developed countries*".

4.3.2. Call process types

In examining call processes used by public research funding agencies as outlined above (Section 4.3.1) and subject to the limitations in focus outlined above (Section 4.2), evidence exists of the use of various types of calls seeking desired outcomes including calls that cover different aspects including:

Project sizes; across international funding agencies examples exist of research projects ranging from thousands of dollars to hundreds of millions of euro/dollars. **Research time-frames;** the literature presents examples of research projects that are funded over various time windows ranging from short periods of time to long term studies. **Career stages;** examples exist throughout the literature of call processes designed to support researcher at various stages of their research e.g. early career, senior research fellow. **Thematic priority areas;** examples exist of national governments prioritising critical research areas and assigning funding to those sectors e.g. nanotechnology, artificial intelligence (as distinct from solicited funding). **Research infrastructure;** examples also exist of funding calls specifically focused on the development of research infrastructure, where, rather than focusing on a research topic, funding is allocated to support the research environment and institutions.

Basic/applied research; a major issue in the international funding of research is the competing needs of basic and applied science with evidence showing a lack of support for many types of basic research. Accordingly, funding agencies have sought to set aside funding to support both basic research and the applied sciences. **Education & training;** funding agencies have sought to invest in training and education that surrounds research with international funding agencies funding training in areas e.g. research methods and research ethics. **Scientific communication;** with the move towards open science, funding agencies have sought to invest in outreach and the growth of skillsets in the area of science communication. **International cooperation;** international travel and cooperation represents a major overhead in scientific research. Funding agencies have sought to assist researchers with the provision of funding for attendance at international events of interest e.g. workshops, conferences and seminars.

Research has presented two types of grand challenges namely: "*challenges that are of great difficulty but that may be characterised as technical goals, and second to refer to challenges that are also grand in their scope and that involve societal stakeholders*" (Efstathiou, 2016, p. 3). This corresponds with public research funding agency call processes where large scale challenges centre around a chosen theme or themes and are written in a broader context to allow prospective applicants breath in terms of the structure of their application for funding (Kuhlmann and Rip, 2014). Similarly, Horizon funding calls are also targeted in a broad format (Owen et al., 2012). In this instance funding agencies such as the European Research Council operate in allowing the applicant broad scope in terms of the focus of their proposal contextualised within a given theme.

Another type of call used by science funding agencies specifically centres upon the imparting of government science policy through niche research priorities (Grech, 2000; Lemola, 2002; MacLean, Anderson, et al., 1998). In this instance, specific care is taken in the drafting of the wording of the call document to highlight for the benefit of prospective applicants the specific desired mission objectives or narrow focus of the call. Such call documents tend to be narrower by nature and focus on niche issues and are not part of the focus in this research.

Another example involves a combination of both approaches whereby broader desired impacts (grand challenges) are identified and the mechanism by which these goals are achieved are left to the individual scientists describe in their submissions. The assessment of impact and excellence followed from reforms to NSF assessment criteria in the 1990s (Jasanoff, 2019, p. 230). In this case, both impact and excellence are examined such as in the case of Horizon 2020 (Parker and van Teijlingen, 2012). The process of establishing clear research priorities is of immense significance to science funding agencies. Vella et al., (2000, p. 976), states that the:

"need to involve as many legitimate stakeholders as possible in the identification and prioritisation of research topics is increasingly being recognised. Not only might such a strategy ensure that the interests of all relevant people are considered, it might also increase ownership of the ensuing research and, perhaps, the likelihood of the results influencing clinical practice and policy".

A study by Janger et al., (2019, p. 77) identified various categories of research calls across international funding agencies. Many of the calls identified coincide with the same themes identified at the beginning of this section. Categories included: single project funding (SPF), career, networks and multi-project funding, SPF early career, structural priority area, mobility, thematic priority area, infrastructure, applied research, education & training, scientific communication and international cooperation. Different categories of calls were targeted to help researchers with different stages of their work such as early or late-career or specific tasks such as training or international travel. Assessment criteria include project duration, percentage funded, classification, bottom-up or top-down research questions, who gets funded and the main aim of the scheme. Also, the process included both internal and external reviewers, national and international reviewers and weighted assessment. Assessment criteria outlined by Janger et al., (2019, p. 80) included:

- scientific track record and expertise in view of the proposed project;
- scientific quality of the project: scientific relevance, originality and topicality; additionally, broader impact outside science;
- suitability of methods and feasibility;
- early career applicants (where applying) were subject to extra references and interview requirements.

Evidence also shows that similar assessment criteria are also applied across other international call processes. For example, in ERC applications for funding, special requirements are evident for applicants for early-stage researcher grants (Luukkonen, 2012; Neufeld et al., 2013). In the US, NIH grants are also categorised by size/stage where grant 'R01' is a mature award that provides a researcher four or five years of independent support. Different grants such as 'R21' and 'R03' cover different time periods and sizes of funding. Similar types of grants to those of the NIH were provided by the ERC including; Starting Grants, Consolidator Grants, Advanced Grants, Synergy Grants and Proof of Concept Grants which focus on different durations and sizes. Call processes are managed by grant mangers who perform various functions. Pengbangsa et al., 2016 stated that:

"*In performing its duties, research grant administrator performs functions such as: (1) formulating plans, programs, and budgets, as well as the financial affairs management, (2) accepting proposal registration, (3) preparing material to be used by reviewer in assessing the proposal, (4) monitoring and evaluation of program implementation, (5) preparing information and report on each activities, (6) collecting, processing, and presenting data and information, (7) assessing and revising grant strategy* ."

From the above research (Sections 4.3.1, 4.3.2) the following tasks in call processes are identified by way of summary (see *Table.* 4.1 below). The comparison shows the similarity between research funding call processes and key tasks identified in the Marjanovic et al., (2012) Framework

Table 4.1 - Evidence of tasks in open call process for public research funding agencies

Task	Description	Examples
Selecting a theme or question:	By way of, research priorities, management decision or through consultation with the public/stakeholders a research theme or question is selected for the call processes. It can focus on a broad or narrow research topic or stage of a researcher's career. It can also focus on a specific project related need such as networking or international travel.	In Denmark, the Danish Agency for Science, Technology and Innovation sets out its research objectives in reports which are then used as strategic outlines in the development of call processes. Reports have outlined key areas of interest that require support (Uddannelsesog Forskningsministeriet, 2016).
Advertising:	Different mechanisms are used by funding agencies to advertise open calls. Many funding agencies advertise calls on their website and through paper publications. Open calls are not always truly 'open', and participants of a given skillset can be sought.	In the US, the NSF advertise funding opportunities in four types of announcements namely; program descriptions, program announcements, program solicitations and 'dear colleague' letters (NSF, 2009).
Process management:	Funding agencies use a combination of offline and online processes to manage calls. Funding agencies use web-based platforms for the management of application processes, allocation of awards and ongoing performance evaluation.	In the Netherlands, the NWO uses the ISAAC system for the purposes of managing call processes online. In conjunction with the use of ISAAC, various individual and group submissions occur on an offline basis (NWO, 2017).
Peer review:	When applications are received reviewers are appointed to conduct peer review of the applications. Reviewers are selected based upon their skills or demographics. The task involves the distribution and scoring of applications and can include single or panels of reviewers. In some instances, reviewers are remunerated for their work.	The German Israeli Foundation for Scientific Research and Development (GIF) encompasses a layered peer review approach. In the evaluation process, GIF employs three scientific layers namely; reviewers, the scientific advisory committees and the scientific Board members. Proposals are categorized into scientific fields and are assigned to scientific committees (GIF, 2012).

Task	Description	Examples
Awards:	At the conclusion of funding processes, several tasks are completed in making awards. First, review and scoring details are often provided to participants. Second, where applicants are successful, awards are made. Third, many processes feature ongoing review over the lifetime of the grant duration.	In Germany, along with the issue of research funding through call processes the DFG issues other types of awards. In 2019, ten universities have been earmarked to receive permanent funding along with one university consortium from the DFG (Spang-Grau and Eickhoff, 2019).
Evaluation:	A Science of Science Policy (SoSP) is emerging where funding agencies in conjunction with academia are seeking to develop new measures for excellence and impact in research funding processes. A significant part of the work centres around the use of and development of new metrics and KPIs for funding agencies.	In Finland, the Academy of Finland are conducting an assessment of the evaluation of strategic research programmes and societal impact. The work has involved shared learnings on peer evaluation and metrics from UK institutions operating under the REF (Saari, 2019).

Accordingly, tasks completed within public funding agency call processes coincide with many of the tasks completed under the framework of Marjanovic et al., 2012 making the choice of the framework suitable for application to data. The above section, (Section 4.3) examined the call processes used by funding agencies. The next section, (Section 4.4) examines the challenges faced by funding agencies in the operation of the call processes as outlined above. In the next section, the challenges faced by funding agencies are examined.

4.4. Challenges for funding agencies

Small economies such as Ireland, Denmark and the Netherlands, have prioritised specific research areas in line with strategic needs (Grech, 2000; MacLean, Anderson, et al., 1998). Such needs are different to those of larger economies. Public research funding agencies face numerous challenges in operating call processes which are now examined through the application of the Marjanovic et al., (2012) framework. As presented in Chapter 1, the framework bears similarity to many aspects of funding agency call process tasks and accordingly is suitable for application. Also, like the stakeholders contained in the framework, we see new stakeholders entering the research funding sphere namely the third sector and citizen scientists (Cohn, 2008; Irwin, 2001). Such actors are bringing substantial changes to the way research is built/funded and in the processes and technologies used. For example, initiatives that span crowdsourcing and funded research such as Cancer Research UK and Fold.it (Khatib et al., 2010).

In the following sections, (Section 4A - 4I) the summary tables presented proceed on the basis of the practices outlined in the tables presented in Chapter 3, (see *Table.*3.3 to *Table*. 3.11). In Section 4A, challenges faced in defining and specifying problems are examined, while in Section 4B, challenges faced in advertising the innovation challenge are outlined. In Section 4C, challenges faced in selecting the crowd are discussed and Section 4D presents challenges faced in managing the innovation process. In Section 4E, challenges faced in managing stakeholder relationships are discussed, while Section 4F focuses on challenges faced in assessing/filtering solutions received in the process. In Section 4G, challenges faced in the generation of solutions are outlined. In section 4H, the challenges with potential rewards for participating are presented. Last, in Section 4I, the challenges with

measuring broader socioeconomic impacts of crowdsourcing are examined. The crowdsourcing framework identified in Chapter 3 (see *Fig.* 3.4) is used to address public research funding agency challenges which are now discussed.

4A. Challenges in problem definition and specification

Public research funding agencies face challenges in engaging crowds in problem definition and specification. Agencies face challenges in restricting submissions, scoping problems and selecting problems (Sections 4A-I – 4A-III). A summary of the challenges are presented below (see *Table* 4.2). Identifying and refining problems and deliberating on science through the use of crowds presents as a challenging process (de Graaf et al., 2017; Hagendijk and Irwin, 2006). One major challenge is where a crowd of varying skills may not hold all the skills necessary to identify and refine a problem or complex scientific challenge.

4A - I. Challenges in restricting submissions

One challenge faced by funding agencies is deciding what can be submitted in a call process and how it can be submitted. The challenge is most evident at the start of processes. The management systems used by funding agencies traditionally relied upon paper based systems in accepting submissions before the advent of technology. However, in recent years funding agencies have switched to the use of electronic systems for the management of processes (Ware, 2005). This coincides with the similar use of web based submission systems in crowdsourcing (Kim et al., 2011). One core challenge in task design is deciding what type of submission format or media the crowd can use in making submissions to a challenge. Evidence is available of some systems opting toward the receipt of simple forms of submission (Karp, 2016). Some evidence is also available of new systems such as *Thinklab* being presented to overcome challenges in traditional funding systems (Spaulding and Pitsevich, 2016).

Award management software such as *Reviewr* seeks to overcome traditional challenges where applicants are restricted to only making hardcopy submissions or reviewers collate submissions on excel sheets (Pashte, 2019). This is comparable to peer review processes in journals which also remain traditional despite advances in technology (Tennant, 2018). Evidence shows that in contemporary crowdsourcing systems various types of inputs can be received including text files, check box or drop-down menu selections, audio files or video files. From the literature, there is limited

evidence of funding agencies deciding upon the merits of what submission formats should be used and what restrictions should be placed upon user input.

4A - II. Challenges in scoping problems

There is evidence across the literature of the challenges associated with scoping problems. Science problems can have varying levels of granularity. Accordingly, a challenge is faced in scoping problems where different levels of granularity exist across public calls such as grant funding processes (Baga, 2018). Various stakeholders such as the public can be involved in shaping scientific challenges (Bonney et al., 2009, p. 17). The strategic disaggregation of problems is an area where specific research has been called for in the political and policy sciences. Participants not only require a pre-requisite level of knowledge to participate but, furthermore, domain-specific knowledge can also be required in scoping more complex problems (Rowe et al., 2005, 2010). Funding agencies can face a challenge in setting the granularity of a problem so that it can be widely understood by a diverse crowd.

There is evidence of the challenge of facilitating public participation in scoping science problems and challenges where citizen scientists play a major role in supporting science and research (Bonney et al., 2009). However, this, in turn, raises the question of how contributions from citizen scientists are to be assessed or whether they provide an effective contribution (Chess and Purcell, 1999). Due to the complex nature of many scientific challenges, laypersons and unskilled members of the crowd face participation barriers. The decision to involve the public in scientific debate, deliberation and governance has long presented controversial, where there is a danger that the public can back popular opinion over scientific fact (Hagendijk and Irwin, 2006; Siemsen, 2010). Agencies have sought to build communications policies in an attempt to address this gap (Bielak et al., 2008). Scoping the problem involves shaping the boundaries of the problem, whereas selecting (see Section 4A-III), involves the decision-making process of what problem to select.

4A - III. Challenges in selecting problems

Funding agencies face a challenge of integrating all the key stakeholders necessary in the decision-making process. A difficulty is faced in the involvement of diverse stakeholders in the one ecosystem including laypersons, scientists and in some

instances industry. This challenge is particularly evident in citizen science where a complex group of stakeholders need to interact and share information in decision making process (van Est, 2011; Shirk et al., 2012). Simper et al., (2015, p. 20) in discussing crowdsourcing describe the challenges arising from "*a lack of insight and institutional practice for assigning tasks to the most suitable crowd members*". This is further complicated where there is a disconnect between what the public need from science and what the funding agencies perceive to be necessary research (the ivory tower) (Cheng et al., 2008; Lok, 2010).

Traditionally, in scientific peer review, only experts make the decisions. Increasingly in the healthcare sciences, there is evidence of layperson involvement in the making of decisions such as with public patient initiatives (Truitt et al., 2018; Weiner, 2014). Accordingly, a challenge lies in deciding whether all participants in such processes should have equal or weighted votes based upon their knowledge or skills. In particular, where research argues that in such processes the relationship of citizens and scientists it is not an equal relationship (Palmer and Schibeci, 2014). In the next Section (B), challenges that relate to the advertisement of the innovation challenge are discussed.

***Table* 4.2 - Summary of challenges in problem definition and specification**

Stage	Task	Practices	Challenges
INPUT	**Problem definition and specification** **Section 4A**	**Restricting submissions** **4A-I**	Deciding how and what to limit in submissions received from the crowd.
		Scoping problems **4A-II**	Setting the granularity of a challenge or matching the skill requirements to preferred stakeholders.
		Selecting problems **4A-III**	Facilitating stakeholder involvement and weighting decisions made by participants.

4B. Challenges in the advertisement of the innovation challenge

Funding agencies face challenges in targeting, through communications and advertising, categories of crowd they require to participate (Section 4B-I). A summary of the challenge is presented in *Table* 4.3 below. In the execution of this task, specific skills are required for addressing certain types of challenge and certain demographics need to be engaged. Also, participants sought by funding agencies can reside in

different environments and communities requiring the use of different communication/advertising channels for soliciting involvement.

4B - I. Challenges in targeting participants

Some limited discussion is presented from the literature of specific advertising challenges faced by funding agencies. Traditionally, funding agencies have faced difficulties in engaging certain types of participants namely reviewers with specific skillsets (Perrin, 2008; Porter and Rossini, 1985; Vines et al., 2010). Also, science in general, faces a challenge in targeting public for participation (Felt and Fochler, 2008). With the advent of contemporary platforms, evidence is presented of the challenge for science in the sourcing of skilled and diverse crowds (De Boer et al., 2012). Also, challenges can be faced by funding agencies in ensuring a proper balance of diverse demographics receive research funding (Shavers et al., 2005). Similarly, a challenge is faced by funding agencies in locating desired participants.

Some authors have criticised the idea of public engagement and have labelled this as a buzzword in contemporary science (Bensaude Vincent, 2014). Many experts raise this question in light of the ongoing debate regarding the expert-lay divide in science (Lidskog, 2008). At the very least, research posits that citizens can participate in scientific research in various capacities. (Biegelbauer and Hansen, 2011; Bucchi and Neresini, 2007; Lengwiler, 2008). Although not evident from the literature on funding agencies, it can be inferred that funding agencies face challenges in accessing and using new advertising practices for targeting crowds.

***Table* 4.3 - Summary of challenges in the advertisement of the innovation challenge**

Stage	Task	Practices	Challenges
INPUT	**Advertisement of innovation challenge** **Section 4B**	**Targeting participants** **4B-I**	Targeting participants of a given skillset or demographic.

4C. Challenges in the identification of potential solution providers (filtering the crowd)

Funding agencies face challenges in the identification of potential solution providers (filtering the crowd). In this regard, agencies face challenges in identifying participants and facilitating self-selection for participation (Sections 4C-I – 4C-II). A

summary of the challenges are presented in *Table* 4.4 below. Solution providers can be categorised based on skill and demographic criteria.

4C - I. Challenges in identifying participant categories

Identifying participants presents as a complex process. A major challenge is faced in the sourcing of skilled reviewers. As distinct from targeting participants, identification involves selecting participants from those available, based upon desired criteria such as skill or location. Through the management systems used by funding agencies, funding managers can select reviewers to review individual projects or submissions. Both the search and communication functions within systems are controlled through the grant management software. By way of example, the search capacity in such systems can access internal extramural databases and portfolio management applications (PMA) (Neta et al., 2015). Suitable reviewers are predominantly identified through their experience or curriculum vitae (Derrick, 2018).

Some evidence of challenges is presented where competition is evident in access to peer reviewers. Systems have been developed including prototypes to assist with mining and selecting reviewers (Hettich and Pazzani, 2006). Also a decision support approach is evident in systems for recommending reviewers for specific proposals (Xu et al., 2010). Especially, where many reviewers have become tired of participating in review processes (Arns, 2014; Fliesler, 1997). Reviewers are a scarce commodity and the sourcing of same presents as a challenge. Also, funding agencies are increasingly seeking to involve public crowds and participants from certain demographics in making decisions about science (Van Bekkum and Hilton, 2014). For example, contemporary processes face the challenge of ensuring diverse participation where research has also examined factors such as gender and ethnicity in funded research (Ginther et al., 2011).

Another challenge is faced in deciding how to account for participant's improving skill over time. A crowd's participation can change over time based upon experience gained in the process. This presents a challenge where funding agencies may have to reassess a participants skill over time as they learn and improve through participation (Mason et al., 2012).

4C - II. Challenges in facilitating self-selection

One of the central aspects of many crowdsourcing definitions is the requirement for the crowd to be able to self-select to complete challenges (Afuah and Tucci, 2012; Mack and Landau, 2015). Rogstadius et al., (2011, p. 322) states that "*self-selection is an inherent aspect of a task market*". An important aspect of crowdsourcing rests in the ability of a participant to select the tasks they believe they are most suited to in a trade-off between their skills and potential rewards (DiPalantino and Vojnović, 2009; Ipeirotis et al., 2010). Self-selection presents an opportunity for organisations where participants out of the domain can self-select to address a challenge (Afuah and Tucci, 2012).

However, this presents a corresponding challenge for funding agencies where participants may not hold high levels of skill necessary to assess all types of scientific submissions (Staffelbach et al., 2015; Xu and Bailey, 2011). Harnad, (2000) addresses a particular challenge with peer review, namely, that it is not clear whether the self-appointed reviewers will be qualified specialists. Accordingly, this challenge could prevent agencies from utilizing self-selection for many types of complex submissions received. However, evidence is also available of the use of alternative peer review processes that facilitate self-selection that allow public commentary at various stages of the assessment process (Pöschl, 2010).

***Table* 4.4 - Summary of challenges in the identification of potential solution providers**

Stage	Task	Practices	Challenges
INPUT	**Identification of potential solution providers (filtering the crowd)** **Section 4C**	**Identifying participants** **4C-I**	Identifying and locating suitable participants through search processes.
		Facilitating self-selection **4C-II**	Facilitating the crowds ability to select a task most appropriate to their skills.

4D. Challenges in the management of innovation process

Funding agencies face challenges in engaging crowds in the management of the innovation process. Agencies face challenges in managing risk, training and creating a feedback loop (Sections 4D-I - 4D-III). A summary of the challenges are presented in *Table* 4.5 below. Managing scientific processes presents as a challenging task requiring the interaction of a variety of stakeholders. Where processes are not managed

correctly, participants can face various types of challenges. By way of example, peer review processes can suffer from time delays (Harnad, 1996). The use of crowdsourcing presents as a new departure for many agencies who are now required to manage new types of risks and opportunities within the process.

4D - I. Challenges in managing risk

Some limited discussion is available of the challenge surrounding risk management in call processes. Funding research is risky where agencies face scientific uncertainty and fiscal limitations (Doern and Reed, 2017). Call process managers and reviewers face substantial reporting requirements which are designed to protect the integrity of the process (Danish Ministry of Higher Education and Science, 2014; Godecharle et al., 2013). However, aside from operational risks, a key risk resides in balancing the need for research integrity versus the need for scientific novelty. Research has highlighted the association between risky science and potentially major breakthroughs (Heinze, 2008; Stephan, 1996). Also managing risk is difficult where different stakeholders hold different risk. For example, stakeholders such as "*representatives from social, political, and economic domains. openly discuss various dimensions of risks and their implications*" (Petersen et al., 2011). Accordingly, funding agencies face a challenge in deciding what risk level is required in selecting or funding research.

One of the greatest risks facing funding agencies is the maintenance of scientific excellence in review processes involving the public (Husu and de Cheveigné, 2010). The funders of science are charged with the responsibility of ensuring that only excellent science is funded. Including citizens in processes presents the risk of a potential dilution in standards. It has been argued that the public is limited in how they can contribute to scientific excellence where they are in the greater part not possessed of specialist scientific skills. At the minimum, research has argued that citizens can help improve scientific results (Bonney et al., 2009; Couvet et al., 2008). There is also an absence of discussion as to the challenge of managing upside risk in the literature as this presents as a new departure for funding agencies. Lukkonnen, (2012) *states that "controversy and uncertainty are central characteristics of potentially ground-breaking research proposals"*. Accordingly, agencies in choosing to accept risky but novel submissions need to accept a greater risk threshold.

Research has also highlighted a challenge posed by conservative peer review, where reviewers fail to select submissions that contain novelty (Lee et al., 2013; Nicholson and Ioannidis, 2012). Research has also concluded that peer review does not necessarily have a conservative bias once it is organized appropriately (Langfeldt, 2001). Research in the biosciences has also proposed pooling risky projects into a single entity by way of risk management (Fernandez et al., 2012). Accordingly, challenges are faced by funding agencies in managing risk.

4D - II. Challenges in training

Funding agencies face a challenge in training staff and participants in call processes. Training is required for funding managers covering tasks from the operation of grant management systems, unconscious bias training, communications and the operation of peer review processes. For example, evidence is available of substantial effort expended on the part of funding agencies in informing and training peer reviewers (Min, 2005). In certain scientific domains such as healthcare, there is evidence of training provision for peer review (Freda et al., 2009). Research has also examined if training has improved the success of peer reviewers in detecting defects (Schroter et al., 2008).

Research has also identified the need for training to counter implicit and unconscious biases in certain aspects of healthcare and educational sciences (Staats, 2016; Teal et al., 2012). However, some commentators have contested the need for such training (c.f. Noon, 2018). Science agencies also acknowledge the difficulty in science communication and have provided training for related activities (Miller and Fahy, 2009; Poliakoff and Webb, 2007). Research has shown the necessity to provide training in attempting to address the challenges of the science public divide (Van Bekkum and Hilton, 2014). Research has also shown the challenges in training the public for participation in similar deliberative processes (Abelson et al., 2003).

4D - III. Challenges in creating a feedback loop

Funding agencies face challenges in integrating feedback loops into existing processes where they have been shown to provide benefits across research domains. By way of example, collaborative learning systems have shown the usefulness of integrating feedback loops (Allen et al., 2001).

Although funding agency research does not explicitly address this point, this can be concluded from other aspects of funding agency and crowdsourcing research. Many call processes are presented in a linear sequential fashion. This is comparable to the linear nature of waterfall processes in the project management domain (Royce, 1970). This stands in contrast to crowdsourcing and crowdfunding processes that incorporate iterative development and refinement (Balamurugan et al., 2014). As outlined in Chapter 3, contemporary processes such as those used in software development feature the use iterative processes or iterative stages within processes (Hevner et al., 2004; Highsmith, 2002; Peffers et al., 2007). Limited evidence is available of a similar use of iterative loops or stages by funding agencies. Some evidence is available from funding agencies of the similar use of iterative stages. International funding agencies such as the Canadian Institutes of Health Research (CIHR) use iterative grant assessment processes (CIHR, 2016). Evidence is also available of challenges present in the use of iterative processes in research such as with community-based participatory research (Powers et al., 2006). Accordingly, in the absence of substantial knowledge of the use of such feedback loops, agencies face a challenge in building and integrating iterative feedback.

Table 4.5 - Summary of challenges in the management of the innovation process

Stage	Task	Practices	Challenges
PROCESS	**Management of innovation process** **Section 4D**	**Managing risk** **4D-I**	Managing both negative and positive risks arising from stakeholder involvement.
		Training **4D-II**	Training staff in areas such as peer review, unconscious bias awareness and public engagement.
		Creating a feedback loop **4D-III**	Building iterative cycles into processes to facilitate incremental improvement.

4E. Challenges in the management of the stakeholder relationship

Funding agencies face challenges in the management of the stakeholder relationship. Agencies are required to facilitate interaction between the key stakeholders involved in research call processes. These can include a combination of public and private actors with a vested interest in supporting research (Frey et al., 2006). In particular, agencies face challenges in moderating participation, facilitating communication and in some capacities, compelling participation (Sections 4E-I – 4E-III). A summary of

the challenges are presented in *Table* 4.6 below. Call process managers are required to support complex stakeholder relationships in managing call processes.

4E - I. Challenges in moderating participation

A challenge is faced by funding agencies in using moderators. Some limited evidence exists from the research of their use in managing stakeholder interaction. Various public-private partnerships are evident in research call processes (Beaudry and Allaoui, 2012; Muscio et al., 2013). Stakeholder interactions relationship require management by funding agencies. Agencies are required to interact with other funding agencies and public stakeholders in managing research funding. Jasanoff, (2019) states that a challenge facing science governance is how to incorporate the public voice into the 'front-end' of science, previously the domain of experts. To this end, a challenge is faced in how to moderate stakeholder interactions.

Examples of moderating participation are evident across the sciences. In setting health research priorities citizen juries are involved where "*facilitators or moderators are present to guide the process and witnesses provide expert evidence*" (Gooberman-Hill et al., 2008, p. 272). In another example concerning research on public juries in nanotechnology, evidence was presented of stakeholder moderation through committees. A science panel provided specific guidance on nanoscience and technology matters to an oversight panel in moderating citizen interaction (Rogers-Hayden and Pidgeon, 2006). Stakeholders included "*representatives from government, civil society, nanoscience, funding bodies, and academia*" (Rogers-Hayden and Pidgeon, 2006, p. 172). Research in science communication has also highlighted how public institutions have hired moderators to lead sensitive engagement with the public on issues (Bell, 2008, p. 392).

4E - II. Challenges in facilitating communication

Funding agencies face various challenges in leveraging different communication channels to facilitate discussions and interactions between stakeholders. Lepori (2011, p. 355) states that "*public funding is considered as a multilevel and multiactor system, where stable patterns are largely generated by the collective interaction among actors (beyond formal rules and structures)*". Various different modes of communication are used by funding agencies (Palmer and Schibeci, 2014). However, a challenge is faced

by agencies where the type of communication required is complex. For example, Wynne, (2006) highlights the complexity involved where a two-way understanding or dialogue is required rather than the one-way correctional idioms of communication. Petersen et al., (2011, p. 365), speak of the need for boundary organisations to engage in an "*internal and external extension of the peer community*".

Communication with the public, as a stakeholder, is an area of particular interest to funding agencies where two-way interaction is needed to shape policy and impart knowledge. Research has shown that some aspects of science communication focus on formal procedures by which such communication can be enacted over highlighting the voice of the public (Horst and Michael, 2011). Also, communication between public research organisations (PROs) and private entities has been studied vis-à-vis the benefits and novelty that arises. Research has highlighted that interactions between the private sector and PROs have the potential to create and diffuse knowledge. Accordingly communication channels are important (Arza, 2010, p. 477).

4E - III. Challenges in compelling participation

Some very limited evidence is available of the challenges faced by funding agencies in compelling participation. The crowdsourcing literature addresses both, directly and indirectly, issues regarding compelled participation in research funding. In particular, evidence exists of only one type of participant being compelled to participate in one part of funding agency work. Palmer and Schibeci, (2014) speak of a type of science communication (Type 3) that is compelled. They describe where financial support and/or an application requirement is stipulated for a grantee to engage with the public at a more involved level than simple research dissemination. This is confirmed by Andrews et al., (2005) who highlights that institutions can also make research priorities paramount. This presents as a form of compelling actions. By way of example, funding agencies have invested funding in public and stakeholder engagement in areas of specific scientific interest such as oceanography where public engagement is a compelled part of the receipt of funding (Simoniello et al., 2012). Other funding call processes also show evidence of placing requirement on applicants to engage in outreach work and other types of communication related works.

Table 4.6 - Summary of challenges in the management of stakeholder relationship

Stage	Task	Practices	Challenges
PROCESS	**Management of Stakeholder relationship** **Section 4E**	**Moderating participation** **4E-I**	Moderating diverse stakeholder interaction across sectors and disciplines.
		Facilitating communication **4E-II**	Facilitating two-way communication amongst stakeholders including the public.
		Compelling participation **4E-III**	Compelling stakeholder participation through direct and indirect means.

4F. Challenges in the assessment filtering of solution submissions

Funding agencies face challenges in the assessment and filtering of solution submissions. Agencies face challenges in filtering with tools and managing scale (Sections 4F-I – 4F-II). A summary of the challenges are presented in *Table* 4.7 below. Research has shown that funding agencies have shown the challenges faced by voluminous or complex submissions. One major challenge resonates with funding agencies where a generic crowd of varying skills may not hold all the skills necessary to identify and refine a problem or complex scientific challenge.

4F - I. Challenges in filtering with electronic tools

Some limited evidence was available in terms of challenges faced in selecting and using electronic tools to sift through and categorise submissions received. Research in general has sought to engage extra participants where it has been posited that "*If you can multiply the number of people, you can accelerate the research*" (Bender, 2016). However, with extra participants comes larger filtering and reporting requirements. Evidence exists in the use of filtering tools to search for reviewers in funding agencies (Hettich and Pazzani, 2006).

Various practices can be used to mitigate negative effects caused by the volume and complexity of submissions received. To deal with this challenge, funding agencies have in recent years used grant management systems for receiving and sorting submissions received (see Section 4.3.1). However, current tools used are not fit for purpose where research has shown that there is a data deluge faced in recent years by funding agencies (Vorvoreanu et al., 2015).

Accordingly, funding agencies face a challenge in deciding what tools to use in filtering submissions received. Evidence is available of the scale and type of filtering completed by funding agencies in sorting submissions through analysis and expert reviewers.

4F - II. Challenges in managing scale

A further contemporary challenge faced by funding agencies is the creation and management of an ecosystem capable of facilitating scale. The costs and scale of research is a key concern for funding agencies (Fortin and Currie, 2013). Although literature on funding agencies is largely silent on managing scale, examples exist across similar domains of the challenges faced in attempting to manage scale. For example, research has called for proper cyber-infrastructure to support citizen science (Newman et al., 2011). In this regard modern cloud-based cyber-infrastructure can facilitate the scaling of systems quickly (Böhm et al., 2011). Research has specifically addressed the challenges faced by the public sector in using technologies for the management of scale such as cloud computing (Choo, 2010).

Traditional funding agency processes are designed to apply a limited number of reviewers to a limited number of submissions. With the ability to solicit mass interaction from the public new systems are required to facilitate mass participation in a timely manner. For the public sector, various specific challenges are faced in managing scale through ecosystems. Examples include data confidentiality and privacy risks (Hashemi et al., 2013). Managing scale is an increasingly important issue for funding agencies where scientists feel pressure to submit more grant proposals as they compete for increasingly limited funding (Roebber and Schultz, 2011).

Table 4.7 - Summary of challenges in the assessment filtering of solution submissions

Stage	Task	Practices	Challenges
PROCESS	**Assessment / filtering solution submissions** **Section 4F**	**Filtering with electronic tools 4F-I**	Identifying and providing tools for filtering and categorising submissions.
		Managing scale 4F-II	Facilitating the scaling of ecosystems to accommodate numerous/complex interactions.

4G. Challenges in the generation of potential solutions

Funding agencies face challenges in generating solutions at the end of call processes. This challenge bears similarity to the scoping and selection of problems at the start of the process. In particular, agencies face challenges in scoping the solution and selecting solutions (Sections 4G-I – 4G-II). A summary of the challenges are presented in *Table* 4.8 below. A difference is evident between funding agencies and the private sector where there is a greater need for the involvement of expertise in call processes.

4G - I. Challenges in scoping the solution

A challenge is faced by funding agencies in scoping the solution. The practice of scoping can include decision on how other submissions are to be aggregated into a solution. Aggregation in crowdsourcing processes presents as a complex task (Kittur et al., 2011). As outlined above (Section 4H), a challenge is presented where crowds may not hold the skills or experience to make decisions about the scope of science topics or research that is complex in nature. Research has shown that challenges are associated with drawing laypersons into the process of assessing scientific and technological issues alongside experts (Joss, 2002).

However, evidence is also presented from other science domains of lay involvement in the scoping of solutions through various means (Bielak et al., 2008). Interactive deliberative participation, including through the web, can be used in involving the public in breaking the deadlock in contentious issues (Robbins et al., 2008, p. 569). However, a challenge is faced by funding agencies where limited guidance is available from the research as to how crowds can contribute to scoping solutions to complex scientific challenges.

4G - II. Challenges in selecting solutions

Challenges are faced by funding agencies in deciding who gets to select solutions and how solutions are selected. Although research has stressed the importance of involving expert decisions in scientific review and selection processes (Harnad, 1996). However, other research argues that scientists have their own knowledge deficits (Brunk, 2006). Accordingly, value can be obtained through the inclusion of various stakeholders in the decision-making process in addition to scientists (Van Bekkum and Hilton, 2014;

Rowe et al., 2010). Participation in selecting results can range from informing policy to voting (Jordan et al., 2011).

Where funding agencies seek to involve lay persons and experts in making decisions a challenge is faced in deciding how to select solutions. In particular where participants do not hold equivalent skills. Agencies must develop a system to balance the inputs from all stakeholders in reaching a decision that takes into account the need for expertise highlighted by Harnad, (1996). Various types of decision-making mechanisms are evident in research funding calls. For example, in community based participatory research the use of shared decision making power is evident (Viswanathan et al., 2004). Another challenge is faced in the selection and use of appropriate and accurate scoring systems in call processes where a challenge is faced in setting scoring mechanisms that can be understood and used by all participants. For example, the RAE in the UK used point scales to grade research. Reviewers received instruction as to how scoring or marks ranging from 1, 2, 3a, 3b, 4, 5 and 5* were to be assessed and computed in application processes (Bessant et al., 2003). However, limited evidence is available of substantial research into practices for setting selection mechanisms for skilled and unskilled participants. Some limited evidence is available of the training provided by funding agencies to lay participants in an attempt to overcome challenges posed by their lack of skill (Van Bekkum and Hilton, 2014).

Table 4.8 - Summary of challenges in the generation of potential solutions

Stage	Task	Practices	Challenges
OUTPUT	**Generation of potential solutions** **Section 4G**	**Scoping the solution 4G-I**	Facilitating interactions / the aggregation of submissions into solutions.
		Selecting solutions 4G-II	Facilitating stakeholder involvement in selecting solutions.

4H. Challenges in providing potential rewards for solution seekers, solution providers, brokers.

Funding agencies face challenges in setting potential rewards for stakeholders. Identifying intrinsic and extrinsic motivations for participation are critical success factors in engaging and fostering communities (Kleinman et al., 2011; Zheng et al., 2011). From the crowdsourcing perspective, Simper et al., (2015, p. 20) state that a challenge is faced in incentivising participation. However, agencies face challenges in

providing extrinsic incentives and appealing to intrinsic motivations (see Sections 4H-I – 4H-II). A summary of the challenges are presented in *Table* 4.9 below.

4H - I. Challenges in providing extrinsic incentives

Funding agencies face various challenges in providing extrinsic incentives. Research shows that funding agencies pay certain participants in call processes such as peer reviewers (Gasparyan et al., 2015). In similar processes, such as in the case of journal reviews, evidence shows some journals charging scientists for the provision of reviews. However, in practice, only a small number of journals pay their reviewers (Pasternak and Glina, 2014). Research also shows that for public sector agencies, payment of reviewers presents substantial cost overheads (Snell, 2015). Research has argued that participants should be able to receive pay for participation, for example, participation in the design of public health research (Boote et al., 2010). Ethical issues also exist where participants are paid for review works where large financial rewards form part of the process outcomes.

These issues coincide with a worldwide scarcity of expert reviewers in key research domains. It is posited in various pieces of research that participants in review processes should be paid (Gasparyan et al., 2015), including in open access review processes (Smith, 2006b). By contrast in crowdsourcing, participants in private sector processes are often paid and the effect of extrinsic motivation is an area of research interest (DiPalantino and Vojnović, 2009; Goes et al., 2016; Shaw et al., 2011). However, in the public sector the provision of extrinsic incentives to other participants such as the public presents various regulatory and ethical issues. The ethical issues surrounding the receipt of payment for participation in review works is not confined to funding processes. Research shows that a question of ethics regarding incentivisation also arises in journal peer review processes where parties pay to publish (Nicholas et al., 2015). Also, research has cautioned "*against concluding that the provision of money would solve our civic engagement problems*" (Kleinman et al., 2011, p. 233). It follows that intrinsic incentives might not present as the best form of motivation for all kinds of challenges. It follows that funding agencies face several challenges in setting extrinsic incentives in call processes.

4H - II. Challenges in appealing to intrinsic motivations

For the purposes of involving reviewers and public engagement, funding agencies have long relied upon intrinsic motivations in securing stakeholder participation. In some instances, reviewers participate as part of academic duties and to increase their own researcher profile. Scientists engage with tasks such as EPE for various reasons including personal ones (Martin-Sempere et al., 2008). Intrinsic motivations form part of a complex set of reasons for stakeholder participation in the funding and creation of scientific research. For example, in citizen science, research has examined the complex set of reasons for public participation, including intrinsic reasons such as 'egoism' (increase one's own welfare), 'altruism' (increasing the welfare of others), 'collectivism' (increasing the welfare of a specific group that one belongs to), and 'principalism' (upholding one or more principles dear to one's heart) (Rotman et al., 2012, p. 218). Similar reasons are evident in the crowdsourcing domain such as such as framing a task as for the benefit of helping others (Rogstadius et al., 2011).

Table 4.9 - Summary of challenges in providing potential rewards for solution seekers, solution providers, brokers

Stage	Task	Practices	Challenges
OUTPUT	**Potential rewards for solution seekers, solutions providers, brokers** **Section 4H**	**Providing extrinsic incentives 4H-I**	Providing extrinsic or monetary incentives for stakeholder participation.
		Appealing to intrinsic motivations 4H-II	Appealing to intrinsic motivations of participants to engage in call processes.

4I. Challenges in evaluating broader socioeconomic impacts (rewards for the marketplace and society)

In examining crowdsourcing literature, it is evident that many funding agencies, like crowdsourcing initiatives, use standard web and social media metrics in evaluating the success of crowdsourcing platforms. Agencies face some limited challenges in using the web and social media metrics that are used in industry (see Sections 4I-I – 4I-II). Limited evidence, is available of the challenges facing funding agencies in the use of web and social media metrics to measure call process impacts. The nature of metrics using in the open innovation space differs greatly from the metrics used in other solution seeking processes. This is evident is metrics used in open innovation processes (Erkens et al., 2012). A summary of the challenges are presented in *Table* 4.10 below.

4I - I. Challenges in using web and social media metrics

Crowdsourcing research has presented the substantial use of web and social media metrics in the domain. By contrast, funding agencies are faced with challenges in using these metrics where other forms of impact arising from processes requires measurement. In particular, a challenge is faced in establishing and identifying the real impact that arises from funded research (Lane, 2009). Agencies have predominantly used traditional metrics in call processes such as bibliometrics and journal impact factors in assessing performance (Bordons et al., 2006; "The Impact Factor Game", 2006). For example, Roberts (2003), identifies metrics such as "*the number of doctorates produced, external research income and number of papers produced*". Challenges are also presented in the ex-ante assessment of societal impact, where, "*scientists generally dislike impacts considerations, which they often see as both challenging their authority and undermining the autonomy of the scientific enterprise*" (Britt Holbrook and Frodeman, 2011, p. 8). The collection and implementation of metrics for funding agencies also presents as a slow and arduous process where data from a vast number of participants and sources is collated in forming decisions and strategies surrounding metrics. Vorvoreanu et al., (2015) states, for example, that the development:

"*and adoption of the ambitious STAR Metrics project has been difficult and slow, and at the time of data collection for this research project it was yet to meet the needs of decision makers at funding agencies*".

Accordingly, the development and deployment of metrics by funding agencies presents challenges where web and social media metrics alone do not cover all aspects of funding processes that require measurement.

Table 4.10 - Summary of challenges in evaluating broader socioeconomic impacts

Stage	Task	Practices	Challenges
OUTCOME	**Broader socioeconomic Impacts (rewards for the marketplace and society)** **Section 4I**	**Using web and social media metrics** **4I-I**	Using web and social media metrics in evaluating impact.

4.5. Summary

This chapter has provided an overview of the challenges faced in the public funding of science. The next chapter (Chapter 5) will outline the research methodology used. In particular, this chapter has presented the literature relating to funding agency call processes. Also, the tasks completed in research funding call processes were examined and compared to the tasks used in the Marjanovic et al., (2012) framework. Last, the types of challenges faced by funding agencies in using call processes were examined through the application of the framework as a lens. The challenges identified above at sections (4A - 4I) will serve as basis for subsequent discussions in Chapter 8.

Chapter 5. Research methodology

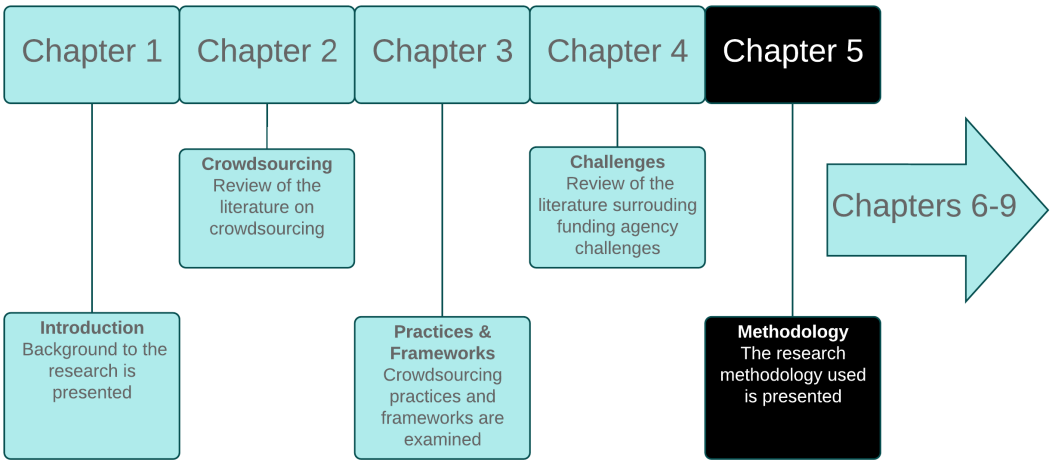


Figure 5.1 - Chapter structure - Chapter 5

5.1. Introduction

In this chapter, the research methodology is outlined. A qualitative interpretivist approach was adopted in this research. The reasons for the choice of this approach and the various aspects of the methodology used are discussed in this chapter. This chapter serves as a basis for the empirical investigation in Chapters 6 and 7 and follows from the context presented in Chapters 1-4 (see Fig. 5.1 above). The early Greeks, in the pursuit of truth, identified two categories namely; "*Doxa (that which was believed to be true) and episteme (that which was known to be true)*" (Hirschheim, 1992). Accordingly, scientific inquiry can be presented as the process of inquiry which transforms doxa into episteme. This process contains four main components namely the philosophical roots, methodological theory, and research design and implementation. The philosophical underpinnings of research approaches have been considered by numerous authors (Denzin and Lincoln, 1994; Guba and Lincoln, 1994; Vaishnavi and Kuechler, 1996; Yin, 2017). As research encompasses the researcher's beliefs about the way in which knowledge is constructed (Cavaye, 1996), this chapter sets out those beliefs and the basis upon which the research methods are chosen. After the introduction (Section 5.1), the philosophical paradigms of research are presented (Section 5.2). Second, the theory behind the methodology used is examined (Section 5.3). The research design is then described (Section 5.4). Thereafter, the expert interviews and case studies are presented (Section 5.5, Section 5.6), before the chapter summary (Section 5.7).

5.2. Philosophical paradigms of research

Research philosophy is defined by Saunders et al., (2011) as "*an overarching term relating to the development of knowledge and the nature of that knowledge"*. Hassan et al., (2018, p. 1) states that "*a lack of attention to and understanding of philosophy can render research and its outcomes misleading or vacuous*". It follows that there is a need for reflection on philosophical underpinnings of research. Evidence shows that information systems research has a greater concentration on practical or methodological issues, rather than the ontological and philosophical reasoning behind research approaches (Dobson, 2001). To this end, Garcia, (1997, p. 444) argues that;

"the starting point of a researcher's methodological choice within information systems is not so much a problem of how many methods we employ or if those are of a quantitative or qualitative nature, but the ability to identify the philosophical and theoretical assumptions that lead to the choice of appropriate methodology".

Several major categorisations of philosophical paradigms are evident in research (see *Fig*. 5.2 below). Although various popular paradigms are in use, the core research paradigms evident in Information Systems are positivist, critical and interpretivist (Creswell and Miller, 2000). The popularity of choice in these paradigms and associated research methodologies has changed at various stages over the decades preceding. Inquiry paradigms according to Guba and Lincoln, (1994, p. 108), are presented as entities that: "*define what they are concerned with and what falls within and outside the limits of legitimate inquiry".*

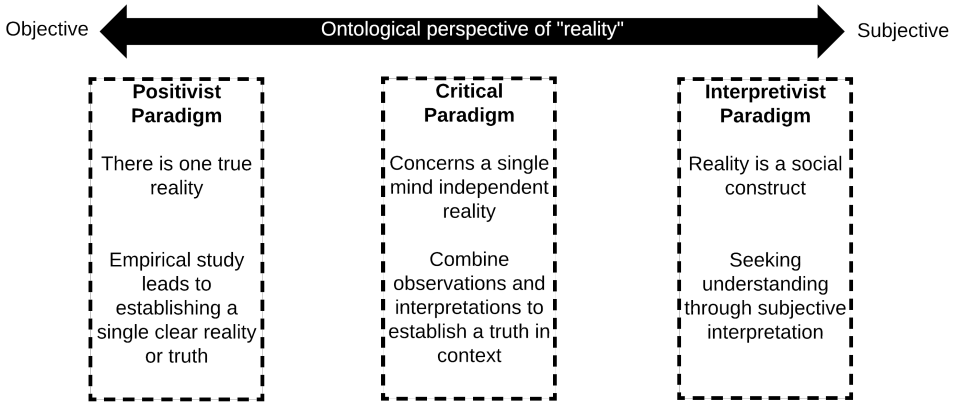


Figure 5.2 - Ontological comparison of research paradigms (adapted from Mingers, 2004; Creswell and Miller, 2000; Järvensivu & Törnroos, 2010; Rubin and Rubin, 2011).

Research paradigms contain fundamental questions namely: (i) ontological questions: what is the form and nature of reality and what can be known about it, (ii) epistemological questions: examining the relationship between the knower and what can be known and (iii) methodological questions: addressing how the inquirer can go about finding out what can be known (Denzin and Lincoln, 1994). The philosophical discussion of ontology (the nature of the world) and epistemology (how we know) is central to understanding the nature of the foundations of research. Accordingly, there is a strong correlation between how the world or reality is viewed and the potential effect upon the research methods chosen (Orlikowski and Baroudi, 1991).

According to Cruickshank, (2004, p. 567), "*ontology is defined as both a fallible interpretation of reality and as a definitive definition of a reality beyond our knowledge claims*". Hirschheim, (1992, p. 13), describes epistemology as referring to; "*our theory of knowledge; in particular, how we acquire knowledge*" with this process divided into two categories namely "*what is knowledge*" and "*how do we obtain valid knowledge*"? According to Rowland, (1995, p. 278), "*particular ontological beliefs lead us to make particular epistemological assumptions*". This relationship highlights the potential of the researcher's own beliefs to affect the methods chosen and the outcome of the research. The methodology chosen dictates how the researcher arrives at the objective or subjective truth. The competing research paradigms considered in this research are now compared and contrasted (Sub-section 5.2.1).

5.2.1. The positivist paradigm

Positivist approaches embrace a specific ontological position, namely realism, which postulates that the universe is comprised of objectively given, immutable objects and structures that exist as empirical entities, on their own (O'Neill, 2006; Smith, 2006a; Trauth and Jessup, 2000; Tsang, 2014). These exist independently of the observer's perspective and understanding of them, which facilitates unbiased and accurate empirical measurement of cause and effect.

Positivist approaches adopt a philosophical stance as that of a 'natural scientist'. In this sense, positivism is associated only with that which can be observed and measured scientifically. In the physical or 'natural world' the existence of a value-free objective reality is assumed as a basic paradigm (Dubé and Paré, 2003). In this

regard, positivist research is deductive in nature where a substantial amount of up-front work is completed by the researcher from the perspective of what is already known (Bryman, 2007). This may take the form of very detailed or narrow research questions. There is not much by way of provision for the emergent with categories of information laid down in advance of data collection. This is known as positivist, deductive reasoning (also known as Theory-then-Research) (Reynolds, 2015).

From an epistemological perspective, positivism seeks falsification and the weight of numbers approach supports this through systematic methods. Burrell and Morgan, (1979) define positivism as an epistemology "*which seeks to explain and predict what happens in the social world by searching for regularities and causal relationships between its constituent elements*". Rubin and Rubin, (2011), state that this is completed through mathematical approaches or through the use of equations for predictive purposes. Positivist researchers have been critical of interpretivist research, claiming it is not 'pure science' in the strictest sense (Sandstrom and Sandstrom, 1995). A major distinction between positivist and interpretivist approaches lies in the means by which knowledge is created. Positivistic approaches rely heavily on deductive or top-down approaches (Cummings, 1998). The researcher will hold a large view kernel idea, which they will seek through reductionism to break down into a testable hypothesis. By contrast, some research does not accept the presupposition of the existence of objective reality as with constructionism (otherwise known as idealism) (c.f. Benbasat and Weber, 1996).

5.2.2. The critical paradigm

In recent decades, post-modernism or post-positivist approaches (critical paradigms) have become more apparent (Smith, 2006a). The rise of post-modernism has evolved in parallel to the deepened questioning of positivist science and associated methods used in research. Critical approaches are often concerned with the idea that our senses deceive us and that in conducting research we experience sensations rather than observe phenomena directly. However, several authors have questioned the real value of critical paradigm to the social sciences and have highlighted problems with the prospective value it offers to research generally (Hammersley, 2009; c.f. Kemp, 2005).

Such approaches offer a compromise between the two polar views of positivism and interpretivist approaches (Mingers, 2004). Healy and Perry, (2000, p. 118) suggest that; "*while positivism concerns a single, concrete reality and interpretivism multiple realities, realism concerns multiple perceptions about a single, mind-independent reality*". Mingers, (2004, p. 300), however, argues that critical realism is important for information systems research because:

"*(i) CR enables us to take a basically realist stance whilst accepting the major critiques of naive realism; (ii) it addresses both natural and social science and thus encompasses the main domains of information systems; and (iii) does potentially fit well with the reality of IS as an applied discipline*".

Also, authors have highlighted that the use of critical approaches potentially make the research output more generalizable, something they argue the interpretivist paradigm does not do well (Tsang, 2014). Critics of this paradigm have argued that a mind-independent reality can be hard to achieve in the conflicting environment of people, processes and technology (Losch, 2009). For example, it can be evident in some cases that multiple realities exist within online communities.

Constructionist approaches through interpretivism allow for the study of multiple realities constructed by people and the study of the implications of those constructions for their lives (Moon and Blackman, 2014). Crowdsourcing ecosystems are social environments where multiple realities and perspectives surround the process. Qualitative analysis also allows for ambiguities/contradictions in the data and such coexisting realities which are a reflection of social reality (Denscombe, 2010). For these reasons, this research adopts an interpretivist approach, outlined in the next section (Sub-section 5.2.3).

5.2.3. The interpretivist paradigm

The positivistic paradigm, anti-naturalists (constructivists) claim that the extension of the natural science methods to the social world is inappropriate (Johannessen and Olaisen, 2005). The interpretivist ontology assumes that multiple concurrent realities can exist within a domain of study. In the social world, humans can assign meanings to interactions a fact that constructivists argue renders positivistic approaches ineffective in such contexts. Interpretive approaches are primarily used by

constructivists in investigating/obtaining meaning as understood by social actors in context. Interpretivism was presented by (Walsham, 1995) in opposition to the existing modus operandi of positivism (c.f. Orlikowski and Baroudi, 1991). Interpretivism only began to emerge as a strong alternative with the works of (Nandhakumar and Jones, 1997) and (Trauth, 2001; Trauth and Jessup, 2000). At this point, interpretivist approaches in IS became both acceptable and mainstream. This shift in focus sought to remove the claim that positivist approaches were in some way supporting the blatant interests of the discipline. In the present day, the increasing roles of human interaction and big data within the technology landscape are placing renewed requirements upon researchers to be adaptive in terms of their research methods used (DeLyser and Sui, 2013; Smith, 2014).

From the epistemological perspective, interpretivist approaches can deal with complex occurrences in a field of study such as emergent properties. Interpretivism focuses on the "*subjective meaning of reality*" over an independent and "*objective reality*" (Burrell and Morgan, 1979). Furthermore, interpretive research approaches greatly assist in understanding the real-world environment within which organisations operate. They are particularly useful where context is an important factor (Stake, 1996). By way of example, where various actors within the system interact, case studies present as a means to answer tough or challenging social questions associated with the environment and processes. Some literature suggests that the value-free stance of science causes difficulty whereby first, this approach does not support decision making either in context or in complex scenarios (Funtowicz and Ravetz, 1993). Second, the focus on generalizability by science often fails to provide the detailed, place-based knowledge necessary for community-based action and adaptation (Wynne, 1992, p. 116, 2006).

Interpretive research is more concerned with language and symbology than a weight of numbers approach adopted in more positivistic approaches. Schwandts (1994, p. 223) states that interpretivism is "*painted in broad strokes..the canvass of interpretivism is layered with ideas stemming from various traditions*". In the case of interpretivist research, inductive reasoning (also known as Research-then-Theory) the researcher may have some basic loose ideas from which themes categories of information emerge during the analysis of data collected.

Induction involves the "*development of a theory as a result of the observation of empirical data*" (Saunders, 2011). Walsham (1995) highlights that interpretivists assume that scientific knowledge should be obtained "*not through hypothetic-deductive reasoning but through the understanding of human and social interaction through which the subjective meaning of the reality is constructed*". This 'subjective meaning' is obtained through an inductive process that can be both behavioural and contextual in focus.

The interpretivist approach stands juxtaposed to the tautological firmness of positivistic inquiry. Induction holds a bottom-up approach whereby observations lead to identifiable patterns, testable hypotheses and thereafter, theoretical contributions. Lincoln and Guba, (1985) contended that positivism "*falls short of being able to deal with emergent conceptual/empirical formulations from a variety of fields*" by ignoring the "humanness" element. This particularly applies to this study where motivational and behavioural considerations are critical in understanding how call processes function. The battle between competing philosophies is evident in the reasons behind the methodological choices made by researchers across research (Creswell, 2013; Yin, 2017). In the next section, the theory underlying the methodological approach used is presented.

5.3. Methodological theory

Methodological theory is the theory about the method used in the research and is concerned about the methods of approaches and what lies behind a piece of research (Punch, 2013). Methods in information systems research are compared across headings such as; "*empirical vs. non-empirical, qualitative vs. quantitative, cross-sectional vs. longitudinal, and across research designs*" (Chen and Hirschheim, 2004). Historically, in information systems research, there has been an evolution in the favoured research methods chosen. Researchers, where selecting a research approach, should base their selection on that which meets the needs of their study and appropriately addresses the questions being asked (Moody, 2000; O'Neill, 2006).

For some time, positivist, quantitative methods were favoured in information systems research approaches (Cavaye, 1996; Goles and Hirschheim, 2000; Orlikowski and Baroudi, 1991). Popular methods in use included case studies, lab experiments

and surveys, with surveys accounting for over 49.1% of the methods used (Orlikowski and Baroudi, 1991, p. 4). By the turn of the millennium, there was a growing disparity between US and European traditions in information systems research. Chen, (2004, p. 197) reflected upon the methodologies used over the previous thirty years and noted that US journals, as opposed to European journals, tended to be "*more positivist, quantitative, cross-sectional and survey oriented*"..

Despite a traditional bias towards quantitative approaches in the collection and evaluation of research data (Cavaye, 1996; Yin, 2003), there has been an increased focus upon qualitative methods within information systems (Yin, 2017). It has been argued that the bias towards positivist/quantitative approaches had been at the expense of the philosophical foundations of rich qualitative and interpretivist approaches/methods used within information systems research (Trauth and Jessup, 2000). Contrasts between qualitative and quantitative approaches are presented below (see *Table 5.1*).

Table 5.1 - Contrasting Qualitative and Quantitative (source; Approaches Bryman & Bell, 2007 and Onwuegbuzie & Leech, 2009)

Description	Quantitative	Qualitative
The role of theory	Deductive	Inductive
Epistemological orientation	Naturalist, positivist	Interpretive
Ontological orientation	Realist	Idealist, constructivist
Characteristics of research approaches	Objective	Subjective
	Impersonal	Personal
	Reductionist	Holistic
	Generalisation	Uniqueness
Types of data	Quantifiers	Describers
	Numbers	Words

Quantitative research methods include "*survey methods, laboratory experiments, formal methods (e.g. econometrics) and numerical methods such as mathematical modelling*" (Zack, 1999). By contrast, qualitative research methods involve the use of qualitative data, such as documents, observation data, so as to explain the social phenomena. Several techniques are available where conducting qualitative research such as the use of focus groups, interviews, word association, in-depth interviews, pilot surveys and case studies (Lune and Berg, 2016). Other popular qualitative research methods in information systems research include the use of Delphi studies and action research. The use of mixed-method approaches is also evident in research such as those examined by (Bergman and Bryman, 2014; Bryman, 2007; Leech and Onwuegbuzie, 2009).

For example, in mixed method approaches a qualitative study can be used to give extra context to a quantitative investigation (Soffer and Hadar, 2007), Mixed method approaches can include studies that feature the use of research employing several methodologies including a survey and case study, However, these are to be set aside from multi-method approaches where more than one world-view can be used in applying multiple research methods in addressing a problem space (Modelling, 2013).

5.3.1. Selecting a research approach

From the methodological perspective, research has called for the use of interpretive empirical approaches in the investigation of this under-researched domain of crowdsourcing (Alam and Campbell, 2013a). Also, IS research shows examples of interpretivist approaches that are applicable in similar contexts (Erickson, Petrick, Trauth, et al., 2012; Malczewski, 2002).

Where selecting a particular research method, a selection is based upon that which meets the needs of the study and appropriately addresses the research questions (Moody, 2000; O'Neill, 2006). As is evident above (*Table 5.2*), interpretivists generally employ the use of qualitative methods, which have an emphasis on human/social contexts (Malczewski, 2002). Kaplan, (2006) presents several reasons why using qualitative methods can be helpful including the need to determine what might be important to measure, to understand and explore what technology or practice means to people and to investigate the influence of social, organizational context.

As presented in Chapter 3, crowdsourcing communities and platforms are inherently human and social ecosystems. There is evidence of quantitative approaches been used in crowdsourcing research (Kaufmann et al., 2011; Liu et al., 2014; Yang et al., 2011). However, evidence also exists in the specific challenges associated with using quantitative methods in similar social contexts. Examples of such challenges synthesized from the literature include: (i) results can be limited as they provide numerical descriptions over and above rich human narratives (ii) quantitative data may miss contextual detail by virtue of been carried out in unnatural environments or contexts (iii) static and rigid approaches to research present as inflexible processes and can restrict discovery; with the use of standard questions there is a risk of bias where the data can/actual reflects the views of the researcher (iv) research outputs can

provide less detail on behaviours and motivations and (v) how people feel is important in processes and can often be lost in pure numerical outputs (Babbie, 2015; Manheim et al., 2008; Nathan and Scobell, 2012). By contrast, qualitative methods focus on the qualities of phenomena being investigated rather than their numeric measurement (c.f. May, 2012; Sutrisna, 2009). Accordingly, it is posited that qualitative interpretivist methods are suitable in seeking to answer the research objectives for the following reasons: (i) participants within crowdsourcing processes embrace multiple realities which are best understood in context, (ii) crowdsourcing processes show the use of language symbols and meanings in engaging in practices (that are social) within crowdsourcing initiatives (iii) a proper social explanation of crowdsourcing process in funding agency contexts must be examined from the perspective of understanding the meaning to be attributed to human participant actions (iv) from the outset well-established information (crowdsourcing framework) is used to advance theory as an adapted framework by inductive and not deductive reasoning. In particular, where participants in such processes can be considered in many instances to be social agents contributing of their own free will or in contributing as part of a community. For these reasons, the use of qualitative methods is employed in the research.

5.3.2. Comparison of qualitative methods

Eysenbach and Till (2001, p. 1103) states that "*qualitative research seeks to acknowledge the existence of and study the interplay of multiple views and voices—including, importantly, lay voices*". The following qualitative methods which facilitate participant voices are compared and contrasted for the purposes of selection;

The Delphi method which originated in the 1950s is defined by Okoli and Pawlowski, (2004), as "*a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem*". Such studies in information systems research feature panels of experts who in turn through interaction and discourse refine solutions to questions or challenges. Due to the emergent nature of the crowdsourcing domain and the nature of expertise, use of the Delphi method has been set aside in favour of expert interview, which offers deeper learnings in a one-on-one context rather than through group interaction.

Focus groups are a form of group interview that capitalises on communication between research participants in order to generate data (Jenny Kitzinger, 1995). The method is particularly useful for exploring people's knowledge and experiences and can be used to examine not only what people think but how they think and why they think that way (Morgan, 1993). However, the method is not without its shortcomings. For example, it can encounter difficulties in cross-cultural settings (Yelland and Gifford, 1995). Several funding agencies examined within this research feature participants from across cultures within the same work setting.

Within the information systems research, examples exist of the use of both qualitative and quantitative ***survey methods***. In information systems research from the methodological perspective, surveys are presented as 'survey research' (Pinsonneault and Kraemer, 1993). Pinsonneault and Kraemer, (1993), states that surveys can have three characteristics namely' (i) to "*produce quantitative descriptions of some aspects of the studied population*", (ii) to ask "*people structured and predefined questions*" and (iii) "*information is generally collected about a fraction of the study population - a sample- but it is collected in such a way as to be able to generalize the findings to the population*". Such approaches are suited to answering specific queries of a population.

Further evidence exists of **multiple methods** been used (Gable, 1994; Morgan, 1993). For example, the combined use of focus groups and case studies. However, for the reasons quoted above, such an approach encompassing such additional methods is not suited to the approach adopted in this research. For example, *mixed-method* approaches by contrast or 'hybrids' may be required where research has varying facets of inquiry, better explained by part quantitative and part qualitative approaches (Kaplan and Duchon, 1988). In practice, research may deploy both quantitative and qualitative/interpretative approaches to better delineate a new problem area. By combining methods as a route to potentially reducing bias the researcher is employing a frame of reference which assumes a knowable reality "*and thereby rejects and idealist or pure constructivist position*" (Abdur-Rahman, 2010). It is argued that due to fundamental divergence in epistemology and ontology, it is not accepted that mixed-method approaches can be applied either to specific instances of this research that favours explanation through the use of qualitative methods.

One of the major questions facing the use of specific methods in information systems research is one of rigour (Dubé and Paré, 2003). The integrity of the research process is critical to ensuring good quality of results arises from the process. To this end in qualitative approaches such as the use of case studies can employ triangulation approaches. This allows for the checking of integrity through the comparison of processes and results. In particular, Yin, (2013), notes four types of triangulation namely: (i) of data sources (ii) among different evaluators (iii) of perspectives to the same data set (theory triangulation and (iv) of methods (methodological triangulation). In this research, different data sources of evidence in the form of documentation, physical interviews and physical artefacts (call process management systems) are examined. Two types of interview approaches were used in this research.

5.4. Research design

In building a research design based upon philosophical considerations, a reflection upon the IS discipline's use of qualitative methods from the interpretivist paradigm is presented. The diagram below (see *Fig.* 5.3) presents an overview of the stages of the research design used, based upon the selections made (see Sections 5.5, 5.6). An explanation is presented of the design implementation later (see Section 5.7). Where multiple qualitative methods are combined in a study, greater potential to achieve rigour and accuracy in research is obtained. For this reasons, two separate qualitative methods were used in collecting and analysing data in this study and are now discussed. The methods used includes expert interviews (Bogner et al., 2009) and multiple case study approach (Stake, 1996, 2006). Multi-method approaches featuring the use of more than one qualitative method, including expert interviews are evident in research (Muskat et al., 2012).

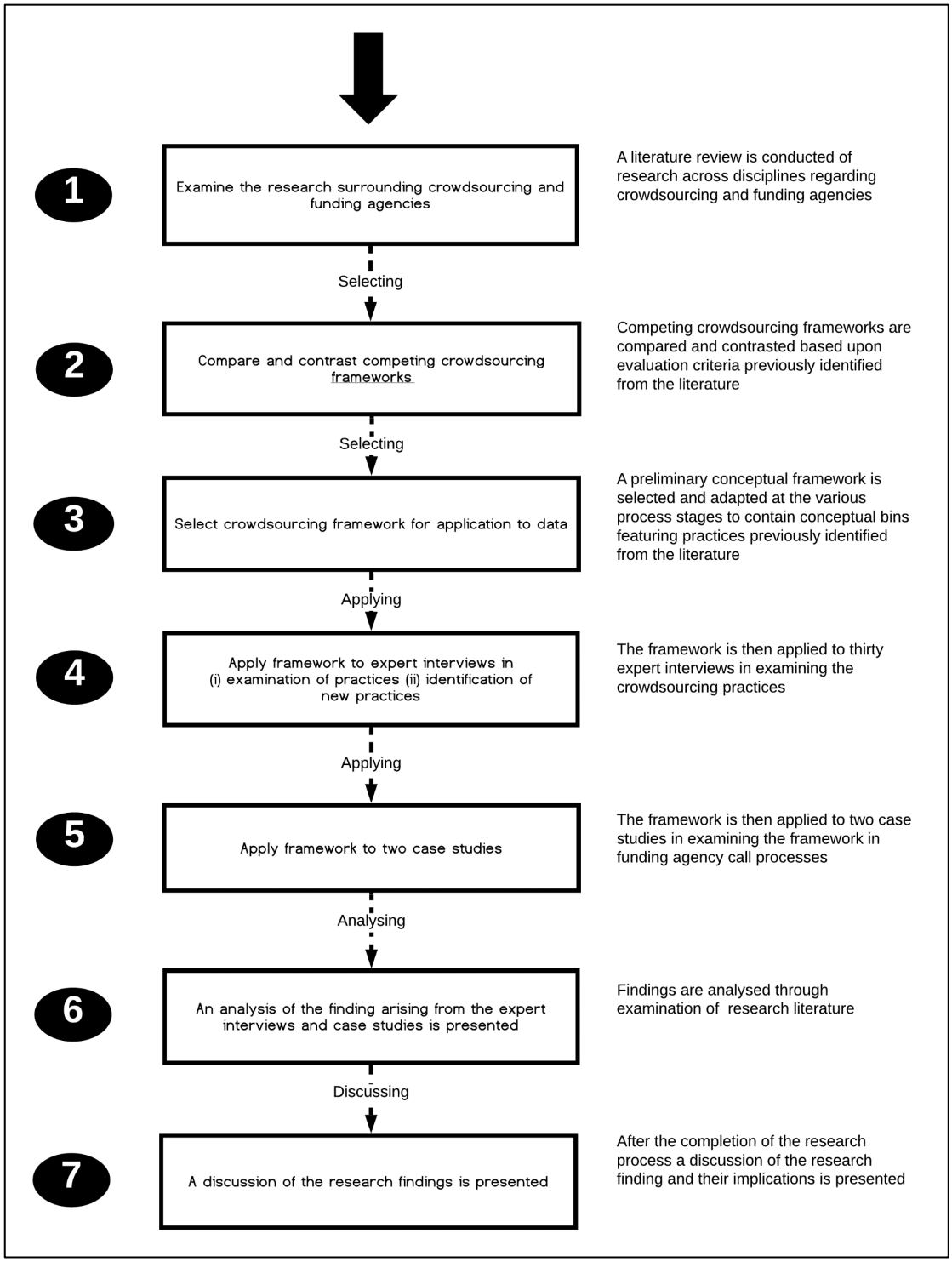


Figure 5.3 - Overview of the research design

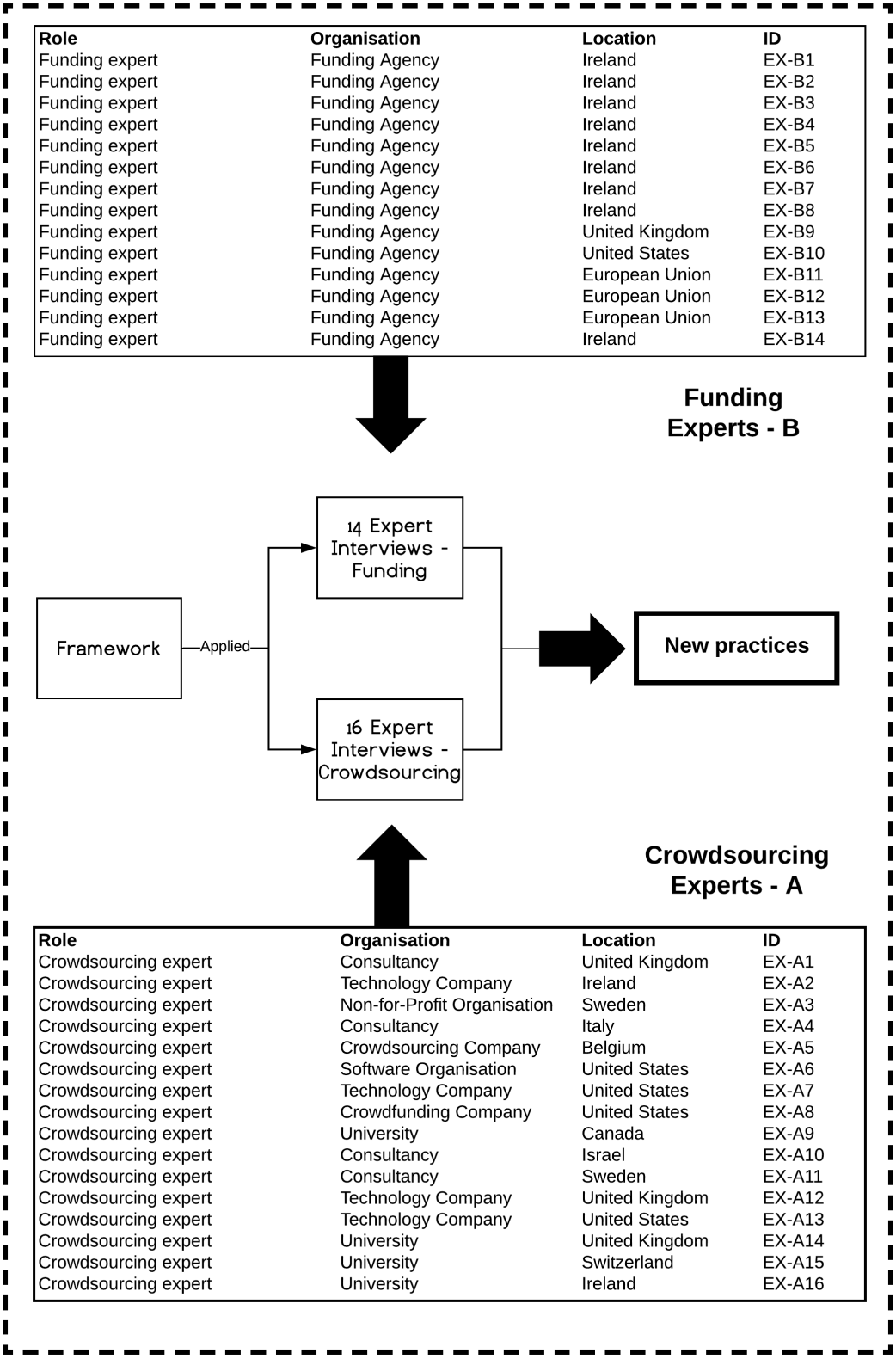
5.5. Expert interviews

In this research expert interviews were conducted with call process experts across two groups, research funding and crowdsourcing (see *Fig*. 5.4 below). The purpose of utilising this methodological approach was to examine the practices through applying the framework and where possible identify new ones. The findings from expert interviews then formed the basis of the revised framework applied to both case studies at the next stage of the process. The use of experts has a long history in qualitative research (Kerkering, 2002; Meyer and Booker, 2001). Evidence shows that experts are canvassed across research domains in various capacities including policy analysis, climate change and enterprise transformation etc. (Abraham et al., 2013; Audenhove, 2007; Otto-Banaszak et al., 2011).

By way of example, experts have also been accessed in prediction (Keeney and von Winterfeldt, 1991; Murray et al., 2009), and risk analysis (Hora and Iman, 1989; Von Krauss et al., 2004). Also, there is evidence of the expert approach in contemporary information systems research, with experts accessed through interviews, panels and Delphi (Conboy and Fitzgerald, 2010; Okoli and Pawlowski, 2004). Within this research, a body of thirty experts is divided into two tranches of process experts namely crowdsourcing experts (fourteen in number) and funding experts (sixteen in number). Each set of experts addressed practices identified in the entire lifecycle of the call process through the framework of Marjanovic et al., (2012). Careful consideration was required in drawing comparisons between the differing expert positions across two separate domains.

An issue that is evident in the literature concerning expert interviews is the issue of potential interviewee bias. Various steps were taken to remove potential biases. First, multiple researchers coded the initial pilot data. Three extra coders examined the transcripts and coding for examples of bias. Second, on the completion of interviews, the interviewees had a chance to review the transcripts to confirm they were satisfied. Third, where available, extra data was collected from documentation and other media/materials surrounding the call processes. This was used to verify assertions made about practices and challenges by the interviewees.

Role	Organisation	Location	ID
Funding expert	Funding Agency	Ireland	EX-B1
Funding expert	Funding Agency	Ireland	EX-B2
Funding expert	Funding Agency	Ireland	EX-B3
Funding expert	Funding Agency	Ireland	EX-B4
Funding expert	Funding Agency	Ireland	EX-B5
Funding expert	Funding Agency	Ireland	EX-B6
Funding expert	Funding Agency	Ireland	EX-B7
Funding expert	Funding Agency	Ireland	EX-B8
Funding expert	Funding Agency	United Kingdom	EX-B9
Funding expert	Funding Agency	United States	EX-B10
Funding expert	Funding Agency	European Union	EX-B11
Funding expert	Funding Agency	European Union	EX-B12
Funding expert	Funding Agency	European Union	EX-B13
Funding expert	Funding Agency	Ireland	EX-B14



Role	Organisation	Location	ID
Crowdsourcing expert	Consultancy	United Kingdom	EX-A1
Crowdsourcing expert	Technology Company	Ireland	EX-A2
Crowdsourcing expert	Non-for-Profit Organisation	Sweden	EX-A3
Crowdsourcing expert	Consultancy	Italy	EX-A4
Crowdsourcing expert	Crowdsourcing Company	Belgium	EX-A5
Crowdsourcing expert	Software Organisation	United States	EX-A6
Crowdsourcing expert	Technology Company	United States	EX-A7
Crowdsourcing expert	Crowdfunding Company	United States	EX-A8
Crowdsourcing expert	University	Canada	EX-A9
Crowdsourcing expert	Consultancy	Israel	EX-A10
Crowdsourcing expert	Consultancy	Sweden	EX-A11
Crowdsourcing expert	Technology Company	United Kingdom	EX-A12
Crowdsourcing expert	Technology Company	United States	EX-A13
Crowdsourcing expert	University	United Kingdom	EX-A14
Crowdsourcing expert	University	Switzerland	EX-A15
Crowdsourcing expert	University	Ireland	EX-A16

Figure 5.4 - Composition of groups of expert interviewees

While the use of expert interviews shows various degrees of similarities with case study interviews used later in the process (see Sub-section 5.6.3) some differences exist. Both methodological approaches use semi-structured interviews with participants guided by a protocol. However, in the case of expert interviews, experts are canvassed for their expertise in addressing and elaborating on problems/questions over and above contextual knowledge alone. In particular those that are to be found in a socio-technical context (Meyer and Booker, 2001). By contrast, in case studies, the data obtained from participants are triangulated with other data sources (Malczewski, 2002; Merriam, 1988).

Accordingly, separate interview protocols were utilised in ensuring rigour for comparison purposes with different protocols used between the expert interviews and case studies. Due to the diversity and distribution of the sample of experts world-wide, convening experts in a single physical location would have presented an immense organisational and budgetary challenge. Accordingly, the researcher resolved to conduct a series of individual expert interviews with the sample set identified. The nationality and number of interviewees is presented below (see *Fig.* 5.5). Although eight of the funding experts were drawn from Ireland, the researcher argues that comparison is still possible where the learnings from the data are applicable in an Irish funding agency context. Also, consistent themes and issues arose across the experts interviewed showing a similarity between the international call processes used.

Figure 5.5 - Nationality of expert interviewees

From the gender perspective, of the funding experts, nine women and five men were interviewed. Of crowdsourcing experts some twelve men and four women were interviewed. Achieving gender balance in the body of interviewees was not possible in the study. The researcher had no control over which experts accepted interview requests despite best efforts to achieve an equal spread over interview requests. However, whilst there was a greater amount of male participants in group A, this was met by a larger group of female participants in group B (see *Fig.* 5.6 below).

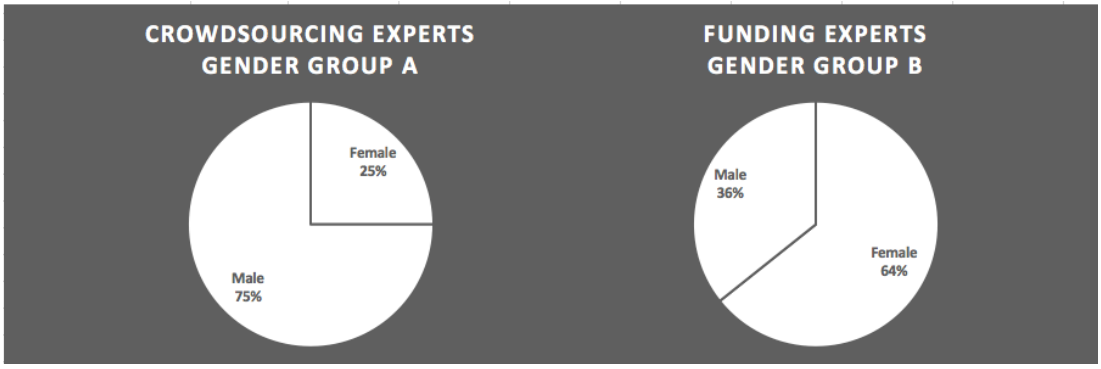


Figure 5.6 - Gender of the expert interviewees

5.5.1. Defining experts

Establishing what counts as expert opinion in research presents as a difficult process (Bogner et al., 2009). Evidence of this challenge has been evident across research domains for some years across both the expert interviews approach (Bellamy et al., 2006; Bogner and Menz, 2002) and Delphi method (Dalkey and Helmer, 1963; Linstone and Turoff, 1975; Turoff, 1971). A challenge evident in expert selection is the removal of apparent biases from the selection process/criteria.

There have been various challenges levied against the method claiming in some instances that it is both subjective and unscientific. Kerkering, (2002, p. 193), in addressing Meyer and Booker (2001), describes typical pitfalls including the "*introduction of bias, the limited number of items (seven) that experts can mentally juggle, the desired "granularity" of the data for analysis, and the "condition effect" on gathering and analysing data"*. However, advantages to the method are also evident. Meyer and Booker, (2001), define expert judgment as "*informed opinion on a technical problem based on an expert's training and experience*".

The same authors state that experts "*are interested not only in the answers to technical questions, but also in problem-solving procedures*". Accordingly, it is posited that experts can provide valuable insights into the processes used by both groups.

5.5.2. Selection of experts

Research addresses the importance of properly pre-defining and enforcing expert selection criteria from the outset (Cooke and McDonald, 1986; Hoffman, 1987). In this study rigorous criteria were established from the outset in the pre-selection of experts. Also, the adoption of the expert interview approach over a large number of experts (thirty in number) provides a better opportunity to establish results closer to subjective truth. As presented in Chapter 4, funding agencies hold a long history spanning over decades in the operation of call processes. As many contemporary public research funding agencies present as established organisations, it was possible to establish a minimum level of expertise based upon work completed, years of experience and engagement with ongoing academic research and shared learnings. In the following tables selection criteria for experts are presented below (see *Table 5.2* and *Table 5.3*).

Table 5.2 - Selection criteria for funding experts

Required domain of expertise	Means of expert location	Criteria for selection
Funding experts who have managed call processes	-Employed at major national or international funding agencies -Personal contacts -Shared funding agency databases -Funding agency portals	>Five years' funding agency experience generally >Three years' funding call process management experience
Funding experts who have engaged in the design/deployment of call processes	-Employed at major national or international funding agencies -Personal contacts -Shared funding agency databases -Funding agency portals	>Three years' experience in designing or deploying stages of funding calls
Funding experts who are cognisant of research surrounding call process management	-Literature review of funding agency process documentation and documentation from shared learning networks	>Three years' participation in learning and sharing networks in the funding call domain at a national or international level

In the case of funding experts, the search was based upon skill and years of experience. According to Meuser and Nagel, (2009), two categories of experts can be are desirable. First, persons who are responsible for the development, implementation or control of solutions/strategies/policies. Second, persons who have privileged access to information about groups of persons or decision processes.

The search for interviewees extended through national and international public research funding agencies, call documentation, literature concerning funding agencies and learning and sharing networks. Candidates with a minimum of three years' experience in managing call processes were included in the sample set elected. In particular a time period of three years was selected where agency information detailed that it can take upwards of thirty-six months for a funding call to be advertised, completed with a full ex post evaluation of outputs completed. Academic and professional experience from the CVs and biographical information posted about the candidates was considered in the selection process.

In the case of crowdsourcing, the criteria for establishing expertise was extended to academics and researchers based in the domain. Similarly, academic and professional experience was gauged from the CVs and biographies posted online of the candidates. Membership of crowdsourcing organisations and attendance at crowdsourcing conferences was also used for selection purposes. A substantial amount of academic literature was perused in the process of identifying suitable expertise for the purposes of interviews. Similarly, a minimum of three years' experience was set out for expertise in the domain. This provide challenging in candidate selection, where crowdsourcing presents as a young domain.

Table 5.3 - Selection criteria for crowdsourcing experts

Required domain of expertise	Means of expert location	Criteria for selection
Crowdsourcing practitioners who have managed call processes	-Membership of crowdsourcing associations groups -Crowdsourcing conferences -Crowdsourcing, crowdfunding and Open innovation industry blogs	>Five years' crowdsourcing open innovation experience generally >Three years' call process management experience
Crowdsourcing practitioners who have engaged in the design/deployment of call processes	-Membership of crowdsourcing associations groups -Crowdsourcing conferences -Crowdsourcing, crowdfunding and Open innovation industry blogs	>Three years' experience in designing or deploying stages of crowdsourcing calls
Academics who are cognisant of/research crowdsourcing	-Literature review of relevant academic and practitioner journals and conferences	>Three crowdsourcing publications in refereed journal/conferences

5.5.3. Data collection - expert interviews

Expert interview data were gathered between January 2016 and December of 2017. The Marjanovic et al., (2012) framework was used to guide the development of the interview protocol and associated interview questions. Over a course of several iterations, two different protocols were developed, guided by the Marjanovic et al., (2012) framework and associated practices identified (see Chapter 3). The wording of the questions in line with the framework headings were reviewed and revised until two appropriate protocols were prepared with one version for crowdsourcing experts and another version for research funding experts. A sample protocol used in the interviews with funding experts in contained at *Appendix* D.

A series of questions surrounding the framework tasks and practices were formulated and used to guide the discussion with the experts in a semi-structured interview format. The questions were used as prompts to solicit expert opinion on the tasks/practices delineated in the framework. Through this process the experts were in a position to elaborate from experience as to the practices identified and new practices suited to the various stages of the process identified. The framework stages serve as intellectual "bins" (Miles et al., 2013) for the purposes of collecting the data. The framework aided the collection of data by providing a conceptual guide, founded on theory, for the collection and sorting of data into the various framework parts for subsequent analysis.

The interviewees were contacted with the majority of interviews conducted over Skype/VOIP. The balance of interviews with experts were conducted face-to-face in the United Kingdom, United States,. Ireland, Belgium and the Netherlands. Apple recording software LogicX was used to record and improve the audio quality through a process called normalisation which fixes the audio files relative volume (see *Fig*. 5.8 below). Using compression ambient noises and plosives were removed from the files to allow better audio to text conversion. After this the audio files were loaded into Dragon Dictate from Nuance. The automatic audio text conversion feature was used with the files achieving about 70% accuracy in speech to text conversion. After this the transcripts were afforded line numbers and manually checked for discrepancies.

To increase speed in the process of checking transcripts the researcher played files at 1.5x speed which allowed a faster checking of the transcript quality thereby allowing more time for data analysis. The researcher used the set of field notes for each interview in conjunction with the audio recording and transcripts to insure accuracy. This was of particular assistance for two audio files where poor audio results were obtained. In both instances background noise affected the tapes and both interviewees had strong accents.

5.5.4. Coding process

Similar coding processes were used at the expert interview and case study stages of the process. The use of frameworks to guide the coding process is evident in multidisciplinary qualitative research (for example see Gale et al., 2013). Qualitative analysis was undertaken using the coding technique advanced by Strauss and Corbin, (1998). Interviews were transcribed and then coded based on the seed categories (Miles et al., 2013) represented by the various stages of the crowdsourcing process. Through the use of an open-ended analysis approach, new categories of information (practices) emerged from the data. As part of the formation of the codes used with the transcripts of the recordings, some 79 codes were initially utilised.

The first two levels of codes related to the framework tasks (Codes 1) and the practices identified (Codes 2). Also, further codes were used (Codes 3) for the purposes of identifying key actors, key parts of the framework, key points, finding and potential future research. From the coding process completed, individual documents containing quotes directly relating to points at issue were assembled and used in the discussion and analysis section of this research (see Chapter 8). A colour coded bar was enabled through NVivo for highlighting layers of coding that existed in the transcripts (see *Appendix B*). Some tranches of text were tagged multiple times for different practices as they were relevant in multiple scenarios. This enabled quick interpretation of sections of text throughout the transcripts in the subsequent analysis process.

The coding process proceeded over two main stages. First, two pilot semi-structured interviews were completed with participants at the start of the process. The interviews were recorded and transcribed. the initial base of some 79 codes were then

reduced. The PhD supervisors on this project independently reviewed the coded transcripts and made recommendations as to the removal of excess or surplus codes.

Some eighteen codes were removed from the initial draft code book as they were deemed not relevant to the research objectives at the root of the process. Thereafter, at the second stage of the draft coding process, multiple coding was completed where a post-doctoral researcher independently coded the two pilot expert transcripts with the coding book containing some 61 codes.

Barbour, (2001) states that "*Although multiple coding does not usually demand complete replication of results, it does involve the cross checking of coding strategies and interpretation of data by independent researchers*". Inter-rater reliability scores were calculated for the codes with Kappa scoring recorded across the codes (See *Fig.* 5.7 below).

Name	Fil...	Kappa	Agreement
1AFS Assessment filtering of solution submissions		0.93	99.94
1AVC Advertisement of the innovation challenge		0.61	99.72
1FC Identification of potential solution providers		0.67	99.83
1GPS Generation of potential solutions		0.52	99.50
1IMP Broader socioeconomic impacts (rewards for...		0.50	99.77
1IPR Problem definition and specification		0.18	99.50
1MIP Management of innovation process		0.31	99.49
1MSR Management of stakeholder relationship		0.73	99.83
1PR Potential rewards for solution seekers, solution...		0.82	99.77

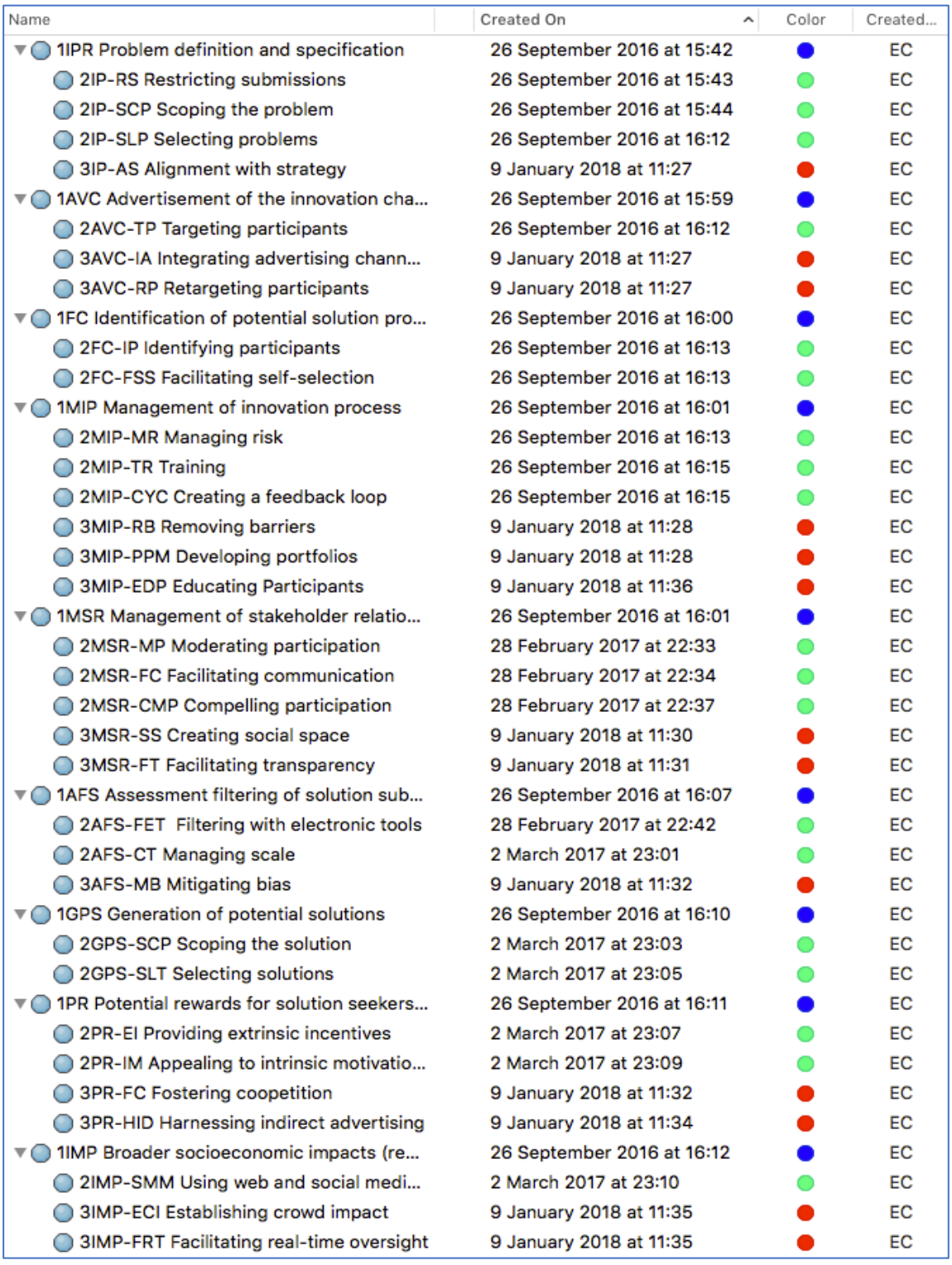
Figure 5.7 - Inter-rater reliability scores on pilot interviews

Kappa scores can be categorised as follows with **Below 0.40** categorised as Poor agreement**, Between 0.40 – 0.75** categorised as Fair to good agreement and last, **Over 0.75** is counted as Excellent agreement. In this case, two Kappa scores were identified as poor. However, after some discussion with the second coder amendments were made to the code book to clarify the express meaning of the weaker codes identified which addressed the coding issue and added greater clarity to the process.

Figure 5.8 - Normalising transcription files

The coding process involves breaking down the data into discrete 'incidents' or 'units' (Lincoln and Guba, 1985) and coding them to categories. Inside the NVivo software, these categories are displayed as 'Nodes'. Computer-based tools may aid with the coding and categorising transcripts of data collected through interviews or as documentary evidence (Yin, 2017). The nodes presented below (see *Fig.* 5.9) were structured based upon the headings and tasks in the framework of Marjanovic et al., (2012). After expert interviews were completed and new practices were identified, these were added as new nodes to NVivo (see the red dots at *Fig.* 5.9 below).

As tranches of text relating to the nodes were identified text was highlighted, dragged and dropped in linking to the nodes. To this end it is important to note that with the use of NVivo for Mac analysis software, the researcher does not transfer the hermeneutic task to the computer, rather the computer is merely used as a tool for visualising the output of researcher's hermeneutic process in a digital format. Upon the process completion, the practices identified as a result of the coding and analysis are re-examined in the context of the research literature and where appropriate added to the adapted framework. Several categorisation and display features contained within N-Vivo were utilised for organising the coding process including the Codebook function. A segment of the codebook is provided at *Table*. 5.4 below by way of example.



Name	Created On	Color	Created...
1IPR Problem definition and specification	26 September 2016 at 15:42		EC
2IP-RS Restricting submissions	26 September 2016 at 15:43		EC
2IP-SCP Scoping the problem	26 September 2016 at 15:44		EC
2IP-SLP Selecting problems	26 September 2016 at 16:12		EC
3IP-AS Alignment with strategy	9 January 2018 at 11:27		EC
1AVC Advertisement of the innovation cha...	26 September 2016 at 15:59		EC
2AVC-TP Targeting participants	26 September 2016 at 16:12		EC
3AVC-IA Integrating advertising chann...	9 January 2018 at 11:27		EC
3AVC-RP Retargeting participants	9 January 2018 at 11:27		EC
1FC Identification of potential solution pro...	26 September 2016 at 16:00		EC
2FC-IP Identifying participants	26 September 2016 at 16:13		EC
2FC-FSS Facilitating self-selection	26 September 2016 at 16:13		EC
1MIP Management of innovation process	26 September 2016 at 16:01		EC
2MIP-MR Managing risk	26 September 2016 at 16:13		EC
2MIP-TR Training	26 September 2016 at 16:15		EC
2MIP-CYC Creating a feedback loop	26 September 2016 at 16:15		EC
3MIP-RB Removing barriers	9 January 2018 at 11:28		EC
3MIP-PPM Developing portfolios	9 January 2018 at 11:28		EC
3MIP-EDP Educating Participants	9 January 2018 at 11:36		EC
1MSR Management of stakeholder relatio...	26 September 2016 at 16:01		EC
2MSR-MP Moderating participation	28 February 2017 at 22:33		EC
2MSR-FC Facilitating communication	28 February 2017 at 22:34		EC
2MSR-CMP Compelling participation	28 February 2017 at 22:37		EC
3MSR-SS Creating social space	9 January 2018 at 11:30		EC
3MSR-FT Facilitating transparency	9 January 2018 at 11:31		EC
1AFS Assessment filtering of solution sub...	26 September 2016 at 16:07		EC
2AFS-FET Filtering with electronic tools	28 February 2017 at 22:42		EC
2AFS-CT Managing scale	2 March 2017 at 23:01		EC
3AFS-MB Mitigating bias	9 January 2018 at 11:32		EC
1GPS Generation of potential solutions	26 September 2016 at 16:10		EC
2GPS-SCP Scoping the solution	2 March 2017 at 23:03		EC
2GPS-SLT Selecting solutions	2 March 2017 at 23:05		EC
1PR Potential rewards for solution seekers...	26 September 2016 at 16:11		EC
2PR-EI Providing extrinsic incentives	2 March 2017 at 23:07		EC
2PR-IM Appealing to intrinsic motivatio...	2 March 2017 at 23:09		EC
3PR-FC Fostering coopetition	9 January 2018 at 11:32		EC
3PR-HID Harnessing indirect advertising	9 January 2018 at 11:34		EC
1IMP Broader socioeconomic impacts (re...	26 September 2016 at 16:12		EC
2IMP-SMM Using web and social medi...	2 March 2017 at 23:10		EC
3IMP-ECI Establishing crowd impact	9 January 2018 at 11:35		EC
3IMP-FRT Facilitating real-time oversight	9 January 2018 at 11:35		EC

Figure 5.9 – N-Vivo coding framework nodes structure

Table 5.4 - Table section from N-Vivo Codebook

Name	Description
1AFS Assessment filtering of solution submissions	The assessment and filtering of solutions encompasses the practice of managing and filtering submissions received in a call process.
2AFS-CT Managing scale	Contemporary crowdsourcing platforms feature the ability to receive large amounts of traffic, accordingly, they require the ability to scale resources or manage scale where required.
2AFS-FET Filtering with electronic tools	Similar to tools used in online communities the filtering of submissions with electronic tools is a contemporary feature of call processes and includes the likes of text search functions.
3AFS-MB Mitigating bias	The use of the practice encompasses the mitigation or removal of undue biases evident within the call process.

5.5.5. Ethical considerations

Various ethical considerations were implemented in the design of the research. Ethics presents as an important consideration in research (Resnik, 2014). In particular in the use of qualitative approaches for examining online systems (Eysenbach and Till, 2001). For example, Roberts, (2015), addresses the issue of anonymity in qualitative studies involving online communities where the visibility of participants can effect outcomes. The researcher used accepted ethical guidelines in completing the research. From the earliest stages of the research anonymity was an important consideration where one candidate refused to participate in the study based on commercial and IP risk associated with the interview process. Also, as the research related to the provision of funding to scientific research projects, the researcher was obliged to take into account various ethical considerations. Both expert interviews and case studies were completed on a strictly confidential basis with anonymity afforded to interviewees. This was necessary where in certain instances participants were critical of their own organisations, work processes and in some instances, institutions/solutions that received funding.

Accordingly, anonymity was extended at the express request of candidates across various funding agencies involved in the research. Also, crowdsourcing experts requested anonymity where sensitive details of commercial crowdsourcing systems were examined and, in some instances, processes and participants were called into question. Last, the researcher relied upon anonymity to ensure that no conflict of

interest arose between the funding provided for this research and any Irish research funding agencies investigated herein. One important consideration arising from the choice of methodology rested in the potential for bias within the expert interviews. This was dealt with in two capacities. First, through the use of subsequent cases studies via a mixed method qualitative approach the opportunity existed to compare interviews and check for differences and biases. Second, interviewer bias was avoided where the interviewer was blind as to prospective practices or new practices that were yet to arise from the data.

5.6. Multi case study approach

A case study based approach is particularly suitable in this research where case studies are used in theory development (George, 2019). The research in question adopted the use of a qualitative multiple case study approach such as that advocated by (Stake, 1996). After the completion of expert interviews (see Section 5.5 above) new practices were identified and added to the preliminary conceptual framework. The framework was then applied as a lens in both case studies for the purpose of examining the practices in context. By comparison between multiple cases, researchers utilizing case study research designs are interested in what is common about the case and also what might be extraordinary (Stake et al., 2005). Examining more than one case afford the researcher the prospect of comparison across key theoretical headings to highlight new learnings. Case studies present as one leading form of research approach used in qualitative research approaches. Yin's (2013), definition advanced of the term case study as: "*an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident*" (Yin, 2013).. Case study approaches can be used in the examination of practices used within call processes and how practices can be used to overcome challenges previously identified.

Case study research has for some time formed a methodological backbone within information systems research (Walsham, 1995). Stake describes them as holding issues that reflect complex, situated problematic relationships (Stake, 2006). A distinction must be drawn as to whether a single case or multiple cases are required to understand a particular context (Eisenhardt and Graebner, 2007; Stake, 2006; Yin, 2017). In the context of this research either the use of a single case study approach or

the conducting of case studies into one specific type of funding agency will not provide sufficient data to answer the research objectives presented. For questions starting with how and why a case study approach can be used. Within this context, the investigator is not required to be possessed of control of the behavioural events. Advantages of using more than one case are outlined by Miles and Hubermann, (1994). Primarily, as in this instance, cross-referencing between case instances can be executed in the search for cross-case patterns. The outcome of such cross-referencing can identify instances that are not idiosyncratic and thereby increase the generalizability of the research (Miles and Huberman, 1994).

According to Benbasat et al., (1987), multiple-case studies are used when cases are 'descriptive' or when building or testing a theory. In this research, a multiple case approach is advocated considering the shortcomings that could arise from a single case approach where funding agencies do not know the full extent of challenges faced in open call processes or the full extent of practices used by contemporary crowdsourcing enabled organisations. Accordingly, the use of the multiple case study approach as advocated by Stake is adopted for the purposes of this research which advocates to use of a small number of cases to understand a particular context (Stake, 1996).

For the purposes of this study, two illustrative case studies were chosen. Illustrative case studies are used for the purposes of demonstrating the application of a theoretical supposition in context (Yin, 2017). The focus of the two case studies selected is on illustrating practices from the adapted framework in context as established from the previous stage of the research. Illustrative case studies are used across the social sciences (Baker et al., 2015; Jackson, 1991; Levy, 2008). From within this research, the framework of Marjanovic et al., (2012) is applied as theory.

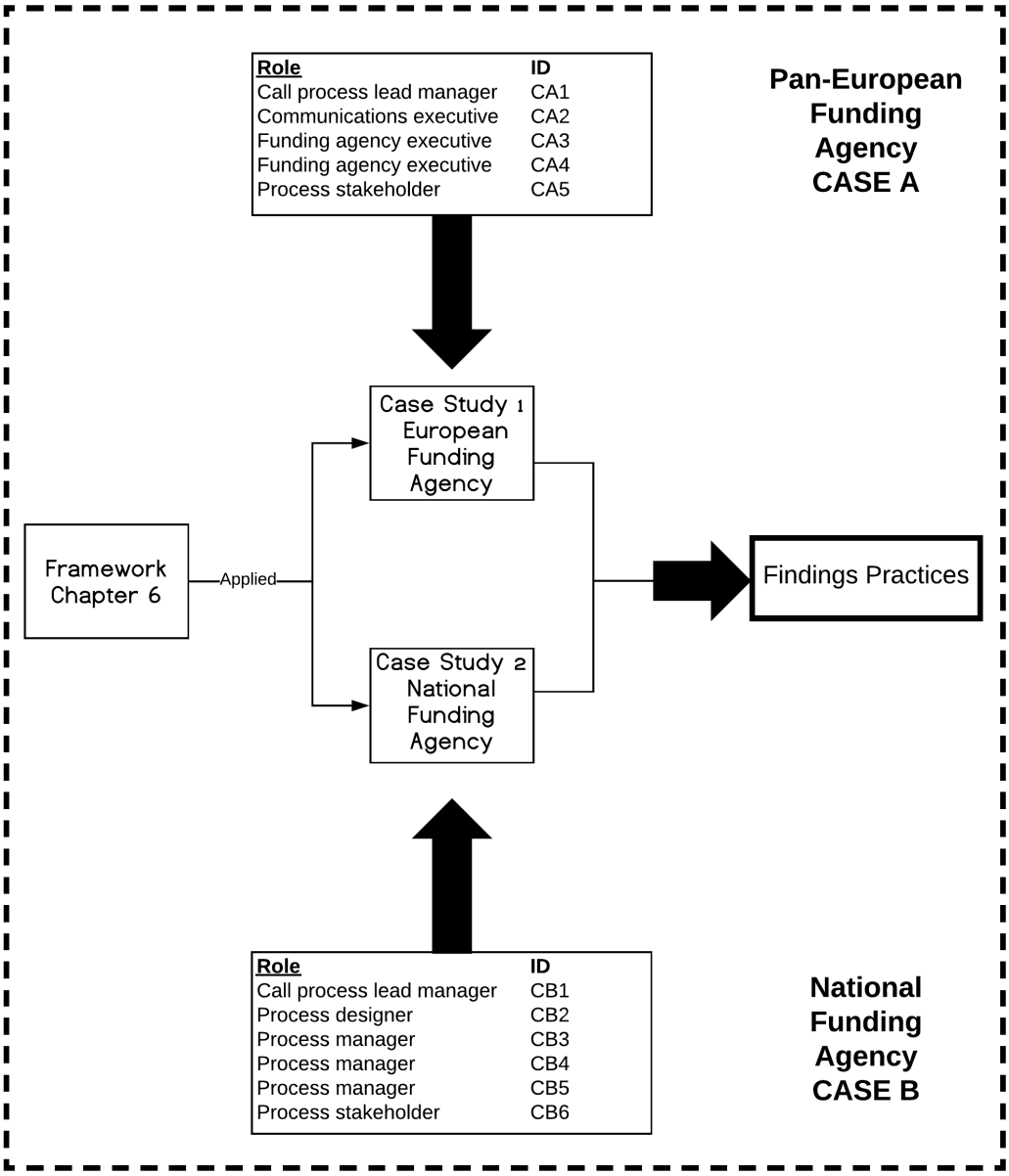


Figure 5.10 - Composition of case studies completed in the research

5.6.1. Unit of analysis

In the context of this research, the unit of analysis is the call process. Stake, (Stake, 1996) states that case study is a choice of what is to be studied but he also highlights that the method does not define the case. Yin, (2013), states that the selection of a unit of analysis for the purpose of completing case study analysis relates to the problem of "*defining what the case is*". In a modern information systems research context, the units of analysis within cases include people, organisations, teams, processes and artefacts amongst other instances (Yin, 2013).

5.6.2. Selection of cases

Within the present research an immediate limitation is faced whereby a limited number of public research funding agencies are using crowdsourcing. This in turn presents a further challenge in case selection where only call processes in line with the criteria established in Chapter 4, (Section 4.2) can be utilised. To this end three cases were identified as suitable for investigation where the organisations were: (i) wholly public in structure and funding, (ii) featured call processes where panels of reviewers and not individuals were responsible for making decisions in respect of funding, (iii) consider both impact and excellence criteria in the evaluation of submissions. Although some commercial stakeholders participated across the three cases, all three programmes provided only public monies. Upon closer investigation it became evident that in one of the three cases, although diverse stakeholders including the public could vote, they held no capacity to influence the questions at the root of the call processes which were pre-determined by the public research funding agency. Accordingly, the third case was discarded and two were selected for investigation.

Aside from the selection criteria addressed in Chapter 4, research also suggests various criteria for selecting specific cases worthy of investigation including extreme situations, critical incidents, social dramas, polar types, and high experience levels of the phenomenon under study (Berg, 1968; Stake, 2006). Research has encouraged the use of extreme examples to make research more generalizable where homogeneity in the cases provides limited understanding (Nieto and Pérez, 2000). As this research relates to state-funded research initiatives covering both ends of the spectrum in terms of size and crowd focus are examined. The cases are now outlined as follows.

Case A: European Pan-National Funding Agency. The research programme invests in transformative frontier research and innovation with a high potential impact on technology, to benefit the European economy and society. Interviews and the examination of documents took place both onsite and through the internet. The agency has been involved in exploring open innovation and crowdsourcing options in the building of the next generation of funded European research. As part of the research mandate the unit has engaged in a call process to elicit online feedback and interaction regarding the use of crowdsourcing and crowdfunding in scientific research. The agency used Internet based interactions in a crowdsourcing format to solicit public

opinion and data on a host of issues relating to engagement processes in the funding process. The application of the framework across the entire lifecycle of a European project serves to test the full extent of practices and metrics identified within the framework. Although, limited peer reviewed publications were available in respect of the call process, a substantial amount of operational documentation and media relating to the platform were readily available for examination in the case study.

Case B: National funding agency is a large-scale consultation process completed by a national funding agency for the purposes of creating a research programme. As the agency held an office solely for administrative purposes, interviews were predominantly completed via the internet. Also, learnings regarding the process were obtained from publications related to the initiative and support documentation that was provided online. Videos and other media were also examined. Peer reviewed academic publications were published in respect of the call process completed. The research agenda presented a large number of solutions and is the result of a unique bottom-up initiative, driven by the public in the country in question. The initiative also provided scientists with suggested pathways for research collaboration. The agency developed custom software for the sorting and management of submissions received through the initiative's website. Furthermore, a comprehensive report was produced by leading scientists as a result of the completion of the call process. A combination of call process mangers and technical leads responsible for the platform were consulted with in the case study.

5.6.3. Data collection - case studies

The physical methods of collecting interview data were identical to those used in the collection of expert interviews including the recording and processing of audio files, and automatic audio/text conversion (see Sub-section 5.5.3 above). However, both case studies also featured the examination of process documentation and media supporting both call processes. A third interview protocol was prepared along similar lines to the version used in the expert interviews. However, some slight alterations were made to the questions to allow for contextual considerations. Case studies feature a combination of qualitative methods for collecting data for the purposes of analysis. To the forefront of such tools is the use of interviews. As presented in Section 5.5, interviews can be structured, semi-structured, or unstructured.

Merriam, (1988) described a responsive interview process where the interviewer "*types, asks good questions, has questions to avoid, probes, uses the interview guide, monitors and manages the interaction between interviewee and respondent, records and evaluates interview data*". Kaplan and Maxwell, (2006) states that: "*Open-ended interviewing requires a skilful and systematic approach to questioning participants. This can range from informal and conversational interviews to ones with a specific agenda*". In this context, they identify two goals namely: eliciting the respondent's views on their own terms (not choosing from preselected answers) and not been bound to rigid questions so as to allow for unanticipated and potentially valuable information to emerge. The use of a semi-structured interview approach in qualitative case studies allows the interviewer to encompass these possibilities in their approach. Rubin and Rubin, (2011) address how in-depth interviews can surface sensitive or hidden topics. Where many funding agencies are public bodies in nature and call/process managers are subject to usual work politics, many hidden positions and issues can underlie processes.

Accordingly, in-depth interviews present as a means towards understanding and contextualising this process. Turner, (2018, p. 755), in citing McNamara**,** (2009), states that the strength of the general interview guide approach is the ability of the researcher "…*to ensure that the same general areas of information are collected from each interviewee; this provides more focus than the conversational approach, but still allows a degree of freedom and adaptability in getting information from the interviewee*". Semi-structured interviews, or focused interviews, can be more flexible and allow the researcher to better understand the perspective of the interviewees (Baškarada, 2014; Dane, 2010; Daymon and Holloway, 2010).

In semi-structured interviews, a researcher can refocus the questions, or prompt for more information, if something interesting or novel emerges. To this end, such an approach allows the emergence of practices heretofore not evident in the literature that can, in turn, be compared across the cases. Stake, (Stake, 1996) addresses the use of triangulation as a means for achieving clarity and to arrive at incontestable descriptions. In the context of this research challenges and practices identified from interviews are triangulated against procedural documentation and artefacts used by the funding agencies. Process documentation in open calls was also examined**.**

5.6.4. Triangulation of data

Whilst certain aspects to call processes are hidden, great transparency was evident in both cases over many types of procedural documentation available. Such documentation featured details of process stages, practices used, composite actors and timescales involved. Call documentation also contained details of voting mechanisms and weightings attributed in selection processes. Such schematics and flow charts were invaluable in understanding the flow of call processes.

Also, support documentation for the technical aspects of both call processes were accessible. As part of the coding process manuals and support information ,where relevant, was coded and analysed. (see *Appendix C* for an example). A summary of the types of documentation and media examined is presented below (see *Table* 5.5). The call management systems and software used by funding agencies were supported by documentation and videos with service providers presenting details as to the operation of the platforms and features contained therein. Physical artefacts in the form of these platforms used in the crowdsourcing process were examined as to features used and practices evident.

Table 5.5 - Documentation and media collected/accessed in both case studies

Type of information	Case A	Case B
Support information	The website (active) contains a substantial help section with the materials drawn from the open source platform used	The website (now closed) contained details for the participants as to how to provide submissions and complete the process
Platform usage manuals	Various pdf manuals regarding the usage of the website were available for scrutiny	Limited pdf manuals were available with more documents distributed directly to experts for juries
Support videos	Some videos as to platform usage were available. Six years' worth of interviews and support videos have been amassed on Youtube for public consumption	No videos as to platform usage were available , however, many videos including a TedX talk was available regarding the overall process
Open source Git or repository	A well supported Git is available with active participation from developers	No Git was available as the software was custom developed
Peer reviewed studies or publications	One major peer reviewed journal publication in Philosophy and Technology	One major and well subscribed text book was published arising from the call process

5.6.5. Implementation of research design

The multicase study features an interview protocols guided in structure by the theoretical framework of Marjanovic et al., (2012). The conclusions drawn from the data analysis are comparable across the cases where compared against the headings identified within the framework from practices perspective. The interview questions centred on themes surrounding the tasks and practices highlighted in the Marjanovic et al., (2012) framework and any additional practices identified in the expert interviews presented in Chapter 6. Data were gathered between February 2017 to January 2018. Data were collected from case studies including artefacts (funding agency portals, see *Table 5.4* above) and semi-structured interviews. A protocol was developed based upon the Marjanovic et al., (2012) and in following a format highlighted by (Jacob and Furgerson, 2012; Rabionet, 2011; Yin, 2017). Access to national and international Funding agencies was supported by Science Foundation Ireland (SFI) and the Irish Research Council (IRC) who held points of contact with their sister agencies. Prior to completing the case studies, a large degree of information regarding the structure of the organisations, roles of the staff involved and structure of call processes were accessed online and thereby facilitated the researcher in the process of identifying key personnel for interview.

Following this, several other issues emerged during the interview processes which required further clarification. Additional invitations to interview were extended. For example, in case A there was confusion at one point as to whether teams of managers or an individual were making the final decision as to a solution in the process and one further manager was contacted. Also, in case B it was not clear the extent to which the funding agency were evaluating proposals for research topics versus proposals for new research themes. Again, a further call process manager was contacted to clarify the point. The opinions of managers in each of the funding agencies were considered in the selection of ideal candidates for interview based upon the needs of the protocols prepared.

Similar to expert interviews, the protocol guided the interviews where a semi-structured approach was utilised in the case studies. Interviews ranged from 35 minutes to 1 hour 33 in length. The average interview lasted approximately one hour. Interviews were stored electronically for transcription and analysis purposes.

Interviewees were sent details of the scope of the study in advance prior to the creation of appointment times for interviews. Also, each recorded interview featured the use of handwritten field notes. This was completed for the purposes of ensuring no core points were missed in the event of audio errors or loss of data. In several instances, further follow-ups took place after the interviews for the purposes of clarifying certain points that arose in the interviews. Several interviewees provided printed and pdf documentation associated with the management of the call process which was also scrutinised. These included documents on collating submissions received and marking scales applied.

5.6.6. Theoretical sampling and saturation

According to Baker, Edwards and Doidge, (2012), "*once a qualitative researcher is conducting their research they may find that that the evidence is so repetitive that there is no need to continue*". Accordingly, they posit that saturation is central to qualitative sampling. However, a common misconception about sampling in qualitative research is that numbers are unimportant in ensuring the adequacy of a sampling strategy (Sandelowski, 1995). With theoretical sampling, cases are chosen for theoretical and not statistical, reasons (Glaser et al., 2019). By contrast, traditional hypothesis-testing studies rely on statistical sampling where researchers select a random sample from a population.

In qualitative research, such as case studies, theoretical sampling as a cumulative process can be used to set a sample size (Eisenhardt, 1989; Ozanne et al., 1992). Eisenhardt (1989, p. 537) describes the goal of theoretical sampling as "*to choose cases which are likely to replicate or extend the emergent theory*". Theoretical sampling was conducted in this research as it facilitates the researcher in obtaining the greatest theoretical return whilst exploring new areas (Ozanne et al., 1992). Within this research theoretical sampling continued until a point of 'saturation' where additional data collection and analysis no longer contributed as the adapted framework reached completion for the purposes of investigation. To this end, where sufficient information was to hand to address a point at issue, no further data was collected.

5.6.7. Interview process

Similar to the expert interviews above, (see Sub-section 5.5.3 Sub-section 5.5.4), all completed interviews were transcribed with the assistance of Nuance Dragon Dictate and were subsequently imported to NVivo for Mac. After the data was imported the researcher created nodes within NVivo matching the practices on the framework to tranches of text in the transcripts (see *Table* 5.6 below for a summary of the codes used). From the outset of data collection, a spreadsheet was created using MS Excel which allowed the researcher to clearly track interview progress throughout the phases of data collection and keep a detailed log of the following items: Organisation Details, Interviewee name, funding agency Role/Job Description, Interview Phase Interview Type (electronic/face to face). At the end of the interviews, the time durations were inserted into the notes and the files were transferred from the Apple Recorder App to a local secured storage folder on the researcher's laptop. The number of contributions made by each participant to the overall data was recorded and used as a guide to ensure as much balance as was possible was afforded across the participants See *Fig. 5.12* below).

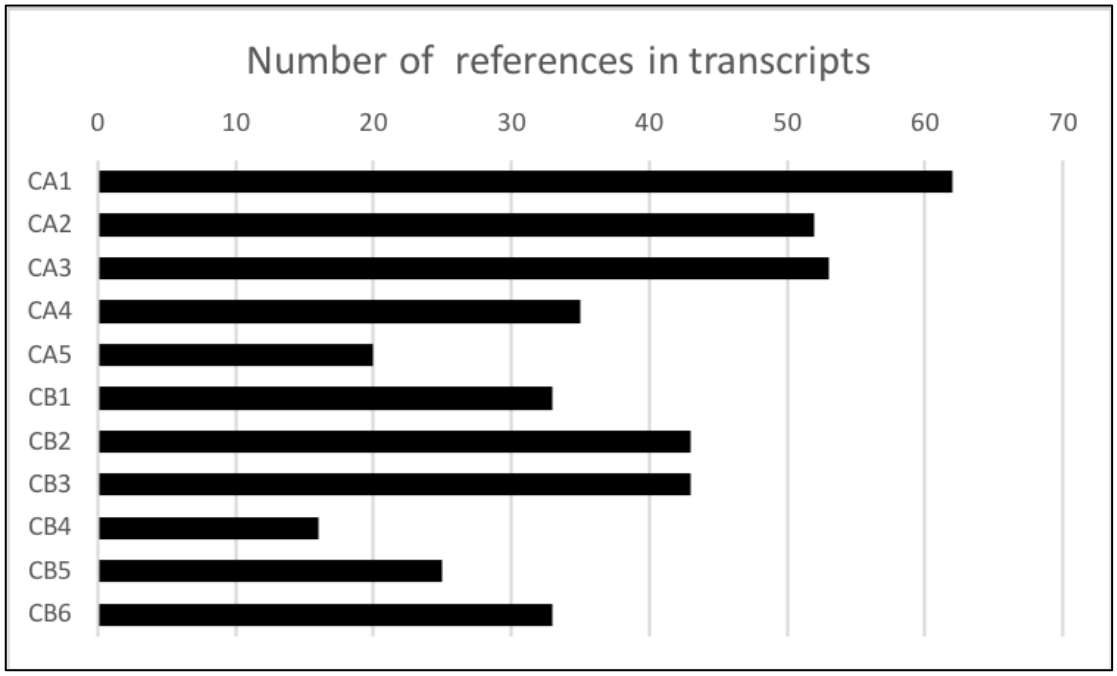


Figure 5.11 - Total number of references in transcripts attributed to case study participants

Kaplan and Duchon (1988) state that a major problem with qualitative research is that multiple realities can arise. This can be from the interpretation of different perspectives

of participants within a research project. To address this problem, various steps were taken outside of triangulation approaches mentioned in the previous above. First, rigorous coding and memo taking processes which provide a traceable, documented justification of the process by which research conclusions were reached, thereby providing an audit trail of the process (Guba, 1981; Lincoln and Guba, 1985). Second, in this study, Science Foundation Ireland, The Higher Education Authority/Irish Research Council served as sounding boards in the presentation of this research.

5.6.8. Comparison across cases

In this research, both cases were designed for the purposes of comparison across the practices identified under the Marjanovic framework. This was designed for the purposes of highlighting any differences or tensions evident across the two call processes. The use of comparative case study analysis stands juxtaposed to complementary forms of analysis. Knight, (2001) Comparative case studies are particularly important to questions of human–environment interaction, combining case study and comparative traditions and thus extending the depth of the individual case study across several instances in time and/or space. In this study learnings were sought from the differences that existed between practices in use by the funding agencies in context. Of particular interest to the study were tensions in existence as to the use of specific practices. Snippets of data under the nodes on the framework across both the expert interviews and case studies were compared and contrasted in seeking either agreement, disagreement or tension as to the practices used.

Table 5.6 - Summary of coding structure

Codes 1	Framework Tasks	Codes 2	Practices	Codes 3	Findings
1IPR	A - Problem definition and specification	2IP-RS 2IP-SCP 2IP-SLP 3IP-AS	A-I Restricting submissions A-II Scoping the problem A-III Selecting problems A-IV Aligning with strategy	1TENS 1LEVID 1CRITP 1FUTR 1FW-STK 1FW-ONL 1FW-OFL 1FW-VIS 1FW-CUR 4IPR-STR 4IPR-DIS 4AVC-ICT 4MIP-TR 4MIP-HDS 4MIP-CYC	Tension Lack of evidence Critical point Future research Stakeholder Online platform Offline platform Stakeholder visibility Community curation Need to inform strategic policy Need for research into Need to harness communications tools ict Need for EPE strategizing TR Need for support in horizontal decision- Need for iterative cycles in processes
1AVC	B - Advertisement of the innovation challenge	2AVC-TP 3AVC-IA 3AVC-RP	B-I Targeting participants B-II Integrating advertising channels B-III Retargeting participants		
1FC	C - Identification of potential solution providers	2FC-IP 2FC-FSS	C-I Identifying participant categories C-II Facilitating self-selection		
1MIP	D - Management of innovation process	2MIP-MR 2MIP-TR 2MIP-CYC 3MIP-EDP 3MIP-RB 3MIP-PPM	D-I Managing risk D-II Training D-III Creating a feedback loop D-IV Educating participants D-V Removing barriers D-VI Developing portfolios		
1MSR	E - Management of the Stakeholder relationship	2MSR-MP 2MSR-FC 2MSR-CMP 3MSR-SS 3MSR-FT	E-I Moderating participation E-II Facilitating communication E-III Compelling participation E-IV Creating social space E-V Facilitating transparency		
1AFS	F - Assessment filtering of solution submissions	2AFS-FT 2AFS-CT 3AFS-MB	F-I Filtering with electronic tools F-II Managing scale F-III Mitigating bias		
1GPS	G – Generation of potential solutions	2GPS-SCP 2GPS-SLT	G-I Scoping the solution G-II Selecting solutions		
1PR	H - Potential rewards for solution seekers, solution providers, brokers	2PR-EI 2PR-IM 3PR-FC 3PR-HID	H-I Providing extrinsic incentives H-II Appealing to intrinsic motivations H-III Fostering coopetition H-IV Harnessing indirect advertising		
1IMP	I - Broader socioeconomic impacts	2IMP-SMM 3IMP-ECI 3IMP-FRT	I-I Using web and social media metrics I-II Establishing crowd impact metrics I-III Facilitating real-time oversight		

5.7. Summary

In the previous sections, the researcher has outlined the structure of the research approach/methodology utilised in this research. The use of the expert interview approach combined with the multiple case study approach has served as the foundation to the answering of the research objectives presented in Chapter 1. Whilst it is accepted that there can be challenges in adopting qualitative research approaches, numerous benefits are presented in using the associated methods (Eisenhardt and Graebner, 2007; Malterud, 2001). Data were collected from a range of different sources. This chapter provides an in-depth analysis of the methods used, as well as some discussion as to the limitations of research approaches adopted. In the next chapter, (Chapter 6), data arising from thirty expert interviews are presented

Chapter 6. Expert interviews

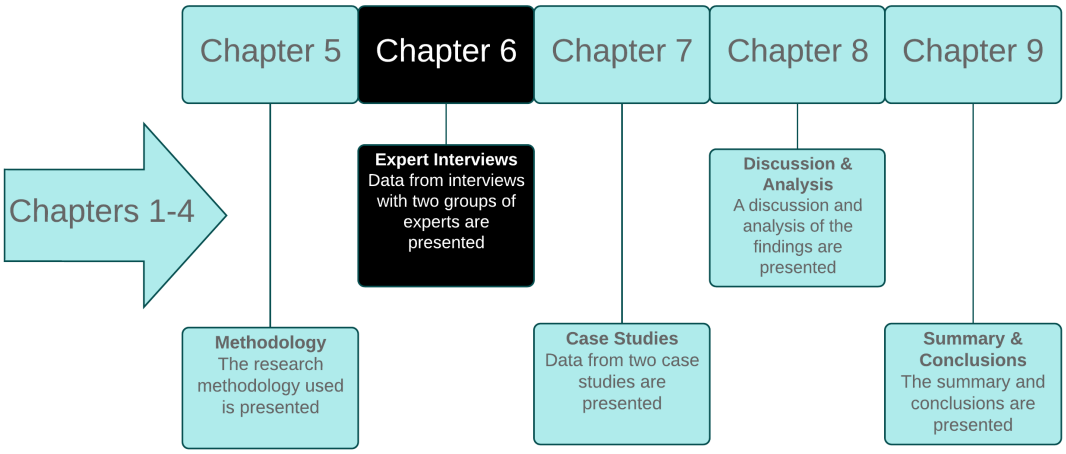


Figure 6.1 - Chapter structure - Chapter 6

6.1. Introduction

In the following sections (6A - 6I), the Marjanovic et al., (2012) framework along with practices identified from Chapter 3, are examined through interviews with two groups of experts. This is completed for the purpose of examining existing practices identified in the literature in addressing RO1.1, RO1.2, RO2.2 and RO2.3. Several new practices are identified in this chapter and added to the Marjanovic et al., (2012) framework for subsequent examination cross both case studies in the next chapter (Chapter 7). This chapter serves to inform the framework and the collection of data in the case studies in Chapter 7 (see *Fig.* 6.1 above).

6A. Problem definition and specification

In the following sections, three categories of practices are examined, and a new fourth category of practices that emerged from the expert data is presented. These include restricting submissions (Section 6AI), scoping problems (Section 6A-II), selecting problems (Section 6A-III) and aligning with strategy (Section 6A-IV). A summary of the expert observations are presented in *Table* 6.1 below. Identifying a problem and setting the boundaries of a problem at the root of a call process is a difficult task requiring resources to be applied by the solution-seeking organization. (EX-A1, EX-A5 and EX-A11). Expert interviewees, described the works involved in identifying and refining problems at the root of call processes.

The primary challenge identified at the input stage of the process relates to balancing the complexity of problems and the required skill from the crowd, which also repeats at a later stage of the crowdsourcing process (see Section 6G). Various practices are used to assist in this part of the process.

6A - I. Restricting submissions

Both sets of experts provided evidence of restrictions in call processes. However, participants suggested that restrictions on submissions were somewhat inadvertent where platforms were limited in terms of what inputs could be made by the crowd. Despite this, some experts offered observations on the practice of restricting submissions and provided context on the what could be restricted. One manager described the option of restricting what the crowd could add to the system by way of input rather than necessarily limiting the question they were to address upfront (EX-B3). Experts discussed restricting the types of submissions a crowd can submit so as to provide some homogeneity over the types and quality of submissions received (EX-A1, EX-A5, EX-B3). A participant cautioned that if "*you do not do this (restrict), you will be flooded with too many rambling or complex submissions*" (EX-B5). However, two participants from group B also cautioned that restriction is a two-way street, where, on the one hand, there is a need to ensure submissions received are not too poor to be useful yet, on the other hand, are not too complex to decipher (EX-B3, EX-B5). Another participant described how they had considered limiting what users could input to choices on a dropdown menu but that the team avoided this, for fear that it would unduly restrict novelty in submissions (EX-A1). However, despite offering mostly hypothetical supports to the practice, no participants were able to give active in-use examples or details of supports provided in the use of the practice. In summary, although limited examples were available from practice, both sets of experts supported the need for the practice.

6A - II. Scoping problems

A difference of perspective was evident across both sets of experts. On the one hand funding agencies have traditionally completed most of the work in scoping problems. However, by contrast, some crowdsourcing experts stated that where problems are broken up into smaller pieces, unskilled participants can also participate in challenges. However, participants in group A cautioned that the practices by which problems

could be broken up were not always clear (EX-A1, EX-A5, EX-A11). Accordingly, shaping the wording of a call was identified by both groups as a key part of the scoping process which allows the solution seekers to set the size of the task at hand (EX-A5, EX-B4, EX-A1). Two participants highlighted that the process of scoping the problem will often involve several complex interactions in trying to shape/iterate a wording that best reflects the problem in need of resolution (EX-A5, EX-A11). One expert cautioned that failing to properly frame the problem upfront can lead to a ripple effect where *"it is necessary to disaggregate the problem or break it into bite-size chunks for the crowd"* (EX-A5). Another participant described how refining the scope of calls presents as "*a complicated task requiring a great depth of management interaction with other stakeholders in the shaping the call*" (EX-B13). Experts confirmed the view that the public crowd does not have all the skills necessary for solving all scientific challenges. One participant described a practice of scientists "*match(ing) the task or part of a challenge to a person or groups of persons with a relevant skill who are best positioned to give the best answers*" (EX-B4). An expert from group B confirmed for similar reasons that this is why experts will always need to decide if the crowd are skilled enough to participate in scoping complex problems (EX-B3). In summary, consensus holds that how the problem is broken down bears impact on the process. Furthermore, some expert involvement is required in scoping problems.

6A - III. Selecting problems

Several experts described the difficulty in agreeing who should decide what problem to select (EX-A1, EX-A9, EX-A14, EX-B4, EX-B3). Several experts from both groups also discussed how solution seekers must decide on how decisions are to be made by the crowd in selecting a problem (EX-A1, EX-B4, EX-B3 EX-A5). One participant stated that "*this idea might seem obvious, but you would be amazed how much controversy it causes"* (EX-B3). The practice involves shared responsibility in decision making or using mechanisms such as voting. Stakeholders in the decision-making process can involve the private sector, large corporations and the public. Participants cautioned that such joint decision-making processes show mixed levels of success where several participants described challenges in agreeing selections amongst stakeholders (EX-B4, EX-B3 EX-A5).

There was evidence of confusion amongst the experts as to whether government, the public or both should pick winners or the problem in need of resolution. By way of example, an academic expert expressed one viewpoint that *"this task is the job of elected officials on behalf of the public to complete, as much of the public are not qualified enough to do this kind of work"* (EX-A9). Two other crowdsourcing experts expressed the contrasting view that that the process of selecting the problem was something that might be done jointly with other stakeholders including the public (EX-A1, EX-A14). However, participants added that the means through which this could be achieved was unclear.

6A - IV. Aligning with strategy

In questioning the experts, it became apparent that aligning problems with strategy was a new practice required early in the process. The practice was predominantly highlighted by funding experts, however some crowdsourcing examples were also identified (EX-A1, EX-B1, EX-B3, EX-B5, EX-A5). Agency participants identified that in discussing the restriction of submission types, they were more concerned with a desire to restrict submissions in-line with agency goals. Experts confirmed that governments identify topics of strategic interest that required funding, including 'priority areas' or 'top sectors' within which calls are framed (EX-A1, EX-B1, EX-B5). Evidence suggests that currently, this strategic alignment takes place predominantly at the input stage of the process (EX-B1, EX-B3). In selecting a problem, difficulties are also faced by both government and private organisations in keeping up to date with industry trends and being of the cutting edge of problem selection. Three crowdsourcing experts spoke of the great lengths managers must go to in keeping the finger on the pulse of industry problems and the grand problems in need of resolution (EX-B13, EX-A1, EX-A5). While many scientists are supportive of public consultation, experts from the funding agencies expressed reservations as to the motivations of public crowds where the public has different short-term needs to the long-term goals of the funding agencies (EX-B1, EX-B3). Managers in both domains spoke of the need to bridge this gap with the public in terms of generating a shared understanding of problems from their perspective. This was described by several experts as a type of disconnect in terms of shared understanding around the strategic nature and scope of the problems that agencies were concerned about (EX-A11, EX-A1, EX-B3).

Table 6.1 - Expert interviews - problem definition and specification

Stage	Task	Practices	Description
INPUT	**Problem definition and specification** **Section 6A**	**Restricting submissions** **6A-I**	Experts across both domains were wary of unduly restricting submissions but chose to mainly limit the format through which submissions were received.
		Scoping problems **6A-II**	Participants highlighted that some degree of expert input is required in conjunction with other stakeholders in scoping the problem.
		Selecting problems **6A-III**	Evidence highlights that there was a lack of guidance available as to how joint decisions can be made by stakeholders.
		Aligning with strategy **6A-IV**	Experts spoke of the need to bridge the public needs for research and the agencies research focus/research priorities.

6B. Advertisement of innovation challenge

Evidence indicates that funding agencies need to move towards a new type of advertising to leverage the full benefits arising from crowdsourcing. This need is set against a background of an excess of applicants seeking funding. Evidence from several participants revealed how the agencies need to change their advertising and must be continually seeking and engaging new crowds throughout the entire process and not just at the start of the process (EX-A1, EX-A5, EX-A11). In the following sections, the discussion of three categories of practices are examined by two categories of experts. These include the existing practice of targeting participants (Section 6B-I) and two new practices of integrating advertising channels (Section 6B-II) and retargeting participants (Section 6B-III). A table summarising the practices is provided in the conclusion of this section (see *Table* 6.2 below).

Funding experts confirmed the overriding the view that in the case of traditional call processes, few challenges are faced in the advertising of calls to existing stakeholders (EX-B3, EX-B12). Evidence suggests that funding managers hold the view that there is a current lack of necessity on the part of funding agencies in engaging crowds for solutions where a steady stream of scientists are seeking funding (EX-B3, EX-A9). Evidence was also presented from several call process experts that funding agencies have lists of existing reviewers and only need to use limited channels to find additional stakeholders and reviewers (EX-B1, EX-B3, EX-B4, EX-B6). Accordingly, advertisement channels have not been of major importance

in traditional processes. One call process expert also explained that "*if I need to find an expert, let's say a reviewer, I don't go online, I'd go directly to colleagues in the know*" (EX-B10).

6B - I. Targeting participants

Both sets of experts confirm the need to engage desired categories of participants outside the organisation. A funding expert described the challenges faced in the initial discussions with stakeholders around a call where "*it can be hard to get them (stakeholders) to even engage in the process of shaping a call*" (EX-B1). Accordingly, it is posited that advertising plays a critical role in the sourcing of desired participants. Another call process manager describes the challenges associated with this aspect of the process where "*we actually put the call itself as a draft on our website for feedback, but we didn't get back much actually, not much substance more comments saying yes great idea*" (EX-B12). The expert went on to explain that with better advertising perhaps more feedback would have been received. A crowdsourcing expert describes how some national cultures can also have an effect in terms of the culture of participation in processes. In contrasting two European examples, the importance of advertising is highlighted where they observed that:

"*All this boils down to culture…the (public) see advertisements and are happy to engage in challenges whereas in (another country) people are more reticent to participate in open initiatives. People weren't sure about what they were signing up to do (asking) what am I doing here, what is the expectation?*" (EX-A12).

Several crowdsourcing experts provided evidence of advertising beyond the immediate boundaries of the organisation in seeking to engage new lay and skilled solution providers, (EX-A7, EX-A8, EX-A16). For example, a crowdsourcing process designer described this as "*not a simple case of build it and they will come, unlike old processes you must go and actively engage the people you need to participate and find out where they are hiding*" (EX-A7). One funding expert in a national funding agency confirmed that considerations such as advertising to demographics based upon age, gender and skill must be taken into account in advertising contemporary call processes (EX-B9).

A call process expert in a pan-European funding agency also confirmed that in contemporary call processes "*from the point of view of inclusivity, it is imperative to ensure all the different strata within society are as actively engaged as possible in the mission of the funding agency*" (EX-B12). In summary, both sets of experts confirm the need to target specific groups of participants based on skill or demographic requirements.

6B - II. Integrating advertising channels

Crowdsourcing experts predominantly spoke of a need to integrate advertising channels to target both online and offline participants (EX-A1, EX-A5, EX-A12, EX-A14). Some limited discussion of the point was presented by funding experts (EX-B1, EX-B12, EX-B10). One crowdsourcing expert cited an example of the breadth and diversity of stakeholders filtered in one crowdsourcing system as an example of the challenge faced in integrating advertising channels. This included:

"*internal people, financial directors, clinical leads, and then community staff, people who are in the community working for (the group), but also were brining patients involved into that and we are going out to the wider organisation so people not necessarily working for that one organisation, also people who work in other organisations and those on the Internet*" (EX-A14).

Three crowdsourcing experts provided evidence that many organisations make a fundamental mistake in advertising crowdsourcing as something set aside from their other offerings (EX-A1, EX-A12, EX-A5). In other words, they fail to fully integrate the advertising and use piecemeal approaches (EX-A1, EX-A5). Several crowdsourcing experts also described the risk of the overreliance upon the idea of new technology solving all our advertising problems. For example, a crowdsourcing expert described how "*there is a presumption that in having great software / social media channels you will get more crowd members and ideas into the system but this is not the case as it is about how you build your campaign and who you are engaging when you are communicating"* (EX-A14). In summary, evidence from experts suggests that a more holistic approach is required in advertising for crowdsourcing with managers controlling online and offline channels in an integrated fashion.

6B - III. Retargeting participants

Several experts highlighted a new practice of retargeting participants with advertising in retaining community participation. In particular, There is strong evidence from crowdsourcing experts of the need to develop strategies for re-integrating failed applicants into subsequent calls (EX-A1, EX-A5, EX-A11). The same is not expressly evident in the case of funding agencies. However, some limited awareness was evident from funding experts or the need to retarget. A funding expert states that in order "*to have an impact on the fabric community or village they work with, building and retaining this community is the most important and most difficult challenge*" (EX-B13). A funding expert in a similar context also described the commensurate challenge of "*building trust with applicants and the community generally in the processes where.. building this trust is a necessary component in retaining crowd members over the long term*" (EX-B6). A funding expert describes how strong advertising is needed to retain participants. He states that "*engaging and retaining relationships with international stakeholders is a necessary but tough business where researchers are poor at communication and lack the necessary skills and training*" (EX-B2). This mind-set stands in stark contrast to crowdsourcing initiatives where the solution seeker is continually striving to keep stakeholders engaged and retained within the system (EX-B10, EX-A12, EX-A16).

Table 6.2 - Expert interviews – advertisement of innovation challenge

Stage	Task	Practices	Description
INPUT	**Advertisement of innovation challenge** **Section 6B**	**Targeting participants 6B-I**	Experts across both domains spoke of the need to target both skilled participants and participants from desired demographics.
		Integrating advertising channels 6B-II	Crowdsourcing experts highlighted the need to integrate all the advertising channels into a combined approach. Limited support for this practice was evident from funding experts.
		Retargeting participants 6B-III	Crowdsourcing experts show concern as to the need to re-target previous participants with advertising. Funding experts confirm that their focus to date has not sought to re-integrate previous participants.

6C. Identification of potential solution providers (filtering the crowd)

Evidence shows that various practices are used to form crowds from participant pools within call processes. This process is similar to the practice of seeking participants through advertising.

However, in this instance the practice focuses upon the allocation of the crowd to tasks of a given requirement. Crowdsourcing experts show that rather than narrowing the search for one group of skilled participants, they attempt to form as broad and as diverse a crowd as is possible (EX-A2, EX-A8, EX-A18). Funding experts, by contrast, have provided evidence of a narrower approach. In the following sections, the discussion of two categories of practices is examined by two categories of experts. These include identifying participant categories (Section 6C-I) and facilitating self-selection (Section 6C-II). A summary of the expert observations are presented in *Table* 6.3 below. There is some evidence showing an awareness on the part of funding agencies as to the narrow search approach they adopt. A funding expert also states that another problem facing funding agency ecosystems can be that everybody has come from the same skill domain (homogenous skill sets) and says that accordingly, "*to get new ideas it is good to liaise with people outside the bubble from different crowds and communities*" (EX-B4).

6C - I. Identifying participant categories

Experts spoke of the practices for identifying participant categories. Finding crowds that are sufficiently skilled to participate in a call presents as an important practice. For example, several experts from both domains provided evidence that the types of crowd members filtered have a direct effect on whether the funding agency achieves their aims through the call process (i.e. EX-A1, EX-A5, EX-B1, EX-B11). Whereas previously, agencies have sought specific skills, now agencies filter participants based on other criteria.

The practice is confirmed where various funding agency experts confirm the use of tools for searching through participants based on pre-defined criteria such as qualifications, age, location and gender (EX-B1, EX-B3, EX-B6, EX-B11). Evidence shows the importance for funding agencies of being able to identify requisite skills through a search function. For example, one funding expert spoke of this issue where "*it is impossible for agencies to deploy the correct reviewers in all instances to the most relevant calls where we (they) did not have a deep knowledge of these reviewers or their skills*" (EX-B4). Some experts were also of the view that value rested in seeking/filtering both generic crowds and skilled crowds (EX-B2, EX-B3).

Despite the common use of generic, unrestricted crowds in crowdsourcing systems, there was evidence from experts of the need for organisations to be able to filter based upon skill and other criteria. A crowdsourcing expert, for example, states that in filtering membership:

"*in life or death questions, questions where there's a right and wrong, a truth and a falsehood, and there are consequences, I think the ones who should define (are the scientists)*" (EX-A9).

Some evidence also suggested that looking exclusively in skilled crowds can stymie results. For example, one crowdsourcing expert described how "*this can present itself in looking for the wrong kind of wisdom from the wrong crowd, where wisdom is distributed across different groups in the crowd"* (EX-A5). In summary, experts confirm that despite the need to obtain broad and diverse crowds, managers need the facility to search and select different categories of participants.

6C - II. Facilitating self-selection

In Chapter 3, it was identified that a feature of many contemporary crowdsourcing systems is that solution seekers can self-select tasks they wish to complete. To this end several crowdsourcing call experts discuss the potential use of broad crowds in selecting science tasks within call processes (EX-A6, EX-A3). Funding experts, by contrast, expressed an extreme wariness as to the practice, where scientific excellence is at issue and a dilution of review standards or skills might arise through unskilled participant involvement (EX-B4, EX-B11). A crowdsourcing expert states that "*even where a potential solution provider self-selects to participate in a call, it follows that he (they) may not have the skills necessary to provide proactive participation or be knowledgeable in terms of the skills they do/do not possess*" (EX-A9).

A funding expert (EX-B12), also confirmed the view that a call process from start to finish can be too complex at certain stages to accommodate participation from unskilled crowds. They describe the difficulty of assigning public reviewers in a process, whereby participants indicate a topic preference as a form of self-selection and a reviewer then assigns them to a task without knowledge of skills. In summary a difference is evident as to whether crowds can self-select for tasks in call processes.

Table 6.3 - Expert interviews – identification of potential solution providers

Stage	Task	Practices	Description
INPUT	**Identification of potential solution providers** **Section 6C**	**Identifying participant categories 6C-I**	Strong evidence provided from both sets of experts of the need to filter and categorise participants based on skills and demographic criteria.
		Facilitating self-selection 6C-II	Funding experts show concern as to the crowds ability to self-select based on skill criteria.

6D. Management of innovation process

Experts discussed the work involved in pivoting organizational management process structures, strategies and cultures towards crowdsourcing. Several crowdsourcing experts expressed a view that traditional funding agency call processes and structures would have to change to accommodate new crowdsourcing norms (EX-A1, EX-A4, EX-A5). By contrast, several call managers in traditional funding agency processes provided evidence that they were not as acutely aware of a contemporary need to move towards a more open management culture (EX-B1, EX-B5 and EX-B6). In the following sections, the discussion of six categories of practices is examined by two categories of experts. These include managing risk (Section 6D-I), training (Section 6D-II), creating a feedback loop (Section 6D-III). New practices such as educating participants (Section 6D-IV), removing barriers to participation (Section 6D-V) and developing portfolios (Section 6D-VI). A summary of the expert observations are presented in *Table* 6.4 below.

The interviews with experts as to the management of the process presented some contrasting observations. Some reluctance is evident on the part of several funding experts with one funding expert suggesting that, "*it remains to be seen if crowdsourcing calls will present as an easier process from the management perspective where chances are they will just be different but not necessarily easier*" (EX-B1). Another crowdsourcing expert also elaborated that because of this management attitude, public bodies "*tend to be on the latter end of picking up any new forms of novel management thinking by stating that they are usually last to embrace it coming from a management culture of always been right*" (EX-A1).

6D - I. Managing risk

A difference of opinion is evident between the two groups of experts with regard to the use of practices for managing risk.

Two experts described the public funding agencies as conservative in their risk management strategy (EX-B5, EX-A5). One funding expert stated that in "*large public sector-based processes, where there are no incentives for thinking outside the box, practitioners within these systems tend to play it safe"* (EX-B12). Another funding expert described how there is a tendency in the agencies to default towards smaller, trusted, reliable calls rather than large, risky and unyielding, suggesting that "*It is not that they do not do new things, but the environment dictates certain types of actions considering it is taxpayers' money. The fear is if we do something a little bit out there you don't want a letter in from a (politician)"* (EX-B5). In summary, both however, spoke of a desire to access upside risk (EX-B5, EX-B12). By contrast, crowdsourcing experts spoke of a link between risk taking and innovation with several participants speaking of a need to access upside risk (EX-A1, EX-A7, EX-A9). One crowdsourcing expert also noted that "*in open contests you don't need to worry about risks as much where the crowd jointly assume the risk of success or failure together*" (EA-A9).

Limiting research topics forms part of risk management where topics are based upon the needs of government or enterprise (EX-B1, EX-B3). A crowdsourcing expert offers an explanation for limiting topics in the fact that "*it is very easy to get companies to participate in the research that is to the forefront of company's own needs and the governments are aware of this*" (EX-A1). Experts in both domains highlighted the concern that crowds can turn into unruly mobs thereby stymieing effective participation (EX-A9, EX-A1, EX-B7). Several funding experts also expressed a fear in engaging the public, confirming that it is not an area of expertise held by many agencies (EX-B2, EX-B3, EX-B10). Several crowdsourcing experts also posited that crowds as opposed to funding agency managers can manage risk (EX-A5, EX-A11, EX-A12). For instance, one crowdsourcing expert provides an example where complex challenges associated with urban planning risk were addressed and balanced through crowd interaction. In this instance, the crowd elected not to select an option that involved only 1 percent (%) risk: "*The solution seekers challenged them on this to see if they understood the risk level involved and the crowd confirmed that they understood fully the nature of the risk but for our part as managers, deciding that they understood this proved a complicated task*" (EX-A5).

In summary, from the evidence presented funding agencies are more risk adverse than the private sector with crowdsourcing experts more open to the use of practices that leverage upside risk.

6D - II. Training

Training is flagged by experts in both groups as a clear requirement for the management of the call process. One expert described the practice as "*facilitating informed participation throughout the process*" (EX-A9). Several experts provided evidence of the need to provide online support and documentation to applicants and reviewers alike to help them navigate through the entire stages of the call process (EX-A5, EX-A11, EX-B1, EX-B3, EX-B5). Several experts also spoke of the need to train participants in the use of better communication methods at each stage of the call process and after the process concludes. Furthermore, two call process experts described another form of training required for the public to review and comment upon research (EX-B2, EX-B11). One funding expert described a specific training process devised to facilitate public participation in a health research call. She stated that: "*we provided a workshop guided by an area manager who showed how the forms were to be interpreted, read and screened. Also we highlighted where to go if they had queries.*" (EX-B14).

A funding agency executive confirms a further hidden aspect of training namely "*that openness can be present in the organisational culture without necessarily been codified*" (EX-B13). Training can facilitate the surfacing and codification of process tasks and behaviours. Very few of the experts could cite how crowdsourcing management practices could be collated or shared where no such guidance exists for many traditional funding agencies. Three funding experts spoke of their lack of knowledge of crowdsourcing and how this could be operationalised through practices (EX-B1, EX-B6, EX-B8). In summary both crowd and funding experts confirmed a need for training in the use of the crowdsourcing process.

6D - III. Creating a feedback loop

Limited evidence of practices for incorporating feedback or iterative development were apparent in two different contexts amongst the two sets of experts.

For instance, crowdsourcing experts spoke of examples from practice where problems were put back to the crowd for further refinement (EX-A1, EX-A12, EX-A18). As one crowdsourcing expert explained, "*I have seen across several call and even open innovation tournaments where ideas that were just good enough were given further treatment. In theory, you can do this as many times as you like but, you don't want the crowd to get bored or loose energy*" (EX-A12). In a similar vein, another crowdsourcing expert described how "*most modern broker platforms will let you incorporate iteration stages with the click of a buttons. So long as you are willing to pay extra there is always a willing crowd*" (EX-A18).

In contrast to the above, several funding experts highlighted the linear nature of funding call processes, where they could provide no examples of iterations in the context of calls (EX-B1, EX, B3, EX-B12). However, two funding experts discussed a form of feedback loops that were used to shape science policy arising from the outcomes of a call process (EX-B2, EX-B12). This presents as a form of iteration, where one funding expert described how:

"*we realized that major changes had to be made to our own policy and future calls in the (health area) domain to make sure we had better focus and better representation in the submissions received. So, we pivoted on several call tasks to give us better opportunities*" (EX-A12).

In summary, although neither set of experts spoke of the same type of iteration in the management of the innovation process, both groups were able to provide examples of types of iterations used.

6D - IV. Educating participants

Experts highlight a new practice of educating crowds in call processes. The practice presents as a key desired outcome for research funding agencies. A funding expert in a national agency who confirms that "*the agencies strive to have well informed community and for information to trickle down to the public through the researchers*" (EX-B6). Experts have highlighted that the practice requires strategic management with several funding experts confirming that there is an absence of knowledge or a clear roadmap of how to achieve success in educating participants (EX-B3, EX-B5, EX-B6).

One funding expert explained that "*the whole purpose of examining public engagement options by (funding agencies) is so that the public and other stakeholders can be active and passively educated as to what we do*" (EX-B10). Whilst crowdsourcing experts did not speak of a strong need to educate the public in many crowdsourcing initiatives, several crowdsourcing experts highlighted that organisations need to find a common language through which the crowd can learn. (EX-A1, EX-A3, EX-A12). Educating crowds presents as difficult where another crowdsourcing expert highlights that lay persons speak a different language to professionals (EX-A1). Accordingly, the method and means by which the research is communicated to the public and other stakeholders presents as an important consideration.

The practice of educating crowds also presents as challenging where one participant describes difficulty in educating participants stating that "*there is lots of interesting research out there, but it is not necessarily appealing to a wider audience*" (EX-B2). Several crowdsourcing experts discuss an important aspect of the practice where participants need to be actively engaged to learn (EX-A1, EX-A9, EX-A12). This is supported by one crowdsourcing expert who states that in call processes "*people are delivering information, but no learning is taking place as long as those who learn are not actively involved in the process.*" (EX-A12). In summary, both sets of experts address the need to facilitate the education of participants through actively educating participants in a language they understand.

6D - V. Removing barriers

Some limited discussion of a new practice of removing barriers to participation was evident from the experts. Several experts across both groups discuss the need for implementing practices for creating a lower barrier to entry for crowd participation (EX-B1, EX-B6, EX-A5, EX-A13, EX-A14). Some strategies are evident from practice. Several experts discuss the various types of barriers facing various stakeholders that need to be removed to improve participation such as disability, gender, public sector red tape, technological competence and geographic location (EX-B1, EX-A5, EX-B13, EX-A14). For many types of challenge, funding agencies only managed to obtain a limited demographic spread.

One crowdsourcing expert spoke of the need to make platforms easier to use so older participants or those who are not technologically savvy case participate (EX-A5). Two funding experts described how that the research funding system probably favours men as a competitive arduous process and that more needs to be done to include women (EX-B1, EX-B6).

A funding call manager explained that engaging with existing offline research communities outside the walls of the funding agency can present barriers. In particular, where **"***different communities centre themselves around topics that are of importance to scientific research rather than centring themselves around a particular technology like Facebook*" (EX-B13). One crowdsourcing expert also referred to one such famous example, the *Audubon Bird Count,* which is a community that engage in bird watching and counting (EX-A1). He described how this community of ornithologists are often cited as a historical example of research crowdsourcing. However, many similar types of these communities are not to be found online. A barrier is faced to their participation where they are not online or participating in an online ecosystem. In summary, funding experts more so than crowdsourcing experts are concerned about barriers to participation. Both sets of experts confirmed that more can be done to lower the barriers of entry for key demographics not present in traditional call processes.

6D - VI. Developing portfolios

A new practice of developing portfolios was identified by experts. Both sets of experts suggested that practices are required for ensuring that the problems at the root of call processes provide sufficient coverage and diversification to match the organisations goals. However, the need was much more apparent in the funding group with stronger evidence presented. Four funding experts discussed the difficulties arising from a failure to adopt a portfolio approach to strategic challenges the organisations are trying to address (EX-B3, EX-B11, EX-B13, EX-B14). For example, one funding manager explained that "*it is not discernible if major funding agencies have successfully coordinated strategy in ensuring both fundamental (basic) and applied problems are addressed in a coordinated manner at the meta level*" (EX-B11). Another funding expert also described how it is hard for agencies to check that we have enough types of calls to cover the full spectrum of challenges we are trying to solve (EX-B13). In contrast to this, crowdsourcing experts did not elaborate on substantial strategic

concerns in not having a diverse portfolio of problems from the outset that match their organisational objectives. Two participants spoke of the need to ensure that the platform has a sufficient type and variety of problems to keep people enthusiastic and engaged (EX-A1, EX-A9). One crowdsourcing expert stated that "*I imagine funding agencies would need to make sure they are matching their calls to all the major societal headings*"?

Table 6.4 - Expert interviews – management of innovation process

Stage	Task	Practices	Description
PROCESS	**Management of innovation process** **Section 6D**	**Managing risk 6D-I**	Crowdsourcing experts were predominantly concerned with enabling upside risk. By contrast funding experts were concerned with downside risk in managing public monies.
		Training 6D-II	Crowdsourcing experts emphasised the need for training for participants. Also, funding experts confirmed that certain types of process training was required by funding agencies.
		Creating a feedback loop 6D-III	Crowdsourcing experts spoke of the utility in introducing iterative loops to processes. By contrast funding experts provided examples of the use of policy feedback loops.
		Educating participants 6D-IV	Funding experts provided strong support for the practice of educating participants. Some limited evidence was also presented from crowdsourcing experts.
		Removing barriers 6D-V	Both sets of experts were cognisant of the need to remove barriers to participation for as many classes of participants as is possible.
		Developing portfolios 6D-VI	Funding managers highlighted the need for strategic portfolio considerations. By contrast crowdsourcing experts did not argue a substantial need for such a practice.

However, crowdsourcing experts show little by way of concern as to the need to specifically balance a portfolio of research topics, themes or problems. Several experts confirm that commercial initiatives have a greater tendency to leave the problem selection open to the crowd (EX-A1, EX-A5, EX-A11) and as expressed by one crowdsourcing expert, are more or less happy to "*take whatever comes their way by way of crowd or stakeholder suggestions*" (EX-A1). In summary, the experts concur that funding agencies need to use practices to insure balance over the problem space they are seeking to address including the categories and types of problems they are trying to address.

6E. Management of the stakeholder relationship

Several funding experts described the interactions required with other stakeholders in building a call process and the management of those relationships (EX-B1, EX-B3, EX-B7). Both sets of experts suggests that call processes are labour intensive and require substantial effort in the management of stakeholders including industry and the crowd. In the following sections, the discussion of five categories of practices is examined by two categories of experts. These include moderating participation (Section 6E-I), facilitating communication (Section 6E-II), compelling participation (Section 6E-III), creating social space (Section 6E-IV) and facilitating transparency (Section 6E-V). A summary of the expert observations are presented below in *Table* 6.5.

Extensive communication is completed amongst managers and stakeholders in managing call processes. For example, one crowdsourcing expert explained that some funding or review call systems are "*very labour intensive with hundreds of communications been sent to engage reviewers*" (EX-A9). This is also confirmed by another funding expert who also describes the current process as being **"***incredibly labour intensive on our side where somebody needs to print off the submission, stick it into an envelope, post it out, and then receive back a form from the reviewer that then needs to be transcribed and placed into a word document* (EX-B12). Modern funding agency call processes are not shown to be exclusively online with many process stakeholders interacting in person (EX-B1, EX-B3, EX-B4). Also, a call process expert says managers face complex reporting requirements that are associated with managing large calls (EX-B6)

6E - I. Moderating participation

Evidence shows a difference between experts as to the use of moderation. Management structures differ where three call process experts described a heavily controlled structure in traditional funding agencies not bearing similarity to those of crowdsourcing ecosystems (EX-B1, EX-B11 and EX-B12). A consensus exists across funding experts interviewed in supporting top down management practices such as moderation in funding calls in the majority of instances (EX-B1, EX-B11, EX-B12, EX-B6).

The use of moderators is common across crowdsourcing generally, however, participants describe the approach as more facilitative (EX-A1, EX-A9). There was some evidence of moderator type roles been used by the funding agencies in public consultation in a more flexible rather than determinative manner (EX-B12, EX-B13). However, in crowdsourcing initiatives, two types of moderation were described. First, moderators appointed by the solution seekers to bring participants around to a specific focus or area of interest and second, moderators appointed by the crowd as trusted agents. Several experts from funding agencies identified significant differences with traditional processes previously used (EX-B9, EX-B10, EX-B12). For example, two experts expressed the view that public sector management structures are traditionally vertical in nature as opposed to crowdsourcing initiatives which are more horizontal thereby accounting for the difference between the two types of moderator in use (EX-A1, EX-A5). Some crowdsourcing experts described using moderation to remove unruly participants (EX-A1, EX-A9). Similarly, some funding experts described deleting inappropriate submissions, however, none identified the removal of participants (EX-B1, EX-B6). In summary, both crowdsourcing and funding experts explained a need for the practice of moderation in various capacities.

6E - II. Facilitating communication

Experts from both groups highlight the need to insure that all stakeholders managing and participating in the process have a voice and an ability to share information. Several crowdsourcing experts confirm that communication involves making sure each of the parties and stakeholders have a voice and that this is necessary in the formation of communities (EX-A5, EX-A11). Within crowdsourcing processes, experts confirm the need for new communication systems to facilitate the growth of online communities (EX-A3, EX-A6, EX-A12). By contrast to the above, several funding experts explain that various communication limitations are placed within grant management systems for reasons of secrecy (EX-B1, EX-B3, EX-B5). This challenge stands in contrast to many crowdsourcing initiatives where individual participants can contact each other or the crowd (EX-A1, EX-A5).

A funding expert confirms that other types of stakeholders "*such as external reviewers outside Ireland can be very time sensitive to accepting work depending on the time of year*" (EX-B1).

Another call process expert described the difficulty in facilitating reviewer communication from across different countries within time schedules and work (EX-B5). A challenge faced in this coordination work rests in the fact that generally it is hard to arrange for these individuals to be face-to-face at specific times (EX-A1, EX-A5, EX-A11). This can present as a barrier to forming communities of reviewers across borders. Evidence from crowdsourcing experts shows that the use of digital communication technologies such as email, the platforms, instant messaging and social media have greatly assisted communication in crowdsourcing processes (EX-A1, EX-A9, EX-A11).

6E - III. Compelling participation

Some limited evidence was presented from three experts that compelled participation forms part of many public sector activities, even where government employees must participate as part of their employment (EX-A1, EX-B3, EX-B6). While experts expressed the view that this type of participation had no real potential downside, one expert remarked that ideally compelling anyone to join any process is a bad idea. For example, he explained that "*it would be better to focus on the positive reasons to participate over and above mandating participation*" (EX-A1).

Two funding experts said they could see the need to have certain categories of participants compelled to do certain activities (EX-B3, EX-B6), in particular where they were to receive funding or wanted their research area to form part of the competition. As one expert further elaborated "*with funding in the present day we are trying to get the maximum commitment from the researcher that they will promote science in return for money*" (EX-B6). In summary, it can be concluded that while participation could be compelled in certain instances it does not present as an ideal means by which progress can be achieved in call processes.

6E - IV. Creating social space

Creating social space emerged from the data as a new practice for use by the funding agencies. A limited awareness was apparent on the part of funding experts of the need to create social space within call processes. By contrast, crowdsourcing experts provided strong evidence of the necessity to have a social space where participants can interact and participate. One crowdfunding expert described how funding agencies

need to change their mind set and that ideally, "*the savvy marketplace is always on the lookout for new customers to lure into the portal*" (EX-A6). Crowdsourcing experts also cautioned that growing and retaining communities of solution seekers is a difficult task where communities exist over several layers interacting inside and outside the organisation (EA-E2, EX-B13, EX-A9, EX-A13 and EX-A15).

While evidence exists of the funding agencies using tried and trusted reviewers over long periods of time (EX-B1, EX-B3, EX-B5), crowdsourcing initiatives by contrast show evidence of a greater throughput in participation (EX-A1, EX-A9). Participants stated that this has resulted in the development of practices with a view to retaining crowds and growing online communities (EX-A2, EX-A5, EX-A11). The need for creating a social space is apparent where one funding expert confirmed that:

"*despite having large social media following many contemporary funding agencies struggle to move from passive followers to engaging diverse active communities or developing a sustainable means of involving reviewers and crowd members on an ongoing basis*" (EX-B10).

Evidence shows that funding agencies are preoccupied with competing to retain pools of expert reviewers. Several funding experts, for example, described guarding closely their lists of favoured reviewers (EX-B10, EX-B4, EX-B8). In summary, evidence suggests funding agencies are seeking ways to retain participants.

6E - V. Facilitating transparency

A tension point was apparent between the two groups of experts as to the issue of transparency over call processes. A new practice of facilitating transparency was identified by experts. Transparency addresses the competing needs of crowds for oversight of the process versus the solution seekers need to provide some degree of secrecy over aspects of calls. Several funding experts spoke of a need to maintain secrecy at the very minimum over certain aspects of the call process (EX-B10, EX-B12, EX-B1, EX-B3). In contrast to this, however, several crowdsourcing experts spoke of a need to open-up the public process to a position of complete transparency (EX-A1, EX-A5, EX-A11, EX-A13). Where challenged on the idea of keeping some aspects secret relating to reviewers and voting one crowdsourcing expert remarked

"*this conflict sums up the old world versus new world view in management practices. They have got to let go of these outdated management ideas and realise that big industry big pharma etc are all moving towards this kind of openness*" (EX-A5).

Table 6.5 - Expert interviews – management of stakeholder relationship

Stage	Task	Practices	Description
PROCESS	**Management of stakeholder relationship** **Section 6E**	**Moderating participation 6E-I**	Both sets of experts describe the use of moderators in different contexts. Also, both experts describe the management practice of moderation.
		Facilitating communication 6E-II	Both sets of experts confirm the requirement for the practice of communication. It was also noted that this communication should be two way and not just the dissemination of information by the solution seeker.
		Compelling participation 6E-III	Funding experts provided evidence of agencies compelling grant recipients to engage in outreach works. Outside of this, limited support for the practice of compelling participation was available.
		Creating social space 6E-IV	Crowdsourcing experts spoke of the need to create a social space to facilitate crowd interaction and crowd retention. By contrast the agencies spoke of challenges in retaining reviewers.
		Facilitating transparency 6E-V	A tension exists between both sets of experts. Crowdsourcing experts spoke of the need for complete transparency while funding experts spoke of the need for secrecy in some aspects of the decision-making process.

Different levels of transparency are described across the two sets of experts where one funding agency executive highlighted that "*for funding agencies there is no template or blueprint as to how transparency is to be done in practice*" (EX-B3). This fact is further complicated by the fact that "*contemporary open processes feature several different types of stakeholder all with differing views and needs regarding communication and transparency*" (EX-B10).

A crowdfunding expert identifies "*intellectual property concerns of commercial partners in crowdsourcing calls with the potential of crowds revealing of sensitive intellectual property*" as constituting a major challenge in crowdsourcing (EX-A1). By contrast in the funding sector a funding expert expresses the opinion that "*the call processes should be bust wide open as there is really nothing to hide in calls (and) there should be no objection to the public having oversight of expert review processes*

6F. Assessment filtering of solution submissions

Along with the practice of filtering with tools and managing scale, an additional new practice of mitigating bias was evident from the discussions with both groups of experts. Both sets of experts spoke of the transition in innovation processes from a limited number of applications to large-scale, online ecosystems enabled through software. In the following sections, the discussion of three categories of practices are examined by two categories of experts. These include filtering with tools (Section 6F-I), managing scale (Section 6F-II) and the new practice of mitigating bias (Section 6F-III). A summary of the expert observations are presented in *Table* 6.6 below. Some discussion was provided in depth by one funding expert who spoke of the future of filtering solutions received from stakeholders. He explained that "at *present we can see the push into using AI and semantic analysis tools in tournaments, but who knows where this is going to go with machine learning*" (EX-B11).

6F - I. Filtering with tools

A difference exists between perspectives of experts on the use of electronic tools for filtering submissions received. Limited evidence was provided by funding experts of the need for, and utility of filtering tools in searching the applications received. One applicant stated that "*someone is going to have to review all the applications received anyhow, so I cannot see how you are going to gain much value from being able to search or analyse the minutia*" (EX-B3). By contrast another funding expert hypothesised that in the future advanced electronic search features could help achieve great insights in to submissions stating "*I can foresee the use of AI and machine learning to study all the applications received over time periods. Who knows what you could find, evidence of copying other people's applications, fraud or even the reverse, real uniqueness in thought*" (EX-B5).

Crowdsourcing experts, however, show a substantial use of electronic tools in examining submissions received. For example, as one expert explained, "*we already use forms of semantic analysis that are built into our dashboard as standard. From world clouds and search tools we can highlight trends in submissions received in contests*" (EX-A11). Several other crowdsourcing experts described the use of electronic tools in the filtering process covering advanced search functions (EX-A1, EX-A3, EX-A5, EX-A9).

However, one participant also cautioned that "*you will always need a human in the loop who is going to have to make a call at some point in the filtering process*" (EX-A5). Experts point out that electronic tools are not a universal panacea to the problem of finding good solutions from crowdsourcing. Whereas technology has improved, it does not necessarily provide the solution seeker with better solutions arising from the process (EX-A1, EX-A5, EX-A9, EX-B5, EX-B13). In summary, experts posit that the practice of filtering with electronic tools will see more use in the future by funding agencies, where current use remains low.

6F - II. Managing scale

Both sets of experts spoke of the need for processes to be able to facilitate scale. Several funding experts from large funding agencies spoke of the need to accommodate the receipt of a vast number of submissions (EX-B1, EX-B4, EX-B5, EX-B6). However, crowdsourcing experts also spoke of the need to facilitate scale (EX-A1, EX-A7, EX-A12, EX-A14). The management of scale presents as a major difficulty in contemporary call systems, especially those of large crowdsourcing initiatives. Evidence exists across expert interviewees that many contemporary call processes have built processes taking into account prospective difficulties posed by scale. For example, a call process expert spoke of the challenge where "*electronic platforms used by the agencies need to be scaled to take into account an increase in the numbers of applicants and stakeholders on the*" (EX-B5). A crowdfunding an expert noted that "*old world institutions such as the agencies have not managed to properly address this challenge of scale with appropriate technology*" (EX-A7). Moreover, another funding expert described the problem of information overload in call processes "*because there is no standardisation and one size fits all approach, we (the reviewers) have masses of information to process as they engage with each different submission*" (EX-B6).

One call process expert described how in New Zealand the government received a mass of submissions in one call process (EX-B4) while another crowdsourcing expert described the scale of data arising from public submissions in crowdsourcing processes as in many cases "*probably too big to mine where existing call process management systems are limited in terms of their ability to deal with large scale submissions"* (EX-A16).

There is also difficulty faced by funding agencies in not been prepared for the scale of submissions, for example one call process expert described how she:

"*was very worried if we would get fifty (submissions). We bought advertising in the main newspapers, we put it up for a week on radio as an advert. We had a twitter campaign. After three days, I told everybody please stop tweeting. We were inundated with applications*" (EX-B12).

Several participants described designing platform stages around expected numbers and provisioning cloud computing resources based on anticipated traffic (EX-B4, EX-B5, EX-B6, EX-A7, EX-A12, EX-A14). Similarly, a crowdsourcing expert also spoke of the difficulties faced in building crowdsourcing systems from the perspectives of scale and described how in one large scale crowdsourcing process several staff were required to run a platform that facilitated the participation of several hundred crowd members (EX-A15). The management of complexity presents as a difficulty in call processes at various levels. One crowdfunding expert suggested there is "*an adversity generally to building crowdsourcing systems that are capable of dealing with deep complexity where to date, crowdsourcing organisations opt for lower level mass engagement on non-complex issues*" (EX-A1). Another crowdsourcing expert described this reality as "*disappointing*" and suggests that funding agencies "*should be able to overcome these challenges through good platform design and the use of appropriate IT*" (EX-A5). In summary, as funding agencies achieve greater levels of participation, the practice will assist in scaling systems to deal with issues of scale and complexity.

6F - III. Mitigating bias

Evidence shows that the need to address biases in call processes was of much greater concern to funding experts than crowdsourcing experts. Several crowdsourcing experts expressed confidence that in a transparent call, biases are often taken into account by the crowd (EX-A7, EX-A9, EX-A14). Funding experts by contrast were concerned about the ability of nefarious applicants to swing the crowd into their favour. Several crowdsourcing experts also described how in public engagement, crowds in having knowledge of who were the experts can affect the outcome of the process (EX-A5, EX-A11).

Where the funding agency involves too many crowd members from one community over another, biases can occur (EX-B9, EX-B13). One funding expert explained that even in appointing reviewers to one call process, it does not follow that they should all be from the same discipline and cross disciplinary appointments can help mitigate bias (EX-B13). A similar practice was evident in crowdsourcing calls where selection biases can also occur. One crowdsourcing expert describes this aspect of the challenge where "*in participatory groups you have people who are experts or have too much passion in a given topic and such people might be too much for a particular cause or outcome*" (EA-E2).

Several other experts described how regular members of the public can add value in crowdsourcing calls, even where they have limited skills or experience. In this instance the evidence indicates that the weight of numbers can help to mute individual participants with overtly strong views (EX-A1, EX-A5, EX-A11, EX-B12). In summary, both sets of experts used different means to control biases however, funding agencies showed greater concern as to issues arising from bias.

Table 6.6 - Expert interviews – assessment filtering of solution submissions

Stage	Task	Practices	Description
PROCESS	**Assessment filtering of solution submissions** **Section 6F**	**Filtering with tools 6F-I**	Funding experts spoke of a potential future need for filtering tools. By contrast, crowdsourcing experts spoke of the active use of electronic filtering tools.
		Managing scale 6F-II	Both sets of experts envisaged an increase in the scale and complexity of submissions in the future. Practices and technologies are required to assist with the scaling of call process infrastructure.
		Mitigating bias 6F-III	Both sets of experts spoke of various biases in call processes, however, funding experts were more vocal in the need for a practice of mitigating bias.

6G. Generation of potential solutions

It was found that the practice of generating solutions primarily lies at the output stage of the process. However, further evidence suggests that the practice is also evident in the task of crowd selection at the input stage of the process. In the following sections, the discussion of two categories of practices are examined by two categories of experts. These include scoping the solution (Section 6G-I) and selecting solutions (Section 6G-II). A summary of the expert observations are presented in *Table* 6.7 below.

One crowdfunding expert describes how; "*in some crowdsourcing processes a few prototype solutions can be picked early in the process and refined or discarded at a later stage in the process*" (EX-A6). From the theoretical perspective both sets of experts support the practices associated with generating solutions. A difference exists, again, where funding experts are more concerned of the need for expert involvement.

6G - I. Scoping the solution

The process of scoping the solution bears similarity to the practice of scoping the problem (see section 6A-II above) at the start of the process. A difference of opinion exists between experts, with funding experts expressing a strong need for expertise in the execution of the practice (EX-B1, EX-B2, EX-B3, EX-B6, EX-B12). Several crowdsourcing experts described the process of taking the solutions previously filtered and scoping/amalgamating them into a final version. In this instance, the crowd can play an active role in amalgamating submissions (EX-A5, EX-A6, EX-A9, EX-A14). Thereafter, stakeholders can select or reject the submission (see the next section 6G-II). Funding experts highlighted a lack of immediate examples of how solutions could be scoped from submissions received (EX-B1, EX-B5, EX-B6). One funding expert described how submissions made across several calls were grouped into a new call process. He stated that he was only aware of one example, explaining that "*we saw a concurrent theme emerging across submissions on (platform) and decided to group these into another call topic*" (EX-B6). Another funding expert described a challenge of reducing the complexity of submissions to such a point that the crowd can understand the full extent of the submission (EX-B2). Several crowdsourcing experts also described how in various call processes, solutions can be aggregated across submissions into one larger solution (EX-A1, EX-A5, EX-A11). While it remains to be seen how this could be applied in funding calls, several experts point towards the concept as potentially applicable but that no guidance exists of how to do this (EX-A1, EX-A12, EX-A18).

6G - II. Selecting solutions

The practice of selecting solutions is described by both sets of experts as more than a case of simple voting. Across both cases several participants stressed the need to have experts and lay persons collectively involved in picking solutions (EX-B3, EX-B5, EX-B6, EX-A5, EX-A9).

Several funding experts described the practice of selecting winners/solutions within a call process (EX-B3, EX-B5, EX-B6). In particular, funding experts described the process by which solutions are graded, selected or amalgamated in call processes. A funding expert described the steps involved in the practice including

"*the sending of electronic and sometimes paper copies of applications to the reviewers for grading. A peer review system or portal is used to collect scores and feedback received. Thereafter, the results must be compiled by call managers and reviewed at a committee level. All of this presents as a complicated process requiring hands-on management*" (EX-B3).

However, several call process experts describe the difficulties faced in grading and selecting solutions (EX-B3, EX-B5, EX-B6), for example, agreeing marking standards and reaching consensus across reviewers. As one funding expert pointed out,

"*A cut off mark for funding may be set at eighty eight percent and yet a great number of losers might score high (in the eighties) but not over the mark. This graded selection process can create some confusion and disappointment, especially where losers score close to the cut off threshold for marks*" (EX-B5).

Also, difficulty is faced in deciding who should provide winning solutions with no guidance available as to who should make the decision. One crowdsourcing expert explained that call managers need to reflect upon "*what selection is to be done and with whom the final decision rests*" (EX-A5). One crowdsourcing expert also suggested that not everyone should get to directly select solutions, explaining that the path between the payment of public finances to research and the output are not immediately connected by way of entitlement.

Table 6.7 - Expert interviews – generation of potential solutions

Stage	Task	Practices	Description
OUTPUT	**Generation of potential solutions** **Section 6G**	**Scoping the solution 6G-I**	Both sets of experts show differing positions in relation to the practice. Funding experts expressed a strong need for including experts. Crowdsourcing experts were less disposed to strong expert involvement.
		Selecting solutions 6G-II	Both sets of experts speak of the practice of selecting solutions and concur that not all participants should have equal voting powers.

6H. Potential rewards for solution seekers, solution providers, brokers.

Experts from both groups discussed the rewards available for the different stakeholders in crowdsourcing. Several experts discussed the implications of the different incentives on offer to stakeholders in crowdsourcing. Evidence exists from both groups of experts of both intrinsic and extrinsic motivational factors been designed into call processes at multiple stages. In the following sections, the discussion of four categories of practices is examined by the categories of experts. These include providing extrinsic incentives (Section 6H-I), appealing to intrinsic motivations (Section 6H-II), and the new practices of fostering coopetition (Section 6H-III) and harnessing indirect advertising (Section 6H-IV). A summary of the expert observations are presented in *Table* 6.8 below.

It was found that call process managers in funding calls have been predominantly focused upon incentivising participation at the output stage through the form of paying reviewers (EX-B1, EX-B2, EX-B3, EX-B5). By contrast many contemporary crowdsourcing initiatives seek to encourage crowd participation by providing some incentives up front followed by rewards at the output stage (EX-A2, EX-A10, EX-A11, EX-A15).

While funding agencies provide for the payment of professional or academic reviewers, little by way of provision exists for paying the crowd to participate in calls (EX-B12, EX-A10). Three experts point out that traditionally, peer reviewers are paid in call process for their participation at the output stage and in other instances where they are not paid, their review work is considered part and parcel of their academic portfolio of works (EX-B3, EX-B5, EX-B6, EX-B14). Several experts spoke of ethical and regulatory issues faced in paying crowds to participate. Also, a general difficulty exists in motivating the public into participation in science. In supporting the consensus view, a crowdsourcing expert states that because crowds are motivated by different things "*this points to the need to factor in both intrinsic and extrinsic motivations into the design of calls, however, in practice, we have no real guidance as to how to do this"* (EX-A1).

6H - I. Providing extrinsic incentives

The provision of extrinsic incentives was confirmed by experts across both groups as important for the success of call processes. However, various difficulties including ethical issues and bureaucratic barriers arise in the incentivisation and motivation of crowds through monies. Several experts across both groups said they felt constrained in terms of the rewards they could offer to motivate public participation (EX-B2, EX-A10, EX-A14, EX-A15). Two experts expressed a view that from an ethical perspective, the offer of extrinsic incentives by public agencies, such as money presents bureaucracy issues where the public sector has stricter conditions regarding the payment of monies (EX-B6, EX-A2). Paying participants is not presented as straightforward by a number of participants across both cases (EX-B2, EX-B4, EX-B12, EX-A9, EX-A10, EX-A14). A funding expert stated she was "*not sure of the merits of self-selecting participants being paid to get involved (and) that it is possible to do this when obtaining crowd members for a study but otherwise I am unaware of what to do beyond this where there may be ethical issues with payments*" (EX-B4).

There is evidence of vouchers or small gifts been used to entice crowds into call processes where one funding expert explained by way of example "*we didn't pay them or offer anything in terms of our recruitment. What we did do is give them a voucher*" (EX-B12). Another crowdsourcing expert also described a similar process in a public initiative where small gifts were also provided for participation over and above payment (EX-B2). Even where private organisations can more readily use payment for participation, it was posited that cash does not necessarily solve all problems (EX-A1, EX-A9, EX-A14). However, by contrast to this, one crowdsourcing expert explained a fear held by managers where "*you're going to get just bundles of people clicking a button and you could end up paying quite a lot of money for poor results*" (EX-A16).

6H - II. Appealing to intrinsic motivations

The reliance upon the practice of intrinsically motivating participants shows strong evidence of use across both groups of experts. Several funding experts highlight that, to date, many funding agencies have sought to appeal to intrinsic or personal motivations in securing participation from external participants such as the crowd (EX-B1, EX-B2, EX-B6).

A funding expert described a public research challenge where a prize was given to researchers for participation. The public were enticed into participation through the inclusion of students from second and third level institutions where it was regarded as a "*fun and social event in the x-factor style*" (EX-B2).

Several crowdsourcing experts cited examples from not-for-profit crowdsourcing calls in appealing towards intrinsic motivations such as participants seeking praise from peers and others in seeking to add to their skillset (EX-A1, EX-A3, EX-A14). However, a crowdsourcing expert cautioned that where people volunteer participation for intrinsic reasons, managers need to exercise caution in managing participation. For example *"if you try to filter a group who have volunteered to participate in a challenge you might wind up with a crowd of slim pickings*" (EX-A14). In the crowdsourcing domain a greater spectrum of the deployment of techniques for intrinsic motivations is evident. There is evidence of non-for-profit organisations using advanced strategies for tapping into intrinsic motivations. Experts explained that these organisations are used to appeal to the personal motivations of prospective donors (EX-A3, EX-A14).

6H - III. Fostering coopetition

A new practice was described by crowdsourcing experts where several experts described processes featured the use of 'coopetition'. The practice presents as an opportunity for participants to get personal satisfaction from competing and collaborating with other participants. While there was substantial discussion of the utility of this practice from the crowdsourcing side (EX-A1, EX-A5, EX-A7, EX-A12), there was limited, if any, evidence presented by the funding agency experts of the use of coopetition (EX-B1, EX-B6). The only evidence presented concerned a theoretical application of coopetition, for example one participant explained that "*I expect we are going to have to use new types of entertainment within calls to keep people excited like the major events run by NASA and LEGO. Some part competitions and others featuring a chance to share ideas*" (EX-B1).

Several funding experts by contrast provided examples of collaborative approaches in public consultations (EX-B4, EX-B6, EX-B7). For example, one participant explained, "*although I do not have any examples from our calls, I do know that the public have been involved in jury style meetings where they deliberate jointly*

with scientists in shaping new calls" (EX-B6). However, outside of this, a crowdsourcing expert highlighted that researchers are traditionally used to a competitive culture (such as peer review) as opposed to other open types of open or collaborative management culture (EX-A5). By contrast to funding agencies, crowdsourcing environments show management systems based largely around the facilitation of both competition and collaboration (EX-A1, EX-A5, EX-A7).

6H - IV. Harnessing indirect advertising

Crowdsourcing experts were keen to point out that crowdsourcing systems, in and of themselves, can serve as a form of indirect advertising which presents as a form of reward for the organisation. One crowdsourcing expert described how this can be a form of reward for the organization. He states that "*we have seen the Boaty McBoatface example. Some people think this was a disaster. To the contrary, it raised awareness of the governments environmental work and drew immense public interest*" (EX-A1). Also, two experts specifically pointed to the fact that even negative publicity generated from calls could result in positive interest in the ecosystem (EX-A5, EX-A11). One expert, for instance, explained that "*you have to throw the old rules out the door, new platform-based participation companies and even governments can attract mass interest. Word spreads fast*" (EX-A5). The practice features the crowd engaging with other participants and media about the challenge and generating viral interest (EX-A1, EX-A9).

The potential to go viral was not lost on funding experts who noted that communities and media could be leveraged through the crowd (EX-B4, EX-B11, EX-B13, EX-B14). However, several participants spoke of a fear of the potential downside. One participant remarked "*of course it could be of benefit to us to get extra attention, I acknowledge that, however, think of all the extra unwanted scrutiny we could draw upon ourselves*" (EX-B4). By contrast a crowdfunding expert explained that **"***organisations have an irrational fear of negative outcomes from the results of such advertising"* (EX-B10). Two funding experts (EX-B6, EX-B13) also stated that the challenges could in theory be marketed in such a way as to draw maximum rewards while avoiding potential downside. One such expert explained that "*what we want is the extra participation and support, not the headaches from all the added complex participation*" (EX-B13).

Table 6.8 - Expert interviews – potential rewards

Stage	Task	Practices	Description
OUTPUT	**Potential rewards for solution seekers, solution provides, brokers** **Section 6H**	**Providing extrinsic incentives 6H-I**	Both sets of experts spoke of the importance of offering extrinsic incentives, however, experts highlight that the public sector are limited in terms of reward types they can offer.
		Appealing to intrinsic motivations 6H-II	Both sets of experts spoke of the need to engage participants based upon their intrinsic motivations.
		Fostering coopetition 6H-III	Evidence of a new practice of coopetition emerged with crowdsourcing experts highlighting the need to use both collaboration and competition in calls. Funding experts provided limited support for the practice.
		Harnessing indirect advertising 6H-IV	Both sets of experts highlighted the potential indirect advertising benefits from using crowdsourcing. However, funding experts were concerned about negative publicity.

6I. Broader socioeconomic impacts (rewards for the marketplace and society

The outcome stage of the preliminary conceptual framework addresses the issue of impact arising from crowdsourcing. In the context of funding calls various metrics are used in practice for measuring impact, however, there is some discussion amongst funding experts as to what impact arising from crowdsourcing should look like (EX-B1, EX-B4, EX-B12). In the following sections, the discussion of three categories of practices is examined by two categories of experts. These include using web and social media metrics (Section 6I-I) and the new practices of establishing crowd impact metrics (Section 6I-II) and facilitating real-time oversight (Section 6I-III). One crowdsourcing expert explained that "*crowdsourcing initiatives need to consider how the relative success of the call process can be measured from the very start*" (EX-A1). Several funding experts also confirmed that funding agencies are under increased pressure from governments to benchmark performance and provide confirmation of their relative success where new metrics are required (EX-B1, EX-B3, EX-B4, EX-B7). For example, a funding expert remarked:

"*historically, if you got the projects up and running, peer reviewed and the results communicated clearly, then that was considered a success, as long as the public know that [this] is what research success looks like, however, the situation has changed and it is now harder to measure success in public supported initiatives*" (EX-B4).

6I - I. Using web and social media metrics

Both sets of experts confirm the use of web and social media metrics in measuring crowd involvement through web platforms. Various crowdsourcing experts confirmed the use of web and social media metrics in existing crowdsourcing call processes for the purposes of measuring platform success (EX-A1, EX-A8, EX-A16). By way of example, a crowdsourcing expert explained that in measuring call performance:

"*everything's still goes largely (by social media KPI's). I say largely because there are some people who are trying to change that conversation, but everything still goes by numbers and reach and that's just from traditional advertising and PR that they came from. They've taken this old model and fit into this new one but, it doesn't really matter about the number of website visits it's about been able to transfer that value into something else. Something more that's valuable.*" (EX-A16).

According to one crowdsourcing expert, social media metrics only provide short term indicators of usage (EX-A16). This is supported from the funding agency perspective, experts highlight that impact is measured over much longer timescales (EX-B3, EX-B4, EX-B6). Several funding experts spoke about the use of such metrics with the platform (EX-B3, EX-B4, EX-B10). One participant, for example, suggested that they provide a picture of who visits and where they have visited from. Also, the site statistics can tell the agency how long participants spent on a page and which pages they clicked through (EX-B10). This stands in contrast to a crowdsourcing expert who states that "*we go into depth in terms of the web metrics collected. You can go a lot further that pageviews and location. The good crowdsourcing platforms will use A/B testing to check the crowd's preferences for routes in calls*" (EX-A5). Several participants from both groups confirmed that the exclusive use of web and social media metrics for measuring impact is a poor choice for several reasons.

6I - II. Establishing crowd impact metrics

Both sets of experts confirm the difficulty posed by the absence of metrics for funding agencies with which to measure the impact arising from crowdsourcing. Two participants also spoke about the vast plethora of metrics in use by agencies, which also, unlike web and social media metrics, cover offline activities (EX-B6, EX-B10).

A funding expert points out that a challenge exists in defining KPIs early where in the case of funded research "*big impact is something that happens much later in the process*" (EX-B12). Similarly, another call process expert explained that "*to date agencies have not had a performance indicator to see how we (they) are engaging with the public with no one size agency call system and accordingly this makes it difficult to compare and contrast successes and impact across agencies and competing call processes*" (EX-B6).

Evidence from experts in both domains confirms that the measurement of impact arising from call processes occurs at or after the outcome stage (EX-A1, EX-B4, EX-B6, EX-B12). Both groups of experts suggest that there is an absence of appropriate KPIs for measuring impact as impact occurs over longer timeframes (EX-B3, EX-A1, EX-A16, EX-A12).

Limited examples are available of crowdsourcing metrics in use that can be considered measurements of impact. For example, a funding expert confirms that effective communication of research is an important metric to be measured but that no universally accepted means exists to report on this at present (EX-B2). Accordingly, experts across both domains stress the need for the adoption of metrics that facilitate comparison and benchmarking (EX-A1, EX-A5, EX-A11, EX-B2, EX-B3).

6I - III. Facilitating real-time oversight

Some limited evidence was presented of a new practice of real-time measurement of call processes, Crowdsourcing experts spoke of the need to measure, in real-time, aspects of the process (EX-A1, EX-A5, EX-A10). One crowdsourcing expert, for example, explained how most crowdsourcing platforms contain dashboard to show the real-time the progress of participants. This expert explained that this enables fluid response where

"*sometimes you need to change a challenge or details in response to real-time issues or feedback from the crowd. If I see a drop off in interest from the crowd in a problem and I'll rebadge it to try and generate new interest. Without a live dashboard we would be nowhere near as effective"* (EX-A10).

Two funding experts stressed the potential utility of real-time oversight but stated there was a need to hide certain KPIs and metrics from full view of stakeholders (EX-B1,

EX-B6). By contrast, another crowdsourcing expert also describes how despite the use of technology "*many crowdsourcing processes are faced by challenges where we (stakeholders) do not have real-time oversight of the submissions made by other contributors*" (EX-A5). In summary, despite crowdsourcing experts discussing the utility of real-time oversight and dashboard metrics, funding experts only described the ex-post collection of performance data at the conclusion of the process. No evidence was available of the use of real-time metrics throughout the process over and above standard web and social media metrics.

Table 6.9 - Expert interviews – broader socioeconomic impacts

Stage	Task	Practices	Description
OUTCOME	**Broader socioeconomic impacts, (rewards for the marketplace and society) Section 6I**	**Using web and social media metrics 6I-I**	Both sets of experts spoke of their organisations use of web and social media metrics to monitor platform performance.
		Establishing crowd impact metrics 6I-II	Both sets of experts concurred that new bespoke metrics were required for measuring crowdsourcing impact. Also, both groups spoke of the need to define what constitutes impact from the outset.
		Facilitating real-time oversight 6I-III	Crowdsourcing experts spoke of the utility of the practice in enabling fluid responses to issues in call processes. By contrast funding experts provided little evidence of the practice.

6.2. Summary

In this chapter, the framework of the Marjanovic et al., (2012) along with practices identified from Chapter 3 were applied as a lens to expert interviews. The evidence outlined above supports the presence of new practices which emerged. The new practices identified (*Tables* 6.1 – 6.9) are now adapted into the Marjanovic et al, (2012) Framework (see *Fig.* 6.2 below) and are hereafter applied to two case studies in the next chapter (Chapter 7).

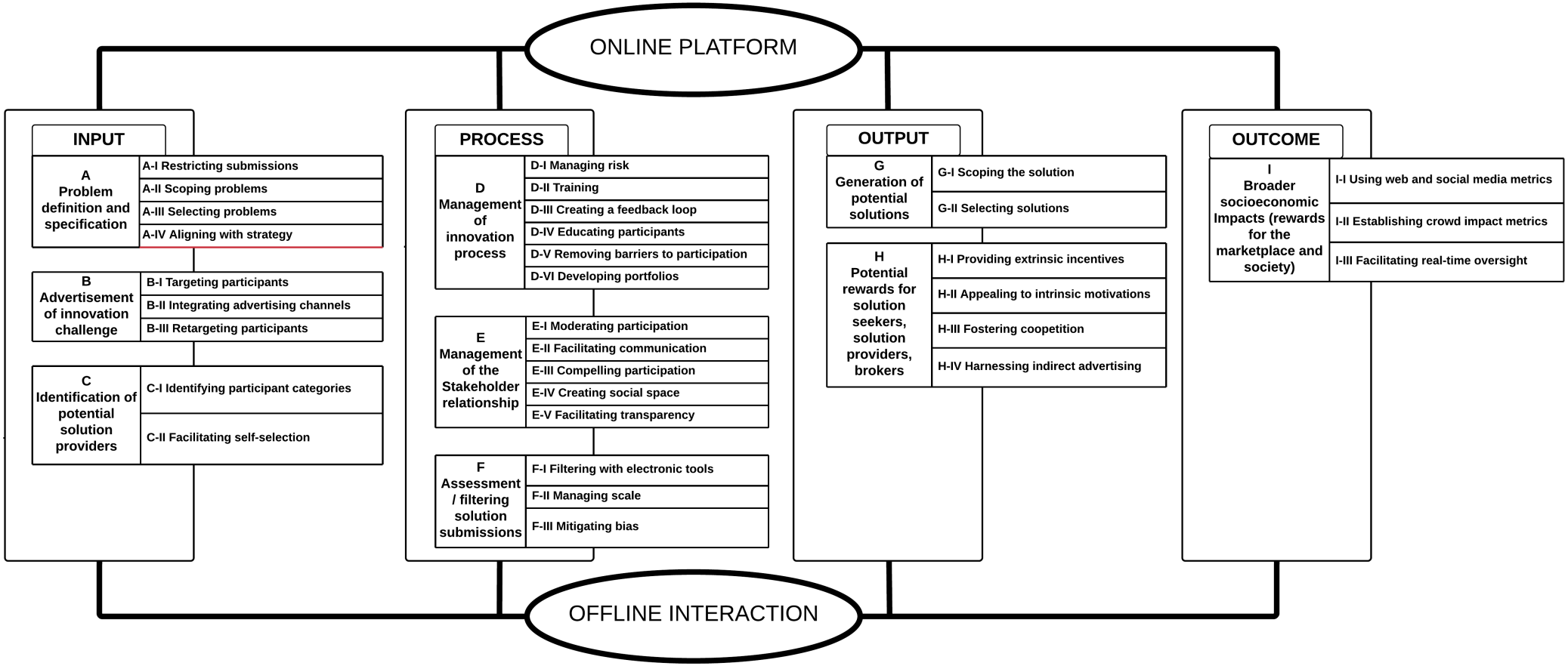


Figure 6.2 - Crowdsourcing practices framework - Adapted from Marjanovic et al., (2012)

Chapter 7. Case studies

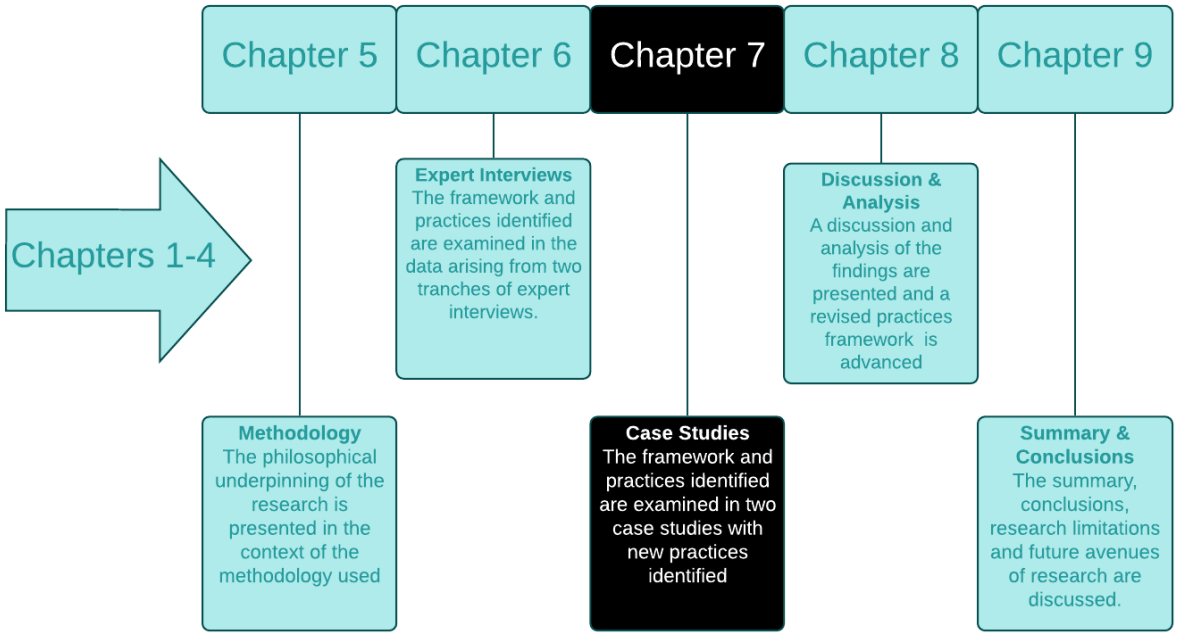


Figure 7.1 - Chapter structure - Chapter 7

7.1. Introduction

In the following sections (Section 7.1, 7A – 7I) the framework of the Marjanovic et al., (2012), is applied across two case studies, as outlined in Chapter 5, (Section 5.4). The purpose of this chapter is to examine the crowdsourcing practices framework and new practices identified over two case studies in addressing research objectives RO1.2, RO2.2 and RO2.3. The next sections proceed as follows. In section 7A, problem definition and specification is presented. In section 7B advertisement of the innovation challenge is addressed. In section 7C the identification of solution providers is discussed. Section 7D addresses the management of the innovation process. Section 7E addresses the management of stakeholder relationships. In section 7F, the assessment/filtering of solution submissions received are presented. In section 7G, generating solutions is discussed. In section 7H, potential rewards for solution seekers, solution providers, brokers are discussed. Last, in section 7I, practices for the measurement of broader socio-economic impacts are examined. This chapter examines the framework from Chapter 6 over two case studies and serves as a basis for the discussion in the subsequent Chapter 8 (see *Fig.* 7.1 above).

7A. Problem definition and specification

In both case studies, evidence was provided in respect of the practices used to involve the crowd in identifying and refining problems. In using these practices, funding agencies sought to facilitate crowds in playing a part in refining/wording problems. Limited evidence was provided of the use of practices for restricting submissions (Section 7A-I), where in both cases, managers resorted to giving participants the choice to insert unrestricted text inputs to the process of identifying and refining problems. However, a clear pattern emerged of the use of practices in scoping problems (Section 7A-II) and selecting problems (Section 7A-III). Significant evidence was also provided of the practice used at this stage of the process in aligning problems with the strategy of the funding agency (Section 7A-IV) as previously identified by the experts. A summary of the case study perspective on the practices is presented in *Table* 7.1 at the end of this section.

7A - I. Restricting submissions

No significant evidence was presented from participants or the call documentation of the deliberate use of practices for restricting submissions (seeking to restrict or narrow how or what the crowd submits). Managers across both cases did not provide any evidence of premediated attempts to limit what text submissions or ideas the crowd could enter on the platform. However, in reality stakeholder were prevented from making contributions by virtue of limitations on the platforms used. From the outset, crowds were not limited in what text they could submit. Across both cases the crowds were restricted in terms of how they could post submissions using text submissions, drop down selections or votes. However, no provision was made for submitting documents, videos or other forms of media including hard copy paper submissions evident in other crowdsourcing systems. Call process managers in case A, chose an open source crowdsourcing website for the management of the process. A communications executive describes how "*under the website which was operated through a CMS (content management systems), participants were completely free to register as users, post comments and vote for outcomes*" (CA2). Through using an easy-to-use, text commenting format, administrators could "*probe crowd submissions further so that a greater understanding could be reached in terms of their idea as to what counted as a problem worthy of fixing*" (CA3).

Support documentation for the website in case A shows that users are free to register for the website so long as they inserted mandatory personal identification information and their affiliation. Also, no other forms of submission outside of text, such as video, could be utilized. In case B, the call process managers developed a basic crowdsourcing website that sought to maximise access to the crowd. Several participants in case B described the importance of correctly setting up the website for the purposes of public engagement where one process designer described how "*the website featured a text box where the crowd could word a post whatever way they liked, and this was coupled with some personal identification criteria they had to select from dropdown menus about themselves"* (CB2). The size of text submissions received were left unrestricted.

7A - II. Scoping problems

In scoping problems, various practices were used across both cases. In case B, various juries of experts were compiled who sat in conjunction with laypersons in refining problems from the initial submissions received (CB3, CB4). In both cases the process of setting the granularity of the problem through crowd input was facilitated by experts (CA3, CA5, CB2, CB3).

Evidence was presented of efforts to meet the public face-to-face using town hall meet ups and public lectures to get engaged with the system of scoping problems or questions from the initial submissions received (CB3, CB5). However, another participant questioned the real value of the practice stating that "*these were very much one-way discussions barring the occasional question from the public who were a bit quiet at many of the events"* (CB4). This fear was also expressed by another participant (CB2).

Other data sources: Supporting documentation for call process managers described how a simpler non-scientific or non-jargon-based language had to be used in public engagement in the process of scoping the problems selected. A participant in case B, in discussing the scoping of problems stated that "*we found that we got back only as good as we were putting into the help notes and documents used to guide people through the process.*" (CB4). Documentation in case B, highlighted how volunteer scientists in the juries were to lead discussions with other stakeholders and the public about the amalgamation of problems into holistic problem statements.

This was facilitated through a map of a stated process and also included reference to scoping the solution (see section 7G-I).

7A - III. Selecting problems

In both cases expert and crowd input was utilised in selecting problems. Efforts were evident in both cases of attempts to balance the inputs from all participants and integrate all stakeholders in the decision making process. However, a difference existed across both cases in who made the final decision regarding problems selected.

In case A, a participant describes how "*the call process managers decided to use a simple system of likes and up-voting. However, decision power exclusively rested with us (call process managers) in deciding what problem was to be selected*" (CA3). Another participant described how this did not work out well for several reasons stating "*People were very happy to post comments and provide a rating for ideas but in the end, we still had to review everything and draw our own conclusions*" (CA4). In discussing the rating stars/likes system that was used for identifying the best project a participant challenged "*if this is really enough in getting the very best answer as they ideally need to be retrospectively examined in conjunction with questions that were asked*" (CA5). A participant described a further aspect of this challenge where "*even where someone likes a submission can we know how much they like it from the rating?* (CA1). *Two participants suggested that, in hindsight, ratings could have been combined with another type of more personal interaction* in making selections (CA1, CA3).

A further aspect evident across both of the cases was the practice of deciding what weight to give the vote of experts in crowds over the vote of lay persons in crowds. In case A, the entirety of vote weighting/decision capacity was given to call process managers. By contrast in case B, voting weight was shared between expert crowd and lay participants. In case B, several participants cautioned that whatever was selected from the process needs to be seen to be part of the crowd backed process with one participant stating, "*the result needs to have the footprint of the crowd on it or else crowd members will become cynical and not participate in future processes*" (CB1). Another participant stated that they feared that as there were no uniform evaluation criteria across juries the results were off balance because and that "*it is important that all projects participate and are evaluated on a similar basis.*" (CB5).

Other data sources: In case A, no guidance was given through documentation on how decisions were to be made other than through moderators making final suggestion to a manager who made a final decision based upon reading the crowd submissions. In case B, a simple democratic voting process was primarily used in the selection of problems. Limited supporting documentation was available on the execution of the voting process where moderators kept the final results of each vote.

7A - IV. Aligning with strategy

Aligning with strategy presents as a fourth practice to facilitate agencies in keeping up with trends and providing strategic balance in addressing problems. Evidence was presented in both cases of the use of such practices to achieve the strategic balance between the needs of the organisation and stakeholders in the alignment of research problems.

In case A, even though the crowd were free to post whatever they liked, initial prompts or suggestions were made in line with high-level strategic targets (CA2, CA4, CA5). In case A, a participant described how in launching call processes "*it is imperative that the managers have a clear grasp of our mission statement and what we are trying to achieve*" (CA1). In case A, the management also directed the funding agency to solicit public opinion via crowdsourcing so that further reflections upon trends of strategic interest could be investigated (CA1, CA2). In case A, a participant described the practice where "*the initial questions posed to the crowd were drawn from high level strategy documentation and at the end of the process we provided feedback"* (CA2)*. This was designed by managers to feed into the overall strategy in the form of a feedback loop* (CA2, CA3). Another participant described how "*this type of practice is important to make sure you are aligned with the public interest in your campaigns*" (CA4).

A participant described the process of iterating feedback into the strategic formulation of ideas for research funding. He describes an approach to alignment where call process managers *engage in two practices namely listening and monitoring. "Listening is more about identifying the ongoing narrative in digital interactions. Monitoring is more about informing as to what are the big topics on an ongoing basis"* (CA2). In this instance, there is a disconnect with the public where the solution seekers can take on board whatever they choose from listening and monitoring.

This stands in contrast to case B, where "*the public through expert juries were actively involved in aligning problems with strategies after the submissions were received"* (CB3, CB5). Several participants stated that balancing both sets of needs is very much a case of trial and error and requires communication. One participant stated that "*it is very hard to see where the border line rests between what we want and what they need, so dialogue presents as the best way to gauge this*" (CB5). By way of further example, in case A, several call process managers spoke of the use of business project management practices from the outset of calls for strategic alignment (CA1, CA2, CA3, CA4). One such example was the use of 'Smart Objectives' whereby goals within a call process should be; "*Specific, Measurable, Attainable, Relevant and Timely*" (CA2).

By contrast, in case B, in aligning all of the submissions received from the crowd into themes, experts from across disciplines aligned the submissions with existing research hubs and trends of interest to the public. A participant in case B, described how that *many managers reworded them to more closely match the most relevant research areas or unfortunately in some cases their own interests*" (CB4). Evidence suggests in case B that some participants who were experts, were inadvertently performing a type of strategic alignment by picking questions from the public that were already known to them and established as key areas of scientific research. However, a questions arises within the interviews as to whether or not this constitutes a form of bias. A participant in case B, states that "*in picking a given topic from public submissions, the manager knew that windfarms were already a hot topic*" (CB1).

Other data sources: Across both cases a substantial amount of documentation guided by strategic considerations was available for use by call managers. In case B, the documentation left strategic considerations open to public submissions and no guidance was applied until after submissions were received. In case A, the initial questions placed before the crowd had already received some degree of strategic treatment in line with research priorities and needs. To this end Internet based documentation concerning the strategic use of the call process was identified with one guiding report collected. In the next section (Section 7B), case study evidence regarding practices that relate to the advertisement of the innovation challenge are discussed.

Table 7.1 - Case studies - problem identification and specification

Stage	Task	Practices	Case A	Case B	Evidence
INPUT	**Problem definition and specification** **Section 7A**	**Restricting submissions 7A-I**	The submission system allowed crowd members to type free text responses or votes to questions placed upon the website by admins. There was no other format or means by which participants could make submissions	A free text box was used where parties were unrestricted by word count, or structure, in terms of how they worded their own submission. No other submission formats were available	Limited evidence presented of attempts to expressly restrict what the crowd submitted. However, online submission formats were restricted to text and vote submissions in both cases
		Scoping problems 7A-II	Crowd submissions, after some engagement from experts online were collated and refined by call process managers into questions of interest to the agency	Participants interacted in meetings of juries that featured both lay and expert membership in collating submissions into themes	Evidence of the use of online discussions, workshops, individual face-to-face meetings, meet the scientists and use of policy documentation in scoping
		Selecting problems 7A-III	After a call manager developed an idea about a problem, committees, groups of colleagues were consulted with and decisions made. The final voting rights rested entirely with managers	Various public meetings including living room chats, town hall meet ups and public lectures were utilised in facilitating crowd involvement in problem selection. Each participant irrespective of skill enjoyed equal voting weight	Evidence of use of juries of mixed skillsets, voting, clustering, expert decisions, likes, up votes, and decisions by offline committees and managers in selecting problems
		Aligning with strategy 7A-IV	Participants were prompted as to the themes or topics that were of concern to the agency before submissions were received on the website	Although public made free unrestricted submission expert juries were used in formulating problems into larger themes that coincided with problems of strategic national interest	Evidence of strategy and policy guidance, monitoring, listening, generating themes of submissions around strategy and the rewording of submissions in line with strategic considerations

7B. Advertisement of innovation challenge

A degree of difference is evident between case A and case B concerning practices used for advertising calls to crowds. Evidence was provided of the use of practices for targeting participants (Section B-I), where in both cases, managers sought to target experts or participants of a given demographic. However, participants predominantly in case B, spoke of the need to integrate advertising channels (Section B-II). Across both cases evidence was also presented of the need to retarget previous participants, in particular if funding agencies were seeking to grow communities (Section B-III). A summary of the case study perspective on the practices is presented in *Table* 7.2 at the end of this section.

Two contrasting strategies were used where in case A, a predominantly digital approach was used to access crowds. By contrast case B additionally used paper and terrestrial based forms of advertising. Also, various forms of direct contact and advertising were used by the agencies in advertising to stakeholders. A participant in case B also stated that the success rate for "*participant engagement in such public systems is really low. In one case, out of several hundred participants targeted only tens of persons participated"* (CB6). Evidence was apparent of the strategic implications from several participants in failing to also adopt a substantial offline and online combined advertising approach. One practitioner states that:

"*you should never force digital where digital isn't necessary and always be asking is this the best way to solve my problem and would I not be better sending up smoke signals or dropping flyers out of a plane. After all it is very important to realise that digital is part of an integrated communications effort."* (CA2).

7B - I. Targeting participants

Although no restrictions were placed upon who could participate in case A, the primary focus was towards online engagement of expertise. This approach was used to target a specific desired demographic of participants. In case A, a combination of exclusively online advertising, direct email marketing, coupled with social media technologies were utilised in advertising to the crowd. Outside of using a general social media and digital marketing approach, the call process managers directly accessed contact details of reviewers and experts on their pan-European database.

Using this data, they directly advertised the call to process to participants who were identified as possessed of key skills. In utilising direct advertising techniques and digital marketing the all process managers also hoped to obtain as high degree of participation as possible from the most appropriate skillset available. However, a participant spoke of the fact that "*anyone could register for the crowdsourcing website however, the interactions were from skilled participants probably because we emailed our best targets directly in encouraging them to join the website"* (CA5). The participant along with one other participant (CA1) also highlighted that as the platform was open source, anyone from across the communities that also used that platform software could also participate.

A participant spoke of "*using a digital approach to advertise a challenge*" (CA2). A further participant from case A spoke of his "*disappointment that the exclusively online advertising approaches failed to draw big crowds"* (CA2). He spoke of the dismay at having access to several advertising channels that feature several thousand subscribers and yet poor results in terms of engagement were obtained.

In case B, evidence shows that managers were more cognisant of a need to tap into both online and offline approaches in targeting participants. In addressing this point a participant says that "*in finding communities of potential participants there is a need to examine community events, local newspapers and you go through the roots that are established, if I were to do this again I think we would go even more offline and local"* (CB6). Two participants in case B also spoke of awareness of a tool that was used in other initiatives and stated that these could be used in future call processes called 'citizen dialogues' (CB2, CB4). One participant described the process where:

"ten staff would go into a community and have conversations with people and sample their views. At the end of these meetings the differing views are collected and synthetized into an overall document and after that they are distributed in a way that best suits the participants through agreement" (CB6).

Similarly, scientists knew of the success of a particular TV show with certain demographics.

Accordingly, this show was chosen as an advertising channel where one participant stated that "*we knew this tv show was very successful with younger people and very popular, so we used this show as a means to target this type of participant*" (CB1).

Other data sources: In case B, evidence of online articles, advertisements and details of TV interviews and shows were examined. The media collected showed that a conscious effort was made by participants to focus on the relationship between scientists and lay-persons. By contrast in case A, save for online social media advertisements for the call, very little by way of supporting documentation was evident for attempts to target specific participants. The researcher did not gain access to either email database of reviewers used by both funding agencies.

7B - II. Integrating advertising channels

Evidence from several participants confirms that practices for using integrated advertising channels are necessary as advertising calls is a difficult task (CA1, CA2, CA4). The practice involves the strategic coordination of multiple advertising channels under a single strategic approach. This stands separate to the piecemeal use of channels. In case A, multiple digital advertising channels were used in contacting crowds.

Case B highlighted the use of a broad online and offline strategy aimed at wide social demographics. In case B, call process managers spoke of a 'funnel approach' whereby their efforts sought to engage both highly skilled citizens and crowd members of a limited skillset with perhaps a passing interest in research (CB1, CB3, CB4). To this end various techniques were used including the combined use of:

"*newspaper advertisements town hall events, workshops, video presentations and research topics, the ready supply of online multimedia documentation through the campaign website, radio and television advertisements, social media marketing to include advertisements on Facebook, Twitter and other social media websites*" (CB1).

A participant also spoke of the relative success of the campaign in engaging citizens through different channels (CB3). This was supported by another participant who stated that he believed that in this call, there were a relatively high proportion of off-line submissions thanks to the use of television advertising. He stated that "*for us TV worked amazingly well, much better than we could have hoped for*" (CB6).

In case B, advertisements concerning the call were taken out in scientific journals and publications. This was completed by call process managers on the basis that an influx of highly skilled participants into the call process would help in the completion of the call to the highest standard possible. A participant said that:

"*this worked to a degree however, this did not deter us from also getting our hands on whoever we could through social media and regular advertising, sure we wanted people wise in the ways of science but to be blunt we wanted whoever we could get our hands on as we thought we would have an empty carousel with the music playing* (CB5).

Other data sources: In case A no documentation was available to support the purposeful integration of advertising strategies. However, by contrast, in case B, internal memoranda used by managers were presented by a participant (CB2) who identified that a coordinated approach was taken over several media channels, online and offline. Also In case B, advertisements concerning the call were examined in two scientific journals.

7B - III. Retargeting participants

Both campaigns used practices for retargeting participants both directly and indirectly. In case A, two interviewees describe using video messages to target and retarget specific demographics in a process based upon IP addresses (CA1, CA2) where one practitioner describes the retargeting process of "*examining click-throughs after an initial introduction followed by a specific retargeting with video or message to persons who viewed videos or showed evidence of engagement based on their IP address*" (CA2). Cookie consents were used in the collection of IP information by the funding agency.

Retargeting practices were used to a minor degree in case B, where scientists would visit crowd members with their permission who had posed or asked questions to answer their queries (CB1, CB3). One participant described this type of interaction as "*very useful where I believe it gave these people a better understanding of the real issues at the root of scientific questions*" (CB3). A further participant observed that:

"*call process managers were in a position to examine gender demographics by way of contributions made on the website. The information garnered from this aspect of crowd filtering allowed us (call process managers) to refine future advertising strategies including retargeting for future calls e.g. to insure more women could be involved*" (CB4).

Other data sources: Limited documentation was available from both case surrounding deliberate practices for retargeting previous participants. In case B, there was some mention in management documentation of the visits conducted to interest groups without any specific indication or direction of how the visits were to be completed. Also in one email a participant also spoke of reengaging old stakeholders in later rounds on top of finding new contributors.

Table 7.2 - Case studies - advertisement of innovation challenge

Stage	Task	Practices	Case A	Case B	Evidence
INPUT	**Advertisement of innovation challenge** **Section 7B**	**Targeting participants 7B-I**	Combination of exclusively online advertising, direct email marketing, coupled with social media technologies were utilised in advertising to the crowd	Both online and offline approaches were used to target as many participants as possible to maximise crowd diversity. Experts were also directly contacted	Evidence provided of attempts to target skilled and unskilled participants through various media
		Integrating advertising channels 7B-II	An integrated strategy was used over exclusively digital approaches including social media and direct email contact targeting skilled persons	Strategic coordination was required to use several different digital and paper channels in contacting both skilled and unskilled participants	Evidence of strategic coordination of the management of advertising channels across both cases. Case B, also incorporated offline advertising
		Retargeting participants 7B-III	Predominantly a cookie based strategy was used to retarget crowd members who had previously visited the website with online advertising	Reviewers specifically homed in upon questions asked by persons who had identified themselves. Scientists visited them to answer questions in detail. Also online retargeting was used	Evidence provided of attempts to retarget participants after submission were received. In case A, efforts were online and in case B, both online and offline techniques were used.

7C. Identification of potential solution providers (filtering the crowd)

In call processes, evidence shows that crowds are filtered as to pre-defined criteria ranging from skill to demographics. Call process managers from both cases expressed the view that both systems were open to the entire public for submissions in two capacities. First, the assistance of skilled members of the crowd is required in proposing problems and solutions. Second, non-skilled or diverse crowd members can provide novelty in crowdsourcing processes or a contribution towards identifying impactful solutions. Evidence was provided of the need to categorise participants for deployment to specific tasks (Section 7C-I). Also evidence was provided of the practice of facilitating self-selection with participants in case A expressing some concerns (Section 7C-II). A summary of the case study perspective on the practices is presented in *Table* 7.3 at the end of this section.

7C - I. Identifying participant categories

As outlined in Chapter 6, (Section 6B-I) various practices are used to identify participant categories from those who have subscribed to the call. In case A, the initial self-selection process completed by prospective crowd participants also included details of their gender age and geographic location where participant described how "*this allowed the call managers to perform some ex post data analysis on the types of applicants who subscribe to the process. It also allowed them to examine some particular biases that occur in crowd formation"* (CA1). In case A, a participant also stated that "*at a very minimum users should login to websites by providing their name and details into a system. The database of participants or potential participants should then be searchable by keywords such as E-Government or open data etc. when you are building your crowd*" (CA3).

In case B, several participants described the process of making sure a sufficient amount of skilled participants were intermingled with crowds for decision making purposes (CB1, CB3, CB5, CB6). One participant remarked that "*in the first place, we weren't so worried about where they came from, so long as they had enough science to lead lay people on technical questions and issues in open discussions*" (CB3). Research has highlighted that a fundamental challenge is faced by funding agencies in sourcing reviewer talent (see Chapter 4).

In accessing existing communities, a participant describes the initial filtering process of asking questions such as "*what things are familiar to them and what will they recognise and thereafter how would we engage them?*" (CA2). In case A, evidence confirms a wide spectrum of skills are directly sourced during the crowdsourcing process where a participant confirmed that "*the difference in skills had a direct effect on ideation process and various levels of administration expertise were employed by the call process managers in effort to refine topics or themes*" (CA1).

In case B, a participant described the challenge of facilitating multidisciplinary interactions and spoke of the process of engaging researchers from the humanities across to the hard sciences. She stated that "*diversity in a crowd is necessary to foster novelty in a project ensuring diverse participation where both public and private stakeholders are engaged including teachers and researchers with the diversity also extended to those working in the applied sciences*" (CB3). Reluctantly, it was acknowledged by two call process managers in case A, that if better crowd membership filtering had been completed upfront, then less effort would have been expended at later stages in the process in terms of refining themes and topics for investigation (CA2, CA3). A participant described filtering tools used to filter crowds based on skill stating:

"*participants applying to become members of the crowd provided some basic demographic details including the level of the education they had obtained, and this allowed call process managers to engage in a basic form of certain questions based upon the educational level or skill of the participants*" (CA4).

Other data sources: in both cases organisational policy documentation identified that the funding agencies had to show due consideration for involving diverse demographics in the attempts to engage the crowd. Apart from indications that this formed part of organisational policy, no evidence existed of the means by which this aspect of identifying participants was to take place within call processes. Also, outside of documentation in case A for the use of the platform, no further guidance was available as to how to narrow searches for skilled participants other than through use of the direct email marketing database.

7C - II. Facilitating self-selection

In Chapter 6, (Section 6C-II), experts confirmed that the crowds ability to self-select for tasks formed an important part of the process. However, some tensions were evident as to the skills required for vetting submissions. In case B, limited evidence was presented of efforts to deliberately filter crowds up-front, based upon skill. A participant observed, "*if anything we tried to make everything as multidisciplinary as possible. Sure, you got clusters of experts from a given field massing around a theme, but this was not planned or deliberate*" (CB1). Data analysis allowed call process managers to remove skill biases, where in case B, a participant described how "*all the crowdsourcing participants around one question presented as being from a highly skilled demographic so we factored this in when we went to refine themes through jury interactions*" (CB4).

A participant in case A, questioned the real value arising from filtering skills stating that at any rate: "*as participants were self-selecting their own educational level we can only assume that this was reasonably accurate as most people had no reason to be untruthful during the process. However, in truth we had no real way of policing this*" (CA1). A participant outlined that "*an important consideration in building diverse audiences is in realising that you are not going to solve the whole problem all at once and to start small.*" (CA2). This approach is supported by several practitioners where call managers do not have to explicitly manage skill across challenges and it can be left to the crowd to self-select the skill required to address a particular aspect/one part of a challenge. One participant said the benefit arising from this approach and spoke of "*the importance of letting persons of skill focus on one or multiple parts of a process depending on their appetite. Especially in the context on non-paid for works*" (CA3). By contrast another participant stated that "*in the community context the comments from unskilled participants who self-elect to participate are not always useful and should be treated as only supportive in making of decisions as to who gets funded*" (CA5).

Other data sources: In both cases no documentary evidence was available concerning the facilitation of self-selection although it was implicit from the processes in both cases that the crowd could select whichever problems they liked.

Table 7.3 - Case studies - identification of potential solution providers

Stage	Task	Practices	Case A	Case B	Evidence
INPUT	**Identification of potential solution providers** **Section C**	**Identifying participant categories C-I**	The practice involved identifying stakeholders of a specific skillset on a given agency database where they are categorised by their skills	People of specific skillsets were contacted through expert databases or niche journals in addition to stakeholders across demographics	Evidence of the use of up-front stakeholder categorisation / selection in case B, and specific stakeholder databases and direct email contact used in case A
		Facilitating self-selection C-II	Skill and personal demographic data placed into system was not policed by administrators, candidates were trusted as to data entered	Similarly, skill and personal demographic data placed into system was not policed by administrators, stakeholders were trusted as to data entered at start of the process	Limited evidence was presented of managers specifically facilitating categorisation through self-selection although stakeholders were free to elect to participate in both cases

7D. Management of innovation process

In the previous section (Section 7C) practices used for the identification of potential solution providers were examined. By contrast, in this section (Section 7D), practices for the management of the innovation process are examined. In this context the practices used for managing participant interactions are examined. Practices include managing risk, training, creating a feedback loop, educating participants, removing barriers to participation and developing problem portfolios. Evidence was provided of as difference of attitudes across both cases with regard to managing risk (Section 7D-I). Also, further evidence was provided as to the need for training and the types of training required by funding agencies (Section 7D-II). In section 7D-III, the practice of creating loops or iterations was examined across both cases with limited evidence available of the extensive use of the practice. Also, evidence was provided of the need to educate participants in call processes (Section 7D-IV). Barriers to participation were discussed with participants with evidence across both cases of a greater need to consider barriers (Section 7D-V). Last, some limited evidence was available of a need to develop strategic portfolios of problems for funding agencies (Section 7D-VI).

A summary of the case study perspective on the practices is presented in *Table* 7.4 at the end of this section.

7D - I. Managing risk

In Chapter 6 a difference was evident amongst both sets of experts as to risk. Funding experts were concerned with managing negative risk. Whereas, crowdsourcing experts were more concerned about leveraging upside risk. Across both cases a similar difference was evident. In case A, participants as part of a large public sector organisation were especially concerned about negative risk. In case B, and by virtue of the broad nature of the agency work, managers sought to access upside risk. This may have arisen by virtue of the structure of the call process where a participant in case B described:

"*feeling much more relaxed about managing risk in the crowdsourcing process. We knew when we took on the job of the panel that we were sharing the responsibility of the risks and benefits together. This meant that the entire world was not resting on my shoulders. I really enjoyed this as it proved quite different to the type of peer review work that I would do from a (national funding agency) perspective"* (CB6).

So as to manage risk, the funding agency in case A adopted a closed approach to decision making. However, several call process managers expressed disappointment with the retention of traditional close management process. One called process manager described how the crowdsourcing process was terminated upon completion with *"no indication from senior management that further crowdsourcing will be utilised in the future where I think there was a real fear on the part of managers that too much power could be ceded to the crowd in terms of how decisions are going to be made."* (CA1). Another participant also described similar viewpoint stating that it is very hard to get people who come from a certain management background to come over to the idea of letting different people manager process stating that:

"*for me this fear was based upon the fact that the process resulted in a significant sum of money being handed over to a researcher and wherever money is at the end of the process invariably a large degree of responsibility will fall on the shoulders of the (call process manager) who wrote the cheque so to speak*" (CA3).

One participant stated that: "*public sector employees are not known as risk takers and the process can be made more innovative where external risk takers (experts) are taken into the process and work as internal employees even though they are contracted externally, these actors come in with fresh ideas and do not become institutionalised*" (CA2). Another participant describes the symbiotic learning relationship that exists between internal and external staff, where internal staff exposed to external participants such as *intra-muros* consultants become more enthusiastic and by contrast the external participants become more tempered. He states that *"you need this kind of symbiosis to foster a crowd that will stay together for at least several call process cycles"* (CA1).

Other data sources: A plethora of documents for managing various forms of risk were evident across both cases. First, evidence was available in case B of best practices for maintaining scientific integrity. In case B, this was contained in policy information on the main website and the commencement documentation for the start of the call process. Likewise, in case A, information concerning risks relating to data disclosure (GDPR) and transparency over call processes was presented in both the website and support documentation for the call process. However, neither case presented documentary support concerning the prospective access of upside risk.

7D - II. Training

Both sets of experts in Chapter 6 spoke of the need for training for participation. Across both cases evidence showed that at present, only a limited amount of training was provided to participants. Participants from both cases spoke of the importance of the initial contact with the crowd by way of educating them as to the website functions, how to participate and further spoke of the challenge of enabling prospective solution providers to learn about research in the decision-making process

Call process managers across both cases used practices in seeking to actively and passively train crowds as to the process and using the platform. Across both cases, participants spoke of the importance of supplying substantial background information and support documentation on the website (CA1, CA3, CA5, CB2, CB3, CB6). A participant in case B explained the logic of this approach and ripple effect in stating that "*in making materials available to participants these materials also became freely available for other similar or likeminded initiatives to use*" (CB6).

Two participants spoke of the use of 'breadcrumbs' in guiding the crowd through stages of the process (CA3, CB2). Call process managers spoke of the desire to have 'breadcrumbs' throughout the process which would facilitate all participants in easily navigating the various different stages and responsibilities for completion within the process where a participant said that:

"*this worked quite well as I did not hear much by way of complaints from participants in using the website. Yes of course we could have got some things better however, I think on the whole it worked quite well. The IT (information technology) team did not speak of receiving any major complaints from people who could not place information into the system*" (CA1).

In case A, a call manager stated that "*in using off-the-shelf crowdsourcing kit from GitHub we knew that the internal navigation was strong and easy to use. Also, the CMS (content management system) allowed us to post similar calls and topics in a way that it was easy for the crowd to learn about our ongoing works"* (CA3). In case B, a participant described the challenge involved in making the website easily navigable and said that "*although the website was easy enough to navigate we have learnings that will make future versions better. Each call process needs to tell a story about what we are trying to achieve, the website is the best way to do this*" (CB2).

In case A, a limited amount of instruction was provided to managers in the use of the platform where only a small cohort of individuals were needed to manage the platform. In case B, instruction and training was provided by experts on an ad hoc basis as the need arose. One participant stated that this was "*because this was our first time running the process and we had to improvise on all fronts*" (CB2). In case B, a participant states that a lack of access to training is a fundamental problem where he believes that "*training needs to be provided for call process managers to participate effectively in the shared management of the call processes where these changes towards open are cultural and incremental over time*" (CB1). In case B, another participant also says that "*from the consulting sector, I was aware that the problems in embracing crowd involvement stemmed from a lack of knowledge (from management) about open innovation and crowdsourcing. I know if we do this again training will be required"* (CB3).

A further aspect to the practice rests in the fact that the crowd also need to receive training as to how to participate in the process (CA1, CA2, CB3, CB5). Participants from both cases expressed the opinion imparting training on using calls was primarily a usability issue and to fix this, the website had to be made easier to use (CB1, CB3). In case B, in public consultations, experts were used as a basis to provide informal training in lay participation (CB5).

Other data sources: Some documentation was used across both cases in the process where in case B, notes for guidance on how to review and stimulate public interaction were provided to moderators. In case A, limited documentation on training was evident with most guidance on participation contained in the help section of the website.

7D - III. Creating a feedback loop

In Chapter 6, both sets of experts expressed a desire to harness the incremental improvements that can be obtained through iterative processes. This position was supported by participants in both cases. However, the support offered was by way of theoretical confirmation. Also, there was a complete absence of documentary evidence in both cases directing the use of iterative processes in both cases. One participant in case A remarked, "*I have always toyed with the idea of giving loosing applicants a second go at the same type of call process. What would they change and do better in the submission a second time*" (CA1)? A type of iterative process was evident in case A. A participant described the process of iterating feedback into the strategic formulation of ideas for research funding. He describes a combined approach where call process managers:

"*engage in two practices namely listening and monitoring. Listening is more about identifying the ongoing narrative in digital interactions. Monitoring is more about informing as to what are the big topics on an ongoing basis. This information is in turn fed to decision makers. The more often these topics hit our agenda, something is done about it"* (CA2).

In this instance, there is a disconnect with the public where the solution seekers can take on board whatever they choose from listening and monitoring without explicit consultation with the public.

Upon examination of the data across both cases a difference of opinion is evident in relation to the strategic integration of crowdsourcing calls as a solution within the full suite of agency call processes. In case B a participant spoke of the express need to fully include the crowd in the loop. In the case B, several participants confirmed the view that iteration within crowdsourcing calls will form an integral part of their open strategy going forward (CB1, CB2, CB6) However, a caveat was provided by a participant who said that:

"*obvious changes will have to be made to close the loop with government. It is pointless for us doing all this work to have the government pull the rug from under our feet so to speak (as they did in this case). If they plan to engage the citizens in this type of work, they need to carry through on the promise to bring to fruition – which is what the citizens want*" (CB3).

Two participants specifically addressed the means by which iteration could be introduced (CA1, CB6). In case A, a participant said that a "*good place to use iterative features is the ideation and problem solving stage of processes. I see good examples in industry where rapid prototyping is using to churn out a product idea quickly. I think we (the agency) can do something just like that*" (CA1). In case B, a participant stated that "*iterating as many possible ideas through the crowd is one place where we can gain extra input and ideas. This is better than a few managers trying to troubleshoot some solutions*" (CB6).

Other data sources: some information was provided from the website of case A regarding listening and monitoring, but participants confirmed that these were verbal skills that were passed on and that limited if any documentation existed concerning the practice.

7D - IV. Educating participants

A significant amount of discussion was evident across both cases regarding the practice of educating participants. Many participants across both cases stated that this practice was a primary objective of the funding agencies for seeking crowds (CA1, CA3, CA4, CB1, CB2, CB3, CB6). As presented in Chapter 4, a major prospective benefit in turning to crowds lies in the prospective education of participants as to research and more generally, informing the public of the work of the agencies.

From the outset of the call process, participants in case A spoke of visualising what educational and informational goals they sought to achieve through involving the public in the call process (CA1, CA4). Participants described seeking to educate the public both actively and passively as to the types of scientific research required for society to function as a whole. However, a participant in case B, questioned the real value arising from the practice stating that "*these (public interactions) were very much one-way discussion barring the occasional question from the public who were a bit quiet at many of the events"* (CB4). This ties in with evidence from Chapter 6, where experts highlighted that scientists are regarded as poor communicators and in some cases do not actively engage call documentation at the root of call processes. This viewpoint was acknowledged by a participant who said that they:

"*had to change not only the words used but the tone of voice trying to communicate points. You know you run a risk of sounding really condescending you're lecturing somebody on some point about research. Scientists were not really good at this and needed to change their tone*" (CB6).

In case B, a participant also stated that education occurred at different levels where:

"*experienced call managers were learning new tips and tricks about public engagement simply by virtue of speaking to other colleagues that they had never spoken to before, furthermore, we (they) learned that they had to change their language trying to communicate complicated scientific facts to laypersons and members of the general crowd"* (CB4).

In case A, where two participants spoke of the need for the public to feel that at the very least the agencies are trying to solve problems (CA1, CA5). A participant in case B also described a process:

"*where experts went and spoke with citizens at home about issues in their own language. Scientists and a camera were sent along to have discussions with known participants about questions they asked. This process provided the scientists with a deeper level of understanding as to the reasons and circumstances of a participant's submissions*" (CB2).

Another minor aspect to the practice of education includes addressing failed applicants.

Call process managers have used practices in an attempt to deal with these challenges and to manage the rejection experienced by candidates who fail to attain funding (CA2, CA5, CB1, CB5). No similar concern or related practices was evident in case

Other data sources: In case A, three pieces of policy documentation regarding education and outreach were consulted by managers in preparing the call covering organisational strategy, outreach activities and STEM education respectively. In case B, participants identified that managers had consulted with the outreach strategies and policy documentation of one national funding agency in forming the call, however, outside of a cursory review, these documents did not form part of the formal process (CB1, CB5). Videos were available in both cases with details of educational goals.

7D - V. Removing barriers to participation

Participants across both cases spoke of an awareness of barriers to participation and the need for practices to remove these.

A barrier to participation in the process can be presented in the form of not holding enough skills for participation in the entire process. Two participants in case A described how the process can be broken up into segments to allow participation in certain easier parts (CA1, CA5). In some systems designers create breadcrumbs to facilitate participants in moving through the process. A practitioner described how certain parts of calls can be carved out to people holding the best skill sets (CA1). However, another practitioner cautions that in breaking up calls to facilitate mass participation participants can lose the overall picture. He gave the example that where "*one part of research involved communication dissemination experts in this area and they were asked to review just this part of the project. This did not prove fruitful because they lost oversight of the whole call*" (CA4). In international call processes language issues can lead to barriers in participation. In case A, a participant also spoke of the fear that it's very easy to misinterpret text where:

"*people visiting the website come from different jurisdictions and accordingly the national languages do not translate well. Sometimes hidden meaning can be missed and also some people misinterpret. The whole point about using this website is to remove doubt however, I'm not quite so sure how are going to do this in the future*".

In case A, a participant also spoke of barriers to connecting with participants where an exclusively digital communication channel is used (CA2). It follows that not every participants uses digital communications channels. He stated that:

"*we had workshops and public engagement meetings which proved very fruitful. When you're going through the process and someone is posting critical comments on the website is very hard to deal with their issues solely by responding in text format. I feel we really lost the connection with the general public through using an exclusive digital channel for the remainder of the call process"* (CA2).

This viewpoint is supported by a participant in case B, who in discussing stakeholders including managers said that:

"*it's very hard to pass on all the information you need to give participants when you are simply using text box on a website. A lot of interactions we have in managing traditional call process requires a lot of telephone calls and talking to people face-to-face. With this website you lose that personal connection*" (CB3).

Evidence also suggests that the public are reluctant to participate where they distrust science. Accordingly, funding agencies must dispel myths regarding research. Science has a challenge in dispelling conjecture concerning research in the media. Across both case, call process managers speak of the need to inform for the purposes of dispelling myths that exist around funded research. In case B, a participant described how "*the public hostile view towards science and research can lead many scientists to hold a siege mentality which means they shut down public communication and outreach*" (CB6). A participant described a similar pan-European project addressing untruths stating that:

"*the project decided to target very specific myths that are in the public psyche. The project was inspired by a project called "REDACTED" which took a light-hearted view to addressing larger challenges. Cartoons, videos and bus stop advertisements were used to speak to people in a language that people understand because in science we use a very different language*" (CA2).

Other data sources: Policy documentation from both organisations spoke of the need to include diverse participants with dedicated sections on both websites and policy documentation apparent.

Also, in case A, specific information was available about the use of assistive technologies on the website including a digital voice readback function for those who were visually impaired. A similar feature was available in case B to assist visually impaired participants in using the website. However, no participants in either case could confirm that the voice function would facilitate participation in the submission process. (CA1).

7D - VI. Developing problem portfolios

Participants across both cases described the practices surrounding a strategic portfolio approach. As confirmed by experts in Chapter 6, funding agencies follow various strategic objectives that they set or follow from government. These objectives can by aligned with top sectors of national research interest. In this instance projects were matched into categories of existing strategic needs (CA1, CA2, CB2, CB5).

A participant in case A stated that he needed very clear goals from the outset of a project. He stated that what he did was "*break it down into very clear ideas of objectives in a pyramid approach by writing down what is your end goal which is very fundamental it starts from that and from this you derive objectives namely two or three portfolios of ideas that will guide you*" (CA2). To some degree this practice was supported in case B, where one participant described how "*although we were led by the crowds in terms of what they wanted, we knew our national top sectors, so it was not unusual in the juries that scientists used these to group what the people wanted around the governments core research themes*" (CB5).

There was also some minimal discussion of the use of strategic portfolios amongst participants (CA1, CA2, CB5, CB2). Participants across both cases described a strategic portfolio approach practice whereby projects were broken into categories of existing strategic needs of the agency. A practitioner stated that he needed very clear goals from the outset of a project. What he did was "*break it down into very clear ideas of objectives in a pyramid approach by writing down what is your end goal and from this you derive objectives namely two or three portfolios of ideas that will guide you*" (CA2).

Other data sources: Outside of national science policy documentation, limited support documentation was provided in case A that served to identify categories or portfolios of interest, or a portfolio style approach. In case B, further documentary evidence of a national priorities or portfolio approach was evident where an academic publication provided a cross national analysis of the development of portfolios of scientific issues or challenges that required resolution. This served as a basis for a portfolio approach in the call process.

Table 7.4 – Case studies – management of innovation process

Stage	Task	Practices	Case A	Case B	Evidence
PROCESS	**Management of innovation process** **Section 7D**	**Managing risk** **7D-I**	Although no express planning was used several participants lamented not utilising risk and resource planning in advance of the call process. Managers were predominantly risk adverse	Several candidates confirmed that risk planning would have to change based on the vast size of the crowd that provided submissions, however, mangers were more open to exploiting upside risk	Evidence shows that managers across both cases were concerned by risk, but managers in case B understood the novelty that could be accessed through seeking upside risk
		Training **7D-II**	Little or no provision for training management for the use of crowdsourcing, however, the website used was easy to navigate with limited training required	Strategic planning and training offered to participants in the adoption of crowdsourcing practices into call processes with website training provided to participants	Evidence across both cases showed that managers were aware that more training is needed for stakeholders in transitioning to crowdsourcing processes
		Creating a feedback loop **7D-III**	The process is designed to directly inform research policy and subsequent call processes by directly soliciting feedback from the crowd	Call process managers crystallised feedback from the process into actionable learnings in the form of publications and reports for use in future attempts to shape policy	Evidence shows that although neither case explicitly featured iterative process loops, however, managers in both cases spoke of informing policy in an iterative manner
		Educating participants **7D-IV**	Managers were not as concerned about educating participants as those contacted had expertise, however, they were keen to educate stakeholders as to the funding agencies mission	Active efforts were made by managers to ensure participants were educated about the funding agencies mission and the research categories in play	A greater emphasis on educating participants was evident in case B, however, both cases featured attempts to educate stakeholders as to the work of the agencies
		Removing barriers **7D-V**	No significant effort was made to remove participation barriers however, the website also featured the use of plain speak videos and audio-visual information to provide knowledge	Managers attempted to make the call processes accessible through face to face meetings with the crowd coupled with videos of these discussions placed on the website	Limited evidence was provided by managers over both cases of an awareness of other barriers to participation outside of skill considerations.
		Developing portfolios **7D-VI**	Evidence presented of a broad strategic approach of managing a portfolio of problems to address the various strategic organisational needs	Solution seekers attempted to ensure that a broad portfolio of themes was identified to cover the entire spectrum of needs	Despite evidence suggesting that managers ensured a portfolio of problems was addressed, little consideration was afforded to the strategic development of a portfolio

7E. Management of stakeholder relationship

In the previous section (Section 7D), practices used for managing and improving the innovation process were examined. By contrast, in this section (Section 7E), practices for the management of the relationship between stakeholders are examined. In this context the interaction and nature of interactions between participants are discussed by the participants. Strong evidence was provided of the use of practices for moderation or moderating participation (Section 7E-I). Also, in both cases, managers sought to facilitate communication in various capacities (7E-II). Limited if any support was evident for compelling participation with some outreach examples presented (section 7E-III). In section 7E-IV evidence was presented, predominantly from case B that managers sought to create social space for participants to interact. Last, evidence was presented of a conflict between participants over what transparency should be extended over call processes (Section 7E-V). A summary of the case study perspective on the practices is presented in *Table* 7.5 at the end of the section.

7E - I. Moderating participation

Evidence was presented by call process managers across both cases of the need to moderate participation. This practice was envisaged by participants in case A as part of a top-down management style in processes. In case A, evidence from all participants showed that the crowd participation was heavily managed with all executive decisions made by call managers. A participant in case A described how that in public initiatives there is a management hierarchy and that decisions are made by the upper management based upon the advices of experts (CA2).

However, participants in case A were not in a position to cite substantial examples of how moderation was used. One participant stated that "*we actively monitored participants. Although some of the comments were strong we chose not to block or restrict the users. This was because the call manager was worried about the low level of participation we achieved*" (CA4). Another participant confirmed that in:

"*assigning a call manager as a moderator we gave them the power to ask questions, elaborate, respond to comments or if necessary remove participants. However, we actually had no need to remove anybody from the process. Even where some of the comments were a bit spectacular*" (CA3).

However, in case B, by contrast, managers spoke of the use of moderation as part of a horizontal style management approach. By contrast, in case B, different practices were used to facilitate a more open decision making in the call process. For example, a participant described how there "*was a degree of experimentation in adopting decision mechanisms where internal and external stakeholders made management choices. One part of this was the crowd picking moderators*" (CB5). Management executives designed the crowdsourcing process with open management practices in mind. As a result, a decentralised management process was utilised to manage the crowdsourcing call where scientists and lay participants alike shared equal participation, voting and decision-making rights in juries. A participant outlined how on occasion the juries picked their own moderators stating "*sometimes it was a scientists, other times an ordinary (lay) person. We changed the person in the role after each round*" (CB4). Multidisciplinary teams were assigned different tasks and stages within the process. Some evidence suggests that the use of switching moderators in public participation increased the speed of the process. One participant described this as:

"*a very beneficial process that we enjoyed greatly which resulted in a greater degree of sharing taking place across the disciplines. We really enjoyed this, I think it helped us move through the system much faster. Many of us learned that this was a very different experience to those in traditional funding review processes where responsibilities placed upon the shoulders of one person. Also, these types of call processes can take quite a bit of time to complete. By contrast I found this approach much faster*" (CB6).

Other data sources: Some brief verbal instruction was given to moderators in case B. An email was examined that was sent to moderators that provided guidance as to how to moderate participation. In case A, no such documentary support was presented in respect of the moderation process.

7E - II. Facilitating communication

In case B, participants spoke of the role played by communication practices in fostering community. Evidence was presented of the use of practices for communication both inside and outside of the process. Practitioners also described communication inside the funding agency and with lead stakeholders.

A participant describes how "*for most of this work we would either use email or phone calls in managing the different aspects of the call*" (CA2). Another participant in case B confirms this stating "*the vast majority of the work completed around the call is actually completed in meetings, over the phone or via email this involves appointing reviewers, establishing key dates and cut-off points*" (CB2). One participant described how the more related to management the task, the more direct the form of communication.

A more complex issue took the form of whether or not crowd members could message each other or communicate directly. Several participants discussed issues relating to this. In case A, a participant described how "*we did not see any reason to restrict the crowd from talking to each other. Only in one instance did two participants start arguing, but it was all acceptable comment*" (CA4). In case B, a participant described participant communication as the "*lifeblood of progress where good ideas come from the social interactions in the crowd*" (CB6). Several participants spoke of communication in a different context for creating a shared understanding around tasks that needed to be completed (CA1, CA3, CB3). In case A, participants were more concerned with uni-directional communication with the crowd where they could learn from, inform and direct participation (CA4, CA5).

Communication practices are also used to facilitate discussions and interactions across disciplines. A participant in case B described the challenge of helping disciplines working together in crowds and described how "*disciplines face a challenge in figuring out how to work together in crowd scenarios and developing a shared sense of understanding*" (CB3).

In case A, a participant explained how "*although the use of the crowdsourcing peer review systems allowed the introduction of diverse stakeholders into the system it did not resolve for us how these people could be interspersed*" (CA3). The participant describes how "*we communicated with each of the participants and specifically encouraged them into the groups where we required discussions*" (CA3). Facilitating communication across disciplines was not presented as a straightforward task. A participant in describing cross-participant communication as a form of cross pollination said that:

"*they were not sure how they could engage in this type cross pollination necessary to form communities. An example of one type of practice used was to form a call so broad that I would invite multidisciplinary participants*" (CA5).

Other data sources: Both websites featured data in respect of communications methods. A participant in case B described how "*for general information and announcements to the crowd we placed these within the portal or on the website*". No specific communications strategy documentation for crowd interactions was presented in case B. By contrast, in case A, a communications manager was responsible for coordinating communications within the call process and used a series of organisational guidance plans in this regard. In particular, one organisational strategic communication plan was used by managers across the organisation and is available on the funding agencies web site. This information was coded and analysed.

7E - III. Compelling participation

Neither group of participants provided evidence of practices or issues arising from seeking compelled or mandatory participation.. Similar to practices discussed by experts in Chapter 6, both sets of participants spoke of compelling participants to engage in EPE works as part of funding. However, this was described by one participant in Case A as an ex-post activity stating "*generally you compel researchers to engage in outreach works after you have given them the funding*" (CA2). However, a participant in case B stated that "*this approach (mandatory participation) would probably not work as the last thing you want to do is make people feel compelled as they would not continue to be involved in future calls*" (CB5).

A participant in case A stated that " *although internal managers form part of the crowd, I cannot see how their compelled participation as part of their job can add to or take away from the process*" (CA1)? Several participants discussed the prospect of using mandatory rules to force participants in a call to review submissions as a prerequisite towards obtaining future funding. A participant described how "*you could force a participant as part of their grant or funding application to perform peer review in other call processes but that this would only cover skilled crowds and not public crowds*" (CA4). Outside of these theoretical discussion, no further evidence was provided and the practice was disregarded across both cases.

Other Data Sources: No documentation was evident in either case confirming a form of compelling participation.

7E - IV. Creating social space

Evidence was presented in both cases that funding agencies were presented with a new type of practice of creating a social space within which stakeholders can interact. In case B, support documentation for the process created by call process managers specifically pointed towards the need to create social interaction through the platform and in offline interactions such as town hall events.

In case A, a participant spoke of the process of moving towards creating a social space as constituting a "*change in mindset the organisation*" (CA1) and he further stated that traditionally:

"*you would just go to the database and select a reviewer, but I have to say I feel somewhat uneasy about this idea of having to entertain people to keep them in a crowd. This is not something that is necessarily easy for the organisation from the resources perspective. This is because we have to review progress and keep an eye on how peer reviewers are doing*" (CA1).

One participant in commenting on the interaction described how it was clear to see that: "*the various stakeholders were happy to engage each other on the website in the comment section. It was very clear as to who these people were as you could see from their profiles their background and what their vested interests were. However, I wonder if this influenced the overall outcome and results? At the end perhaps, people were a little bit insecure about posting comments they could see some great expert in the same thread as themselves*" (CA4)?

One participant in case B spoke of "*the need to engage people across disciplines in call processes as part of the crowd so that we can better balance the needs of the science community with the needs of the public*" (CB3). Several participants spoke of synergies between people in disciplines, people in science and people in industry arising in calls through the use of multidisciplinary collaboration where a participant spoke of the fact that "*a collaborative approach in getting problems to match trends in public needs worked really well in this call*" (CB5). This collaboration was based from a substantial number of offline workshops where participants get to know each

other in advance. The benefits of offline interaction often translate into online interactions, where in case A, one participant described how "*it was not usual to see someone from physics posting comments to a thread on strategic consideration on future emerging technologies"* (CA3). Also, another participant described how a joint arts and mathematics project involving data analytics was formed out of cross disciplinary discussions in the crowd (CB6).

In case B, several participants discussed the benefit arising from interaction amongst stakeholders through encouraging them to remain within the offline ecosystem (CB2, CB3, CB5). In case B a participant stated that:

"*I am pretty sure that if we were to go back to these people again asking for help that they would come back at the drop of a hat where the experience of everybody involved was very positive and was a clear desire for relationships to be maintained going forward*" (CB3).

Other data sources: In case A, no documentary evidence was presented in support of an express desire to create social space however one participant (CB6) stated that it was implicit through the use of an online crowdsourcing platform. In case A, a report describing the process of creating a space for stakeholders to interact was examined.

7E - V. Facilitating transparency

Transparency presented as a major focal point of discussion amongst participants over both cases. In Chapter 6, experts stated that it is difficult to decide on what the crowd should see and should not have access to. Evidence was provided by several participants in both cases of the competing interests of the agency for secrecy over decisions standing juxtaposed to the benefits of transparent decision making in crowdsourcing (CA1, CA2, CB1, CB2, CB6).

Both cases featured in the earliest stages open public commenting on project progress through a digital crowdsourcing website where a participant in case A stated that "*this is seen to facilitate transparency, but this is not (and never was) completed as an alternative to blind peer review by experts but is provided by us as a supplemental means of assessment"* (CA1).

In case A, an open and transparent approach to decisions was used throughout the majority of the submissions process, however, decisions as to the end solution selected by experts were taken behind closed doors. The results were not explicitly made public. In case B, the entire process was completed in an open fashion with no decisions taken behind closed doors with substantial publication of the process results. A participant in case B, describes the transparency afforded where:

"*substantial documentation was distributed by paper and electronic means to the crowd in advance of the call process, informing them of how the call would proceed, secondly through the website a substantial amount of help and support documentation was provided by the court process managers to the public to show them how voting arrangements will proceed and also to show them how solutions were to be selected by the crowd and by expert juries*" (CB2).

A participant discussed the explicit benefits arising from facilitating transparency where a participant stated that:

"*this gave us great buy-in from the crowd they could see that the process was completely open and transparent. For this reason, I think we got lots of extra kudos from the crowd you could not have achieved in other types of call processes. People really bought into the solution"* (CB6).

Other data sources: In case A, managers pointed to one general policy document concerning privacy over communications with the institution and also data protection requirements. By contrast, in case B, one manager pointed towards a general data protection section of the website. However, no documentation was provided expressly relating to transparency over selection in either process.

Table 7.5 - Case studies - management of stakeholder relationship

Stage	Task	Practices	Case A	Case B	Evidence
PROCESS	**Management of Stakeholder relationship** **Section E**	**Moderating participation** **E-I**	A moderator controlled the online submissions and interacted with participants. The moderator led discussion and challenged submissions	The crowd played an active role in moderation with experts also taking on a facilitation role where the crowd shaped and moderated participation jointly	Evidence shows that moderation is used in both cases, however, in case B the moderator role extended to facilitation, whereas in case A, the moderator played a more decisive role
		Facilitating communication **E-II**	Some evidence was presented that staff were aware that successful initiatives in the organisation treated internal and external participants in the same context	Strong evidence of the need to engage those from inside and outside the organisation in the business of completing call processes. Several participants spoke of the community benefit arising from this approach	Evidence shows some limited communication between stakeholders in case A, by contrast, case B featured active online and offline two-way communication methods
		Compelling participation **E-III**	Limited consideration of forcing those seeking funding to participate but internal managers feared it would drive the crowd away	Several participants stated they did not see the necessity of forced or mandatory participation as it was contrary to the mission objectives	Evidence from both cases shows a strong aversion to the idea of forcing people to participate even through their employment obligations
		Creating social space **E-IV**	Participants spoke of a lack of success in creating a living and breathing social space for interaction which may have been due to an exclusively online approach	Several participants confirmed the success obtained in fostering a community based upon both online and offline approaches in facilitating interaction and dialogue	Attempts at creating social space in case B, enjoyed greater success where evidence showed an exclusively online approach in case A, narrowed the prospects for social engagement
		Facilitating transparency **E-V**	Call process managers and senior executives made decisions as to what stages and tasks were open to the crowd. invariably, many aspects to the process were closed	Decisions were made before the call commenced to open full access by call process managers. The entirety of the process was opened to public scrutiny	Evidence shows a strong reluctance on the part of funding managers to open all aspects of call processes with traditions of closed cultures in funding agencies

7F. Assessment filtering of solution submissions

In following the experts in Chapter 6, evidence was presented across both case studies of the practices associated with the assessment or filtering of solution submissions. In case A, a substantial amount of technical setup was completed by the call process managers in advance of the call. A participant observed that "*on that basis the head of the project authorised expenditure of a large sum of money to purchase infrastructure to support third-party crowdsourcing software.*" (CA4). Similarly in case B, several participants described the need for tools to assist with volume and complexity in submissions. Across both cases call process managers were hopeful that practices could be used in dealing with the submissions received. Some evidence was provided of the use of practices for filtering with electronic tools with greater use anticipated in the future (Section 7F-I). Also, managers across both cases provided some evidence of how practice could be used for managing scale in future call processes (section 7F-II). Last, evidence was presented across both cases, but predominantly in case B, of a need to mitigate bias (Section 7F-III). A summary of the case study perspective on the practices is presented in *Table* 7.6 at the end of this section.

7F - I. Filtering with tools

In case A, participants were primarily focused upon resolving the complexity of the submissions received. To this end the practice of filtering with tools was used by different aspects of the call management team who focused on different parts of the submissions. By doing this, call process managers were in a position to obtain a deeper understanding of the submissions been made by the general public. Several different crowdsourcing practices were utilised by call process managers in an effort to deal with the complexity of the submissions received. Several participants described the use of digital tools and strategies to deal with complexity (CB1, CB2, CB3, CB5 CB6). A participant described how *"semantic or textual analysis was used in an effort to rapidly filter vast numbers of submissions"* (CB2). The participant also stated that:

"*we developed practices on the fly to deal with issues surrounding interpretation. For example, spelling across submissions also presented as a problem where one word could have two spellings. The filtering used was only capable of detecting the first spelling, accordingly a new filter was created"* (CB2).

However, the electronic process of filtering submissions did not prove entirely successful where a participant observed that *"we really needed to do much more cleaning and categorising of the data up front for it to be properly interpreted in the textual analysis processes but at least we will know for next time"* (CB3). Because of the failure of a technical approach a participant described how "*the submissions were distributed between juries of experts and laypeople who manually filtered the mass of submissions received where this proved more successful than the use of electronic filtering systems*" (CB5 In case B, a layered approach to filtering was used where a participant described how:

"*groups of questions were rephrased by experts with input from the public. These themes and associated questions were distributed to juries of experts and lay persons who engaged in a process of 'pruning' before the finished list of themes and associated questions were presented back to call process managers*" (CB2).

A participant further described the role and composition of the expert juries "*to whittle down vast numbers of submissions into categories where although they predominantly contained expert scientists they also featured ordinary citizens, agency stakeholders and industry participants*" (CB3). By contrast in case A stakeholders were used in the manual filtering of submissions. To this end a participant stated that:

"*we were somewhat taken aback by how complex some of the submissions were. We had to read between the lines to try and understand where the submissions were going. We had a little bit of concern about this, so we had people from different language backgrounds read the submissions which came from multiple countries. There was a real danger that the submissions would miss the point (in translation) and not deliver us real value*" (CA2).

Other data sources: In case B, no support documentation was provided as to how the search function could be used in filtering submissions. This was due to the fact that the search was completed by a team of experts who were versed in the use of the platform (CB2). By contrast in case A, one manager pointed to the platform help documentation which supported the simple search function on the website. It allowed participants to search through all submission or an individual thread on the website (CA1).

7F - II. Managing scale

Across both cases, managers spoke of the preparations necessary for dealing with issues arising from scale in the volume of submissions received. In case A, managers expected to receive a large number of submissions with some degree of administrator interaction required in addressing issues (CA1, CA3, CA4). This was an estimation completed based upon the volume of subscribers that were evident across the large social media channels used by the organization. However a limited number of submission were in fact received.

In case B, by contrast, call process managers were completely unprepared for the number and type of submissions received from the crowd and expected moderate crowd engagement (CB1, CB3, CB5, CB6). In case B, it was confirmed by a participant that "*at the high end, some 2 to 3000 submissions were expected"* (CB1). However, in case B, tens of thousands of submissions were received placing a great strain on the website.

A similar approach in respect of practices used was evident across both cases where participants spoke of the possibility of leveraging cloud computing. In case A, a participant observed that "*in future we will use cloud-based systems by virtue of the fact that we can add compute and resources as required, depending on the size of crowd we get*" (CA4). A participant in case A also stated that:

"*in reality scale is no longer an issue for platform service providers. Let's face it, cloud computing services through amazon and Microsoft like EC2 or Azure are so cheap nowadays that scaling is not an issue for the natures of these calls. At most, for a day or a few days, you will receive substantial traffic, but certainly no more than a major online retailer, I would imagine*" (CA1).

Other data sources: No substantial support documentation or planning documentation was available in relation to the management of scale in either case. However, a group email in case B, after the call process was completed, pointed towards the need to plan for scale in future call processes. In case A, the minutes of a committee meeting pointed towards anticipated scale in the call as justification for the purchase of the cloud based platform. Outside of this, no other documentation provided support.

7F - III. Mitigating bias

The removal of bias was a practice addressed predominantly in case B. Most of the participants spoke of evidence present in crowds submissions that showed bias in favour of one group who had been trying to game the system. A participant noted "*that if this anomaly had not been obvious in the data it would have resulted in a bias which could have caused different strategic alignment within the process"* (CB2). A participant in case B also described how "*simple text searches and clustering used on the data sets could be help identify clusters that in some instances could reveal signs of possible biases"* (CB2). In case A, one participant described how "*there was clear evidence of participants trying to then drag the discussion to suit their own strategic objectives – objectives that did not match our own"* (CA5). Another participant said that "*the only real way for managers to address this gaming was for the admin to challenge the statements or comments made on the issue posted, outside of this we had no other options available"* (CA3).

Different types of biases are also evident where in case A, a participant addressed domain biases. In case A it was suggested by a participant that "*in the future, crowd participants of a particular skill set emerging from a single given domain could be divided are spread across research questions in an effort to remove the effect of any topic or domain-based biases*" (CA3). Also individuals can hold domain biases. A participant also highlighted "*where the person who picked the best solution from the crowd submissions in this call was very biased towards one approach*" (CA5).

Identifying biases presents difficulty. For example, in case B, a participant described how call process managers could "*see the personal details of who made website submissions however, these details were hidden from the public. Apart from that, all other information was provided on an open basis*" (CB3). In theory, greater transparency can assist stakeholders in the identification of biases. In case A, a participant stated that deciding what aspects of calls to provide transparency needed to be made by call managers on a case by case basis where "*this open approach was OK for this type of call but some types of tasks by virtue of the sensitive nature of the*

Other data sources: In case A evidence shows the practice had not been utilised yet in the call process but could be used in future instances. This was supported by the lack of evidence of the practice in call process documentation and communications in

case A. In case B, no information was presented from the documentation or electronic communication of attempts to complete an upfront identification of bias..

Table 7.6 - Case studies –assessment/filtering of solution submissions

Stage	Task	Practices	Case A	Case B	Evidence
PROCESS	**Assessment filtering of solution submissions** **Section F**	**Filtering with tools F-I**	Limited electronic filtering was used where search features were used after submissions were received in the generation of solutions by call managers	Textual, semantic analysis and search tools were used in categorising submissions in an effort to reduce complexity and group submissions into themes	Evidence shows a greater use of filtering tools in case B, over case A, with both cases showing the potential for the future use of tools such as machine learning
		Managing scale F-II	Evidence suggests cloud technologies were provisioned in anticipation of the receipt of a vast amount of complex submissions but, in the end, extra resources were not required	A moderate amount of traffic was received in case B where several participants spoke of the need to use a cloud-based resource approach for applying extra services in the future	Evidence indicates that both organisations are aware of the potential for assistance from cloud technologies in the management of scale within call processes
		Mitigating bias F-III	An exclusively manager led approach featured moderators examining posts on an ongoing basis for evidence of undue bias	A combination of semantic search tools and expert peer review were used to check for patterns of undue bias in the submissions received	Both cases provided evidence of an awareness on the part of managers of the need to control for specific biases

7G. Generation of potential solutions

Evidence was presented across both cases that the voice of stakeholders was implemented in different ways in the scoping and selecting of solutions from the body of submissions received. In chapter 6 experts confirmed that various practices were in use in scoping and selecting solutions in call processes. However, a difference was evident in the approaches used. For example, in case A, call process managers firmly retained control of all final decisions arising from crowd submissions received. By contrast in case B, the crowd were substantially involved in both scoping and selecting winning solutions within the call process even where there was some suggestions of expert bias in guiding solutions.

Evidence was provided of the practice of selecting solutions which bore similarity to the practice of selecting problems (Section 7G-I), Also, both cases provided examples of the practice of selecting solutions with participants highlighting the need for expert participation (Section 7G-II). A summary of the case study perspective on the practices is presented in *Table* 7.7 at the end of this section.

7G - I. Scoping the solution

A difference was evident between both case as to how solutions were scoped. In both cases, stakeholders took the submission and engaged in various practices for categorizing or amalgamating submissions into solutions. In case A, a participant describes how "*all the submissions were examined by expert teams who consulted strategic plans before using the best submissions that met with our strategic objectives"* (CA1). Another participant in case A described how upon the conclusion of the filtering process "*we took the submissions made and discarded the options that were not a reality for us. We tried to group together what was feasible into a solution*" (CA4).

Another participant in case A, described two main stages of scoping. First, with "*experts commenting on the level of submissions" (CA3). Secondly, experts had "the added possibility to comment at a global level or in respect of the project as a whole*" (CA3). This allowed participants to form a solution from the submission provided. By contrast, in case B, participants described the process of how submissions from various paper and electronic systems had to be amassed into one solution. Scoping was carried out by the juries where a participant observed that "*we used our experts on the juries to try and set the level at which the themes were constructed and give us feedback, obviously this needed some refinement when it came to putting all the final pieces together"* (CB3). This proved as a complex process requiring the use of various types of experts. Although the public and other stakeholders were involved, one participant remarked that "*it was always going to require expertise to match submissions from the website with submissions received at the workshops and public meetings"* (CB2).

Participants in case A, also described visual aspects to the process of scoping solutions. Participants discussed how in the future the crowd could scope solutions.

In case A, a participant observed that *"some participants respond better to visuals than to written materials and we know that call processes are very much dependent upon written materials in supporting the process, so I am open to ideas on how we can make things more visual"* (CA5). This is confirmed by another participant who describes an example system used in a similar call process whereby "*participants can see each other's contributions in real-time which uses symbols for different types of submission and this informs their scoping process*" (CA4).

A participant in case A, described how their institution has two types of inputs requiring scoping namely narrow inputs in the context of a framework/call and broad inputs through social media or digital communications (CA1). A monitoring aspect to the scoping practice was used by call managers whereby:

"*a media monitoring team and data analysts are used to review submissions that are classed as 'active' and 'passive'. Monitoring is more examining topics that mention the institution or are of interest to the institutions and is countenanced as a passive or reactive strategy whereas teams that actively monitor digital submissions, so their institution can respond in a timely manner are classed as active"* (CA2).

Other data sources: A series of guidance documents were presented to moderators and other participants in case B by way of guidance as to the scoping process. One document contained process stages for scoping a problem and subsequently scoping a solution. This document was coded and analysed. However, case A, by contrast, provided no documentation in respect of scoping solutions.

7G - II. Selecting solutions

Across both cases similar mechanisms were used to select solutions. In case A, a participant describes how:

"*the call process managers decided to use a simple system of likes and up-voting. In this case, the purpose of the submissions made by the general public was predominantly gauge sentiment on key issues. However, decision power exclusively rested with us (call process managers) in deciding what was to be selected as a solution*" (CA3).

One participant described how this did not work out well for several reasons, stating:

"*we used the simple voting system in combination with a rating similar to the 'likes' you would have on Facebook, but this did not work out for various reasons people were very happy to post comments and provide a rating for ideas but in the end, we still had to review everything and draw our own conclusions*" (CA4).

In discussing the rating stars/likes system that was used for identifying the best project a participant challenged "*if this is really enough in getting the very best answer as they ideally need to be retrospectively examined in conjunction with questions that were asked*" (CA5). A participant also described a further aspect of this practice where:

"*even where someone likes a submission and we know how much they like it from the rating how do we examine the reasons behind their decision? Under the software it was possible to have a rating system based on a number of stars. In hindsight we could have combined this approach with another type of more personal interaction*" (CA1).

A core aspect of the practice involves deciding what weight to give the vote of experts in crowds over the vote of lay persons in crowds. In case A, the entirety of vote weighting / decision capacity was given to call process managers. By contrast in case B, voting weight was shared between expert crowd and lay participants. Weighting votes on a similar basis across parts of the crowd presents as an important aspect of the practice. Another participant cautioned that there were no uniform evaluation criteria across juries the results were off balance because "*it is important that all projects participate and are evaluated on a similar basis. Otherwise this will lead to confusion*" (CB5).

In case B, although there was minor evidence of some disgruntled crowd members a participant stated that "*for the better part people were happy after the group discussion about what submissions were picked as the whole selection process was open*" (CB5). Another participant observed that "*citizens who participated really felt involved as they also got to vote in the same way as scientists and experts*" (CB4). It is important to point out as stated by a participant in case B, that solutions where finalised "*were accepted these as a 'faits accomplis' out of respect for the crowds who*

worked so hard in providing us with answers. I think this is very important" (CB1). In case B, a subsequent problem arose for the funding agency where the government failed to implement all the crowds recommendations. Accordingly, aspects of the practice also need to insure the lead stakeholders are on board with the process and willing to implement the solution picked. One participant stated "*the result needs to have the footprint of the crowd on it or else crowd members will become cynical and not participate in future processes*" (CB1).

Other data sources: In case B, aside from a mention in the call documentation that democratic voting was to be used on juries, no further support for the practice was expressly described. By contrast in case A, no documentation was provided in respect of how decisions were to be made with an assumption that managers would decide based on the submissions provided.

Table 7.7 - Case studies –generation of potential solutions

Stage	Task	Practices	Case A	Case B	Evidence
OUTPUT	**Generation of potential solutions** **Section G**	**Scoping the solution** **G-I**	Submissions were received from and were assessed by the crowd where their decisions did not carry full weight but were taken into account by managers. Weight of opinions in decision making was assessed by the numbers of likes	Crowd participants voted in a similar capacity on juries as experts with their input carrying equal weight, however, experts were in a position to facilitate discussion in the scoping process	Evidence shows that across both cases the crowd were involved in the process of scoping solutions in a similar capacity to scoping the problem at the start of the process
		Selecting solutions **G-II**	Decisions about which solutions to accept from the crowd was exclusively based upon expert decision after the crowd furnished votes and ratings	Experts cooperated with lay persons in making decisions as to which solutions were accepted where decisions were made jointly	A difference is evident in the practice of selection where in case A, managers selected the solutions where in case B, by contrast, the crowd shared an equal role in selecting the solution

7H. Potential rewards for solution seekers, solution providers, brokers.

In Chapter 6, experts spoke of the importance of incentivisation in crowdsourcing call processes. Establishing motives for participation and the design of incentives forms a major part of the design process in contemporary crowdsourcing. However, evidence presented from both case studies show some of the constraints that are placed upon public sector funding agencies in terms of what they can offer by way of incentivisation and the practices used by call managers to combat this challenge. Participants discussed the provision of extrinsic incentives and associated restrictions (Section 7H-I). Also participants across both cases spoke of the use of intrinsic motivation to secure further participation (Section 7H-II). In section 7H-III participants discussed the concept of coopetition with limited evidence of the use of both collaboration and competition in the same processes. Last, participants across both cases spoke of the potential available to harness indirect advertising from the viral nature of crowd interactions (section 7H-IV). A summary of the case study perspective on the practices is presented in *Table* 7.8 at the end of this section.

7H - I. Providing extrinsic incentives

As outlined by experts in Chapter 6, the provision of extrinsic incentives by public funding agencies presents as a problem. Both sets of experts express awareness of the need for extrinsic incentives to be made available to entice participation. Several participants stated that it is hard to retain a good demographic spread in the crowd where there are no tangible incentives to secure participation (CA1, CA5, CB2, CB3, CB6).

A participant in case A stated that "*there needs to be incentives that are tangible on offer for reviewers to complete work within a crowdsourcing ecosystem*" (CA4). A participant also stated in addressing the lack of extrinsic incentives on offer that "*until we bridge this gap were not going to get much by way of proactive interaction from diverse parts of the crowd such as younger people or those from poorer socio-economic backgrounds*" (CA3). Evidence confirmed that some minor extrinsic incentives were offered in case B however, they comprised as described by one participant as "*small gifts, prizes along with refreshments at the various face to face meetings with nothing more*" (CB1).

Some other evidence was available of practices to promote altruism that required some payments in kind where one participant stated that:

"*to promote the altruistic nature of what we were doing we invited famous YouTube bloggers to the institution to learn how the group worked. People or advocates of a particular area sometimes require language or information structured in a particular way that they can use so 'Youtubers' can reach people at that level*" (CA2).

However, some criticisms were evident. A participant in case A, describes incentivization as "*a double-edged sword. Where you don't offer anything, people get hostile and accuse you of trying to get them to work for free and where you do pay you are the bad guy for giving away public monies*" (CA1). Another participant in case B, cautioned that he does not know about the merits of "*using cash for incentivizing in the public sector due to the fact that most persons in the environment could not personally be seen as risk takers, even cash might not bring out the desired results*" (CB4).

Other data sources: Across both cases the call support documentation was silent as to the offer of any extrinsic incentives. Although funding agencies can pay reviewers for peer review works they are generally limited by governance procedures as to the nature of rewards they can offer the public and other stakeholders for participation in call processes.

7H - II. Appealing to intrinsic motivations

The practice of appealing to intrinsic motivations presents as a widely used but complex practice. In Chapter 6, crowdsourcing experts showed great awareness of the need to use the practice. By contrast, funding experts confirmed that funding agencies are late arrivers in the use of the practice.

In case A, one participant described how "*we took for granted public support and did not examine the personal reasons citizens would participate"* (CA4). No documentary evidence was available to support the express use of the practice in case A. A difference in attitudes to the use of the practice was evident across both cases. A participant in case B, observed that:

"*it is generally those interested in the social good, who have an education who are happy to help science so the narratives around a call need to speak to these targets*" (CB2). However, funding agencies need to use the practice in the engagement of more demographic of interest. Another participant cautioned that: "we *are clearly missing out on engaging young idealistic people. Perhaps tactics that focused on doing a greater good would help to engage them. However, as we are public sector we are very limited here in terms of what we can do to capture the focus of this generation* (CA2).

Across both cases there was evidence of a desire on the part of call process managers to tap into public good will. Two participants (CA2, CB2) spoke of academics and scientists taking a lower paid jobs within the public sector processes because of a desire to make a real change on the world. One participant confirmed that "*this is for reasons of intrinsic motivation and besides there is a big moral issue around incentives and public money. It becomes a public issue where public monies are given away*" (CA2).

As outlined above (Section 7H-I), the offer of exclusively intrinsic motivations can cause problems for funding agencies. In case A, several of the call process managers described receiving angry comments from the crowd where they were not paid for their services. This was despite the fact that the crowd and prospective participants were informed from the outset that there would be no payment for their submissions received in the call (CA4). Several participants took it upon themselves to post angry statements on the submission section.

A participant described a further altercation as a result of not offering incentives for participation where "*in one scenario I even received an invoice from a disgruntled participant who had placed submissions on the website. He also sent a message asking when he was he going to be paid for his services"* (CA1). This interaction left several of the call process managers perplexed with another participant stating "*surely as citizens is our job to support funded research and, on that basis, people should be happy to participate in the community. In academia, academics review each other's works without payment as part of their duties towards the community*" (CA3).

In case B, by contrast, the crowd largely participated without complaint. Despite the fact that several thousand participants interacted through the crowdsourcing ecosystem, no information was available of any major complaints received from the general public for not receiving incentives for payment for their participation. A participant observed that "*because the national initiative was so widespread, participants took it upon themselves to participate out of a sense of duty*" (CB1). A participant in case B, described "*a general sense that people were happy to contribute where they knew they were working towards a better society*" (CB6). This viewpoint was also supported by a practitioner who described one participant remarking that

"*they really felt they were building a better place through being part of the crowd because they could see in our advertising that we were doing this for the greater good and altruistic reasons, I suppose it helped that they knew we were not getting paid to do this work*" (CB4).

Other data sources: Substantial documentation across case B spoke of the need to appeal to intrinsic motivations and the desire on the part of the organisation to motivate public involvement through concern for science and research. This information was coded and analysed. The only written evidence in case A addressing this point was discussions in email correspondence concerning complaints about nonpayment for involvement in the process.

7H - III. Fostering coopetition

In Chapter 6, experts from both groups provided examples of collaboration and competition in various instances. As outlined in Chapter 3, contemporary crowdsourcing shows evidence of the use of coopetition in the improvement of stakeholder experience and the gaming of call processes. Across both cases, no substantial evidence was provided in respect of stakeholders fostering coopetition. However, some theoretical support was on offer from participants.

However, a participant in case A provided some theoretical support for the idea of using coopetition. He noted that "*in retrospect, everything we did in the initial phase was collaborative. Perhaps we should have adopted a more competitive approach and used some kind of competition to get people excited about finding big questions?"* (CA1).

Another participant from case A, describes the ideal balance sought where, "*in theory, if you have a very specific problem you would need a very specific solution and might opt for a competition where you give a cash prize to try and draw out a technical expert to find the most efficient solution"* (CA2). Three participants described how the interplay between participants helped advance better submissions (CA2, CA3, CA5). One participant remarked that "this wasn't competition but candidates were trying to be seen by their peers to be giving us the best suggestions" (CA3).

Other data sources: No supporting documentation or data was evident in case A. Support documentation for the call in case B expressly mandated participants to encourage participation in juries and in stakeholder interactions. The support documentation in case B did not contain a reference to the use of competitions. The campaign director in case B stated that "*this was because of our philosophy and approach of collaboration in addressing problems*" (CB1). However, as previously highlighted, evidence of competitive gaming from groups in crowds was presented in Case B, even where the call process was designed from a collaborative perspective (CB2).

7H - IV. Harnessing indirect advertising

Experts in Chapter 6 spoke of an awareness of the indirect advertising benefits on offer through the use of crowdsourcing. Experts described how individual crowd members thorough their own interactions serve to promote the call process. Despite the awareness of participants across both cases of the need to harness indirect advertising a strong difference was evident between the cases in terms of the approach to capturing publicity. In case A, participants presumed in advance of the call that a significant degree of media attention could be harnessed through social media interactions of the crowd. However, in reality, no secondary or interdict form of advertising was leveraged by the call process managers. A participant in case A stated that: "*despite our best efforts, interactions stayed within the call channel on the platform. Our social media experts could not see any further interaction or advertising outside the platform*" (CA1). Another participant stated that "t*he view was held collectively by the team that this was due to a failure to also engage offline activities in parallel to the online efforts*" (CA4). Both experts identified an awareness on the part of agencies of the need to harness indirect advertising (CA1, CA4).

In case B, by contrast, several participants spoke about the secondary advertising effect achieved through public involvement. One participant described how "*we really did not anticipate how radio and TV participation would capture the public imagination. With all of the activity on the Internet, TV and radio further people outside of our initial advertising reach became mobilised*" (CB2). Another participant in case B described this as a kind of "*snowball effect*" (CB6). A participant in case A also discussed in theory that "*we imagine that in these types of processes that no news is bad news. Next time out the managers might be inclined to provoke a little more controversy to get a bigger group involved*" (CA2). Participants in case B described how the crowd were actively encouraged to talk to friends, neighbours and family about the call process and to share the details on social media. Although not directly requested in case A, participants spoke of a hope that other platform users from outside the call process would also get involved by "*word of mouth*" (CA3).

Other data sources: The call documentation in case B specifically addressed the concept of engaging and inspiring communities through collaboration where the call process was specifically designed to promote awareness. In case B the was no reference to competition or collaboration in the supporting call documentation or specific strategies to support these outside of instructions provided to moderators. In case A no documentary evidence existed in support of the practice.

Table 7.8 - Case studies –potential rewards for solution seekers, solution providers, brokers

Stage	Task	Practices	Case A	Case B	Evidence
OUTPUT	**Potential rewards for solution seekers, solution provides, brokers** **Section H**	**Providing extrinsic incentives H-I**	No monetary payments were offered with managers strongly opposed to the idea of cash payments for participation. By contrast crowd participants were angry about no offer of pay	Case B, participants were strongly opposed to the idea of paying for participation. No strong indication was received from the public that pay or extrinsic incentives were sought. Some moderate forms of extrinsic incentives were used	Evidence shows that funding agencies as public sector organisations are extremely limited in terms of the extrinsic incentives that they can offer. Managers acknowledge that the use of extrinsic incentives would assist the process
		Appealing to intrinsic motivations H-II	A suggestion was made that participants may have engaged to be seen to be engaging for the hope of picking up other paid for work from the agency. Participants spoke of the need to engage crowd via intrinsic motivations	Some prizes and refreshments were paid for by the agency and used to encourage participation. Several participants provided evidence of substantial efforts to capture crowd intrinsic motivations	Across both cases strong evidence was available of the need to appeal to the intrinsic motivations of stakeholders in seeking and retaining participation
		Fostering coopetition H-III	All of the examples provided by participants concerned discussion an collaboration amongst participants. Although some participants were keen to push their own research agendas little by way of direct competition was evident	Similarly, in case B, participants collaborated in respect of assessing and filtering submissions. Although some biases were evident in the system there was no substantial evidence of competition.	Participants across both cases supported the practice of fostering coopetition. Although participants could not provide examples of the practice in use, they were strongly supportive of the prospective utility arising from the practice
		Harnessing indirect advertising H-IV	Managers were cognisant of the potential to harness indirect advertising through the use of communication channels. However, evidence was provided that they were disappointed in the results obtained	The call process enjoyed substantial success in harnessing indirect advertising. Participants were encouraged to spread the word and a substantial degree of indirect advertising was harnessed	Both sets of participants highlighted the potential indirect advertising benefits from using crowdsourcing. However, funding experts were concerned about negative publicity.

7I. Broader socioeconomic impacts (rewards for the marketplace and society

Both agencies describe the need from the start of call processes to establish what success means and what metrics are to be utilized. Several participants spoke out against the prospective use of 'vanity metrics' solely for improving the image of the funding agency over and above metrics that establish real value arising from processes (CA2, CA5, CB3, CB6). There was a degree of similarity between call process managers across both cases in terms of what they required to be measured in the call process for the purposes of establishing impact. In case A, managers were more inclined to rely on metrics from domains such as web and social media metrics, however, they spoke of the need for bespoke crowd impact metrics. In case B, managers used various types of bespoke metrics to evaluate performance in addition to traditional web and social media metrics. Evidence confirmed the use of web and social media metrics for measuring platform performance but evidence highlighted that these metrics were insufficient for measuring the entire impact arising from call processes (Section 7I-I). Also, strong evidence was presented of the need to create new metrics to measure crowds impact in call processes (Section 7I-II). Last, participants spoke of the need for real-time oversight for various reasons including holding the ability to tweak the process (Section 7I-III). A summary of the case study perspective on the practices is presented in *Table* 7.9 at the end of the section.

7I - I. Using web and social media metrics

Both cases relied upon the use of web and social media metrics in measuring platform performance. In Chapter 6 both sets of experts explained how these metrics were similar to those used in digital platforms generally. In case A, a participant described how that "*what we wound up using was a substantial amount of social media and website metrics used in online pay per click marketing. Things like page views, cost per click and follow-through percentage rates were examined*" (CA4). Another participants described how "*exit pages gave us insight into where the crowd were leaving the website. WE then decided to improve these pages to try and retain users*" (CA1). However, the metrics provided in this regard were of limited value according to the participants (CA1, CA2, CA4).

In this context another participant observed how "*this is confusing, because these metrics did not set out to measure properly what we wanted to achieve from the viewpoint of societal impact, for sure, we knew how well the website was doing but we couldn't really say the call was high on impact"* (CA2).

In case B, several participants also described how they used basic online web marketing metrics in attempt to establish how successful the platform was where a participant described using "*metrics such as the amount of time a crowd member spent on a page and also the number of second visits and follow-throughs"* (CB2). As pointed out by another participant in case B: "*the use of these types of measurements are quite common in many web design website projects and not necessarily just in crowdsourcing. There's nothing particularly special about these metrics, however, they do give us a good indication of where we are going with the website*" (CB1).

However, as outlined by another participant in case A, "*there is no guarantee that these types (of metrics) will provide any way of an accurate path towards measuring impact*" (CA3). Other metrics used as highlighted by the participants across both cases are addressed in the next two sections.

Other data sources: In case A, support documentation from the open source platform provided guidance on how to read metrics and traffic through the platform. By contrast, in case B, as the website was bespoke, managers were reliant upon web metrics provided by the hosting provider. No access was obtained by the researcher to the hosting providers support documentation in Case B.

7I - II. Establishing crowd impact metrics

Strong evidence was presented across both cases of the need to establish crowd impact metrics. In chapter 6, experts established that new types of metrics were required to measure crowd impact. As outlined in Chapter 4, funding agencies seek to measure impact and excellence of their operations in various capacities. Several participants echoed the need to move beyond web and social media metrics to developing bespoke impact metrics (CA1, CA2, CA3, CB1, CB2, CB3, CB6).

In the case B, various bespoke metrics were generated for the call process. A participant described how "*various metrics related to semantic and textual analysis were advanced in terms of measuring the effect of the online call process*" (CB2).

However, as outlined by a participant, in discussing his colleagues, "*in our case, some call process managers were firmly of the view that traditional impact metrics used by national funding agencies should be to the core of all measurements throughout the process with these technical metrics should only be used for the purposes of additional reference"* (CB4). A participant stated that in case B, bespoke impact metrics were used where by way of example "*one of the aspects monitored was evaluating utility. Is it a useful project for society at large and if yes/no then why?"* (CB6). In case B, further evidence was also provided of practitioners seeking to confirm the measurement of what degree of citizen questions were converted into themes at the end of the process. This measurement was utilised in attempt to measure the efficacy of the call process in providing impactful solutions (CB1, CB3).

Both sets of participants across cases were canvassed about the use of EPE (Education and Public Engagement) metrics as used by funding agencies but neither group of participants displayed substantial knowledge of what these measures entailed. One participant in case B suggested the term EPE may be localised to Ireland and the UK and that this new area of public engagement metrics is under development worldwide and in its infancy (CB2).

By contrast, no such metrics were available from case A, with a participant describing how "*our IT staff were primarily concerned by the amount of time and participation completed by participants on the website*" (CA1). There was an apparent difference between what the call process managers desired to measure from the process and what the website managers (IT staff) measured. A participant described this misunderstanding as:

"*particularly problematic (as) it is very hard to measure something we don't know, so from the outset we needed to reinforce what our objectives were for the call and what our goals were in the longer term. If you got these right from the beginning, then I believe there would have been less confusion*" (CA5).

Other data sources: In case A, one memorandum speaks of the need to examine what extra points in the process can be measured in future call processes. In case B no discussion was evident in the call process documentation regarding the creation of new metrics.

7I - III. Facilitating real-time oversight

In Chapter 6, both sets of experts identified a need for real-time oversight of various aspects of the call process. In both case studies, participants also addressed the contemporary use of dashboards in call processes. In case A, the platform backend contained some dashboard details as to the numbers of users registered, active, numbers of comments posted and other related participatory metrics. However, outside of this basic dashboard, no substantial suite of metrics was available to use. Several managers in case A spoke of the need for a dashboard to integrate metrics from all appropriate sources (CA1, CA3, CA4). A participant in case A stated that:

"*in this call we were missing a real-time analytics dashboard, necessary to monitor both active and passive participation. Basic measures were used. In future if we can't develop a dashboard we need to be able at the minimum to dump data into a high-quality data analysis suite"* (CA3).

A participant in case B, said that for many managers "the *appetite for a high-quality visualisation of the data from the website died after the textual and semantic analysis process became too cumbersome. However, I would not discount in future a call having a full in-built analytics dashboard*" (CB2). This view was also endorsed by another participant in case B, who observed that:

"*the next run (if there ever is one) will involve a better way of accounting for crowd feedback and sentiment in data collection at the end of the call processes. I suspect there is a difference between the website user data we collected and what the crowd would have said after the jury process ended. A dashboard facility should in theory be able to bridge this gap*" (CB3).

Accordingly, both sets of managers across the two cases were of the view that insights could be gained from the use of real-time dashboards.

Other data sources: No supporting documentation was to be found in either case supporting the active use of real-time oversight. This is outside of web metrics as outlined in Section 7I-I above.

Table 7.9 - Case studies – broader socio-economic impacts

Stage	Task	Practices	Case A	Case B	Evidence
OUTCOME	**Broader socioeconomic impacts, (rewards for the marketplace and society)** **Section 7I**	**Using web and social media metrics** **7I-I**	Standard social media and website performance metrics were used to evaluate crowd interactions in the call process. No data from offline sources was integrated into the metrics collected where participants requested that this be integrated in future	Some standard web analytics and social media metrics were collected as to participation on the website. A multitude of data was collected from online and offline sources and was cleaned and collated. Some participants requested a single data source in future	Across both cases evidence was provided that managers were aware that web and social media metrics only served as a short-term proxy for measuring the impacts of crowdsourcing processes
		Establishing crowd impact metrics **7I-II**	Call managers complained of a lack effort in the call to tie metrics to the original call objectives and state that new bespoke measures are required	Several participants described the use of bespoke metrics relating to impact such as measuring what submissions got turned into larger themes	Evidence was provided by managers in both cases of an express need for metrics to measure impact with confirmation that little by way of guidance was available as to what to measure
		Facilitating real-time oversight **7I-III**	Several candidates lamented the lack of a dashboard to show overall performance in real-time. Real-time analysis provides stakeholders with an opportunity to change strategy and make adjustments	Some participants indicated that an analytics dashboard would be welcome but managers expressed concern as to how all the separate data sources could be easily integrated	Managers across both cases identified that some dashboard analytics were available through the platforms and hosting used but that a fully integrated data analytics suite with real time oversight would be preferable

7.2. Summary

In this chapter, the practices identified in Chapter 6 were compared against the data across two case studies. The evidence outlined above supports the use of the practices identified with some further additions evident from practice. In the next chapter (Chapter 8) the findings from Chapters 6 and 7 are analysed and conclusions are presented in light of a reflection upon research.

Chapter 8. Discussion & analysis

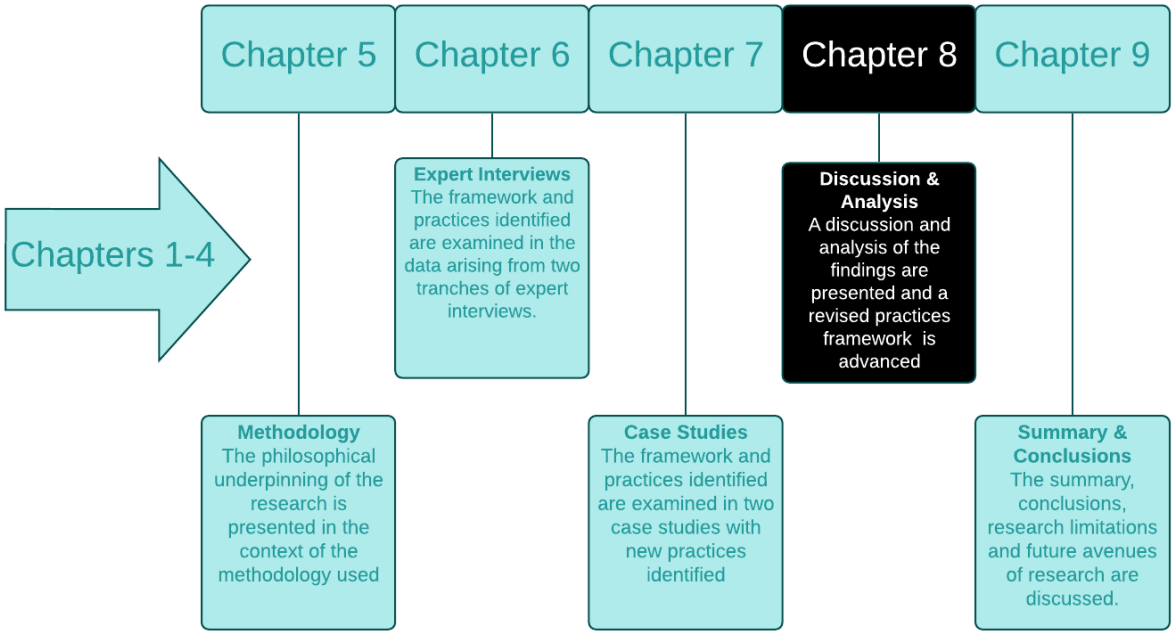


Figure 8.1 - Chapter structure - Chapter 8

8.1. Introduction

In the preceding Chapters 6 and 7, the findings arising from expert interviews and case studies were presented. The purpose of this chapter is to analyse the findings from the study that contribute to addressing the research objectives RO1.1, RO1.2 and RO2.1-2.3. Both the expert interviews and case studies are drawn together in two capacities for the purposes of analysis. First, both research methods are coded in N-Vivo under the same nodes and are readily comparable on a practice-by-practice basis. This facilitated the creation of the tables at *Appendix* A, where data are compared across Chapters 3,4,6 and 7. Second, the contrasting viewpoints across the case studies and experts are compared and contrasted so as to provide deeper insight into the nature of the practices identified from the literature. In adopting the multicase approach of Stake, (Stake, 1996) and in contrasting data over and above a complimentary approach the full extent of challenges faced in the use of the practices are identified. The findings and new crowdsourcing practices arising from Chapters 6 and 7 are now analysed and compared with contemporary research (Sections 8A – 8I) and are summarised in *Appendix* A in a series of tables (see *Tables* 8.1 – 8.9). This chapter informs the recommendations in Chapter 9 (see *Fig.* 8.1 above)

8A. Problem definition and specification

In this section, findings regarding practices in the task of problem definition and specification are examined. The findings reveal that a tension exists between attempts to involve lay persons in the task and the commensurate need for scientific excellence. Through expert interviews one additional practice was identified namely aligning with strategy. The practices are discussed as follows: restricting submissions (Section 8A-I), scoping problems (Section 8A-II), selecting problems (Section 8A-III) and aligning with strategy (Section 8A-IV). A summary of the practices used in the advertisement of innovation challenge are presented in *Table* A in *Appendix* A.

8A - I. Restricting submissions

Evidence shows that funding agencies use the practice of restricting submissions in call processes, if somewhat inadvertently. Expert interviewees identified prospective benefits arising from the use of the practice including the provision of homogeneity over submissions received thereby reducing the complexity in submissions. Also, the use of the practice is consistent with funding agency literature where funding agencies visibly restrict submission types and formats at different stages of the process (see for example EPA, 2019; NIH, 2012). However, the findings in both case studies revealed a lack of (i) specific awareness of the necessity for use of the practice on the part of call process managers and (ii) a lack of guidance available as to how to use the practice. This was despite evidence showing that participants in call processes were limited as to the type of information format through which submissions could be made.

Various possible reasons could be suggested as to why there was a lack of awareness of the practice on the part of interviewees including a lack of support or training in the use of crowdsourcing. Also, it can be suggested that the practice of restricting submissions may have occurred inadvertently where existing off-the-shelf crowdsourcing systems show evidence of being pre-configured to only accept submissions of a certain format. The inability of crowdsourcing systems to accept submissions in both paper/digital and online/offline formats was highlighted in the findings. This suggests that limited provision is made by platform designers as to how to incorporate other submission formats including offline submissions. The analysis also reveals concern on the part of call process managers of unduly restricting the novelty arising from what the crowd submit.

This points towards managers completing a delicate balancing act in restricting trying to restrict submissions without unduly restricting the novelty arising from crowd involvement. This fear is consistent with the hardships and trade-offs evident in crowdsourcing literature encompassing task design (Lukyanenko et al., 2014; Simperl, 2015).

8A - II. Scoping problems

Evidence supports the use of the practice of scoping problems by funding agencies. However, the findings highlight that involving diverse stakeholders in wording or setting the correct granularity of a problem is a challenging part of the practice of scoping. In particular, where participants highlight that science challenges are complex, require skills and are difficult to assess. Throughout the literature similar types of scoping practice are evident. For example, Rotman (2012, p. 225) describes a disaggregation process in scoping as: "*breaking tasks into smaller scale building blocks*". It was evident that a tension exists between the need for lay involvement and the need for funding agencies to achieve scientific excellence, perhaps caused by the lack of guidance available to call process managers as to how to manage the scoping of problems. This tension is also evident in the literature where challenges over lay participants deciding on complex scientific challenges are evident in the research surrounding scientific selection processes (Guinan et al., 2013; Harnad, 1996; Woolley et al., 2016).

In the findings across both case studies a clear preference emerged from the data for expert interaction/involvement in scoping the problem. For example, research has shown how the intellectual and social capital of experts within teams can, in different combinations, effect different results (Dissanayake et al., 2015). Also research shows that lay participation can be used where multiple benefits can be harnessed by the organisation (Boudreau et al., 2012; Wiggins and Crowston, 2011). Research has also shown a mix of both skillsets such as the use of skilled participants in examining different submissions made by lay participants (Kane and Ransbotham, 2016; Saldanha et al., 2014). The findings suggest that lay persons can be involved in making key decisions about research, however, experts also highlighted that a lack of guidance is available as to how this is to be achieved.

Furthermore, crowdsourcing experts also cautioned that participants who self-select to participate can misrepresent their skills. The findings from the study also differed as to how stakeholders can be involved in scoping problems. For example, in the case studies evidence was provided of online engagement in case A, versus face-to-face meetings between stakeholders inside and outside the institution in case B.

8A - III. Selecting problems

It was evident from the study that crowdsourcing processes require a means by which problems can be selected. However, there was no clear evidence as to how this was to be achieved where the findings show that participants across both cases studies dealt with the selection of problems in different ways. In particular, a lack of clarity was evident from the findings as to how diverse stakeholders can inform the selection of problems. By way of example, in case A, the votes assigned by the crowd and ratings assigned to ideas were taken into account by call process managers before final decisions were made by a single manager. They were treated as suggestions more so than being directly implemented. By contrast in case B, a democratic voting process was used in respect of all submissions made which featured various expert and lay stakeholders. Participants were not in a position to identify why the various selection mechanisms were used by the organisations.

The need for clarity is supported in research that has suggested that not all votes in call processes need necessarily be equal and can be weighted (Malone et al., 2011; Tao et al., 2018). For example, first, research has described crowdsourcing as not always being a meritocratic process to produce the objective best ideas but rather also depends on subjective communicative temporal and platform factors (see for example Guth and Brabham, 2017). Second, research has also provided case examples where crowds produce results that were not desired through democratic voting (Lane, 2016; Mackay, 2012). From the findings it is evident that managers lack guidance as to the best means by which the crowds can select solutions or indicate favour as to one solution over another. Another issue that complicates the selection process is the anonymity traditionally associated with voting. Managers expressed a concern for allowing anonymous voting in platforms.

This issue is also evident in literature where in one piece of research *'Your comments are meaner than your score'* research established that score calibration talk influences scientific grant peer review decisions (Pier et al., 2017) implying that social interactions in selection processes can affect scoring systems.

8A - IV. Aligning with strategy

The findings confirm that there is a clear need for funding agencies to align the problem definition and specification process with organizational strategy. The new practice of aligning with strategy was identified by experts. In the findings various direct and indirect means were used to align problems with strategy. Research shows strategic alignment considerations in the use of crowdsourcing (Liu, 2017a). Research also addresses strategic considerations in crowdsourcing (Bentzien et al., 2015; Jette et al., 2015). Malhotra et al., (2017). This is also supported by other research that highlights that managers need to be extremely mindful of the overall goals they are trying to achieve in bounding problems (Brabham, 2008; Lee et al., 2018; Stieger et al., 2012). The need for funding agencies to engage in the strategic alignment of problems was not apparent in the initial examination of both the crowdsourcing and funding agency literature. It is also important to note that a fundamental difference existed in the case study findings. In case B, submissions were left wide open where experts *ex-post* assisted in their strategic alignment with research themes and priorities. By contrast, in case A, the funding agency had specific research topics identified in policy documentation that they were looking to examine through the crowd. Such policy or long term considerations are evident in the literature where Sharma, (2010) notes that it "*is extremely vital that the motives of the crowd are aligned to long term objectives of the crowdsourcing initiative*".

Notwithstanding these differences, the need to align with strategy is consistent with the literature on crowdsourcing systems where research highlights various strategic considerations in the use of crowdsourcing (Amrollahi et al., 2014; Rouse, 2010; Tong et al., 2014). The findings also highlighted the challenge of strategic goal awareness both with call process managers and crowd participants. Although the study highlighted a need for strategic consideration, the literature goes much deeper on the point of crowdsourcing and strategy.

For example, research shows that strategic goal awareness can extend beyond the immediate problems in the call process to other issues such as sustainability, global sourcing issues and the internal sourcing of ideas (Ågerfalk and Fitzgerald, 2008; Feller et al., 2012; Zuchowski et al., 2016). Such strategic considerations are broader than the challenge at the centre of the call process and according to research also require addressing by call process managers.

Some sporadic evidence was provided from the findings that call process managers considered greater strategic objectives in formulating call processes over and above immediate strategic goals for answering specific questions or challenges. For example, in case A, two participants mentioned the use of UN policy documentations in considering strategic European research needs. The findings show that participants were also concerned about the multidisciplinary alignment of problems and that they believed the strategic use of crowdsourcing was a means by which to achieve this. This finding is supported by the literature where crowdsourcing and other forms of open innovation present as a means to engage multiple actors and types of actor across different disciplines and ecosystems. For example, numerous examples exist from research of solutions provided by actors from outside the solution seeker's discipline of origin (Afuah and Tucci, 2012; Jeppesen and Lakhani, 2010; Lakhani and Panetta, 2016).

8B. Advertisement of innovation challenge

In this section, findings regarding practices in the advertisement of the innovation challenge are examined. The findings reveal that although funding agencies are seeking to advertise and target participants in new ways, existing processes differ from the practices used by contemporary crowdsourcing processes. Through expert interviews two additional practices were identified including using integrated advertising channels and the retargeting of previous participants. The practices are discussed as follows: targeting participants (Section 8B-I), integrating advertising channels (Section 8B-II), and retargeting previous participants (Section 8B-III). A summary of the practices used in the advertisement of innovation challenge are presented in *Table* B at *Appendix* A.

8B - I. Targeting participants

Although the findings confirm funding agencies engage in the targeting of specific participants, a significant gap exists to the advertising practices used by contemporary crowdsourcing initiatives. It was apparent from the findings that practices were required by funding agencies for the sourcing of desired types of participants, i.e. based on age, skill, gender and location. However, call process managers highlighted that they did not possess the practices necessary to fully achieve their goals. Despite the lack of awareness on the part of funding agencies as to how to target participants, examples are available from research of public sector agencies using practices for targeting desired demographics (Brabham, 2008; Ipeirotis and Gabrilovich, 2014).

Although evidence was available in case A that some consideration had been afforded to matching the initial advertising of calls to desired demographics of participants, by contrast there was a substantial difference evident with case B as to the number and types of advertising channels utilised. The types of struggles faced by the funding agencies evident in the findings are not inconsistent with those faced by other types of organisations as presented from the research. Research has highlighted the challenges and opportunities in targeting publics or specific users in crowds (Brabham, 2012b; Ipeirotis and Gabrilovich, 2014). Knowledge of the types of participants available and demographics has been a key factor for consideration in open innovation and crowdsourcing environments (Huizingh, 2011; Kazai et al., 2012a).

The findings further reveal contrasting successes in the use of different targeting approaches by funding agencies. For example, in case A, a predominantly online approach was used for advertising purposes combining the use of a digital platform with social media channels, while in case B, a variety of online and offline approaches were utilised which yielded great results. The latter approach is supported by research where literature has addressed how off-line knowledge networks enabled with IT can improve performance (see for example Aral et al., 2012). However, this conflicts with exclusively electronic advertising approaches such as those used in case A. Nonetheless, the use of online idea competitions and systems can lead to more and better ideas at a lower cost per idea were compared against off-line approaches such as the use of focus groups (Schweitzer et al., 2012).

8B - II. Integrating advertising channels

Similar to commercial crowdsourcing initiatives, funding agencies have attempted to use integrated advertising approaches where multiple advertising channels are leveraged to improve participation in call processes. The findings reveal the use of a new practice of integrating advertising channels where funding agencies displayed varying degrees of success. Crowdsourcing research is largely silent on the issue of the strategic management of advertising channels, however, in other domains such as management and marketing, evidence exists of integrated/strategic marketing and advertising approaches (Carlson et al., 2003; Chan-Olmsted and Ha, 2003; Mulhern, 2009).

Within the findings, several experts had expressed the fear that piecemeal approaches to advertising in respect of crowdsourcing would probably not bear fruit. Experts also suggested that an integrated approach to advertising strategies was required and that funding agencies were not traditionally strong in this area. The express need for the practice is consistent with research portraying organisations using integrated advertising approaches (see for example Barger and Labrecque, 2013), while other research shows the need for public sector organisations to embrace strategic or social advertising approaches (Raftopoulou and Hogg, 2010). Moreover, a body of research exists on the strategic use of managed advertising approaches, for example, with regard to the strategic coordination of advertising within competitive processes (Castronovo and Huang, 2012; Roth and Kimani, 2014; Vernuccio and Ceccotti, 2015). Despite evidence from the findings that this practice was in use there was no express plan presented for the strategic coordination of an integrated advertising strategy in both case studies. This finding may imply that managers were either intuitively using the practice without express guidance or borrowing the practice from other forms of education and public engagement activities used by the funding agencies.

8B - III. Retargeting participants

Crowdsourcing experts provided evidence of retargeting previous participants. Also, in both case studies, evidence was presented in confirmation of the use of the new practice to retargeting previous participants in call processes.

Participants across both cases described the use of various techniques for re-engaging previous participants through online and offline means. For example, case A featured an online approach using advertising to retarget the IP addresses of previous participants. By contrast, case B, featured the integration of both online and offline strategies. In another example, scientists visited the homes of participants who provided questions to provide more details and explanation.

Although not evident in research surrounding funding agency call processes, the use of the practice is consistent with literature in other domains such as marketing where research has addressed the various aspects of retargeting (Bleier and Eisenbeiss, 2015; Kumar et al., 2011; Lambrecht and Tucker, 2013). A difference of approaches was evident between both cases where in case A, online strategies were used to re-target visitors to the website while in case B an off-line approach was also adopted by scientists who physically called out to visit people who had submitted questions to the challenge.

However, the findings reveal that despite the use of the practice, retargeting is complex and its use was not well supported in the organisations. Moreover, managers have limited guidance available as to its use. Such challenges are consistent with the marketing literature which has outlined various similar complexities in retargeting (see for example Lambrecht and Tucker, 2013). Literature shows complexity and challenges associated with the use of the practice. For example, existing research also cautions that despite the long term effectiveness of a retargeting strategy, users who are re-targeted can become bored and disaffected with challenges and refrain from re-engaging with the system (see for example Ghose and Todri-Adamopoulos, 2016). The findings show that the practice was executed largely without guidance or express knowledge from managers as to how or why the practice was to be used.

8C. Identification of potential solution providers (filtering the crowd)

In this section, findings regarding practices in the identification of potential solution providers are examined. The findings revealed that although funding agencies seek to filter and distribute participants to tasks based upon skill and other criteria, a difference exists between the funding agencies use of the practices and those of commercial/philanthropic organisations.

The practices are discussed as follows: identifying participant categories (Section 8C-I) and facilitating self-selection (Section 8C-II).

8C - I. Identifying participant categories

The findings confirm that although funding agencies, like many commercial crowdsourcing initiatives, identify specific categories of participants for assignment to challenges, the practice is applied in a limited manner. Many commercial and philanthropic crowdsourcing initiatives are unrestricted in terms of the types of participants that they seek in heterogeneous crowdsourcing (Geiger et al., 2012; Luo et al., 2014). It was evident from the case studies that demographic and profile information was collected from participants as they joined the call process. This is consistent with the use of the practice in other crowdsourcing systems (Kazai et al., 2012b; Pavlick et al., 2014). The use of the practice by funding agencies is consistent with the literature where research shows crowdsourcing initiatives categorising both skilled and generic crowds in call processes. For instance, research has indicated that scientific challenges of a particular nature do require participants of specific or minimum expertise or skill homogeneity (Brabham, 2010; Tijssen et al., 2002). Research also highlights that many crowdsourcing systems feature the ability to distribute participants to tasks based upon requirements including demographic and other considerations (Brabham, 2010; Jarrett et al., 2015; Kazai et al., 2012b; Pavlick et al., 2014).

However, the findings also show that the use of the practice is limited by the funding agencies restricted approach to categorising participants. For example, the findings show that outside of skilled reviewers and lay participants, agencies have not expended substantial effort in targeting other demographics. For example, young and old, national or international, male and female etc. In particular, managers across both case studies spoke of a desire to be able to access such categorisations of participants who may hold answers to complex challenges. They also spoke of a desire, after the fact, to have obtained greater nuanced detail concerning participants to better facilitate their allocation of future crowds against different types of challenges. This need, is commensurate with research that has shown the importance of gathering detailed demographic data for similar strategic considerations (Martinez and Walton, 2013).

8C - II. Facilitating self-selection

The study confirmed that funding agencies use the practice of self-selection in call processes with varying degrees of reluctance evident as to the use of the practice. In particular, concern was evident from experts and across the case studies of the ability of participants to self-select in funding agency call processes, primarily where scientific skill was required to assess submissions. The use of the practice is consistent with the literature where self-selection for participation is present in key definitions of crowdsourcing and is regarded in many cases as a constituent component (Afuah and Tucci, 2012; Rogstadius et al., 2011).

In both cases, participants were free to participate based on whatever theme or problem most suited their preferences. This stands in contrast to the traditional funding agency approaches of appointing suitably qualified experts or reviewers in call processes (c.f. Harnad, 2000, 2014). In the findings, experts displayed differing attitudes to self-selection with a difference apparent between the crowdsourcing and funding agency experts. In particular, scepticism was evident on the part of funding experts as to the crowd's ability to self-select to complete complex tasks.

Crowdsourcing experts highlighted the desire of organisations to facilitate self-selection where benefits can accrue. Large commercial and philanthropic crowdsourcing initiatives have visibly gained benefits from the ability of the crowds to self-organise and self-select in the completion of complex tasks. For example, self-organisation within ecosystems has been shown to accelerate collective learning processes that underlie certain types of process (see Krancher et al., 2018; Mack and Landau, 2015). However, by contrast, the prospective applications of crowdsourcing in scientific domains does not present as a straightforward practice. For instance, research has shown that an important consideration surrounding self-organisation and self-selection are the roles that members assume within ecosystems and the effects arising from contribution behaviours (see for example, Füller et al., 2014). No evidence is available from the findings that funding agencies address similar considerations in using the practice. This might due to a lack of experience is using similar practices where traditional approaches have favoured expert retention in assessing submissions.

8D. Management of innovation process

The study revealed the use of practices for the management of the innovation process. Issues surrounding the adaption of funding agency management processes to the management practices and more open culture that facilitates crowdsourcing were evident from the findings. In this section, findings regarding practices are examined namely: managing risk (Section 8D-I), training (Section 8D-II), creating a feedback loop (Section 8D-III), educating participants (Section 8D-IV), removing barriers to participation (Section 8D-V) and developing problem portfolios (Section 8D-VI). A summary of the practices used in the management of innovation process are presented in *Table* D at *Appendix* A.

8D - I. Managing risk

The findings revealed that funding agencies engage in the practice of managing risk within call processes. However, the findings also show a significant difference between public funding agencies and commercial crowdsourcing initiatives vis-à-vis attitudes to risk and the practice of risk management. For example, funding agencies seek to mitigate various types of risks in call processes, predominantly related to the maintenance of scientific excellence or the use of platforms. Risks associated with maintaining scientific excellence are mitigated through expert peer review and the ongoing review of projects that have been awarded funding. This is consistent with research which shows that active policing of scientific standards by funding agencies through various means such as peer review and impact assessment (Bornmann and Daniel, 2006; Braun, 1998). A difference was also evident between both groups of experts as to risk tolerance. For example, crowdsourcing experts identified a higher risk tolerance in commercial innovation processes predicated by a desire to tap into novelty. This is consistent to approaches in crowdsourced innovation as opposed to the risk aversion evident in centralised funding systems (Berezin, 1998; Boudreau and Lakhani, 2013). By way of contrast funding experts were fearful of negative consequences arising from crowd engagement. Several participants pointed towards risk aversion in the culture of funding agencies. Research in the public sector has highlighted the challenges in risk acceptance in the public sector(Bozeman and Kingsley, 1998; Buurman et al., 2012).

The use of the practice by funding agencies is consistent with research within information systems governance literature. For example, research highlights governance mechanisms that can assist call process managers in the management of their platforms (for example see Blohm et al., 2018). Also, some evidence has been presented from research of examining risk as it relates to the crowdsourcing process from the business perspective (Kamoun et al., 2015; Nirosh Kannangara and Uguccioni, 2013). Whereas interviewees in both cases addressed the practice of risk management to a limited degree, several interviewees in case B spoke of the substantial resources that had been expended in managing risks associated with the crowdsourcing platform. By contrast, in case A, interviewees described their attempts to balance the management of risk on the project against the resources available to the funding agency. However, the findings show a desire on the part of the agencies to access upside risk in a similar manner to innovation processes where several participants in both case studies described a need to access upside risk.

8D - II. Training

From the findings it was evident that (i) managers express a clear need for crowdsourcing training and (ii) limited guidance was available as to how funding agencies could deploy training practices for crowdsourcing. In particular, the findings highlight that funding agencies, in moving towards crowdsourcing, have not offered substantial consideration to what types of training are required for the management of the process. This need is consistent with the literature where research has highlighted the need for similar types of training (Buettner, 2015; Gadiraju et al., 2015). The findings also revealed that interviewees displayed little knowledge of the means by which to move towards crowdsourcing management structures where some candidates displayed a lack of awareness of the finer points of crowdsourcing. Interviewees confirmed that further learnings in the area of crowdsourcing in open innovation were required from the management perspective in areas such as incentivisation and communication. This is consistent with the literature which shows that organisations must develop scalable approaches for defining self-explanatory tasks the contributors can process independently, allocate tasks to appropriate contributors, and eventually, regulate misbehaviour of contributors (Blohm et al., 2018; Majchrzak and Malhotra, 2013; Saxton et al., 2013). Such approaches fall within the ambit of training required by participants within crowdsourcing ecosystems.

Other related examples are evident as to why the practice is required by funding agencies. For example, technology once institutionalised can become invisible to management and accordingly it is important that management are aware of IT capabilities (see for example Baptista et al., 2010). Also, within the expert systems domain, research has established that actors within the ecosystem, including developers, require additional training to improve people skills (Yoon et al., 1995). A similar argument could also be extended in support of the need for crowdsourcing training. Overall, the findings reveal the concern of managers as to the types of communications and interactions required to engage crowds.

In conjunction with a need for training, there is evidence from managers that practices can be used to integrate open culture into the governance of call processes. Research has examined self-governance within open systems such as Wikipedia where researchers examined how various forces produce and regulate social structures on the site (see for example Forte et al., 2009). Where governance structures are put in place to facilitate an open culture, the open innovation mind-set can facilitate the better operation of public sector platforms (Charalabidis et al., 2014; Loukis et al., 2017; Parker and Bradley, 2000).

8D - III. Creating a feedback loop

Limited evidence was provided from the expert interviews and both case studies of the use of a practice of creating a feedback loop. However, several participants spoke of the prospective utility on offer from the potential use of the practice. It was posited that agencies could utilise practices for creating a feedback loop. For example, both sets of experts identified the need to iterate solutions and inform policy from the outputs of call processes.

The lack of support for this practice from the findings is inconsistent with the literature across domains which strongly support the use of the practice. For example, research addresses the use of iterative process cycles such as those used in agile software development seeking to evoke a form of continuous improvement in processes (Balamurugan et al., 2012; Dingsøyr et al., 2012). Further research has also examined similar iterative processes such as positive feedback models (Baker et al., 2017) and continuous feedback (Krancher et al., 2018).

The participants in both case studies highlighted that funding agencies do not have access to substantial guidance as to the means by which iterative loops can be readily integrated into call processes.

8D - IV. Educating participants

The findings indicate support for the use of the practice of educating participants. For example several funding agency experts specifically highlighted the need to educate participants as to the work of funding agencies and more generally as to science. This need is commensurate with research that suggests that the funding agencies have a role to play in education and teaching programmes that surround science (Handelman et al. 2004). This was strongly confirmed from the data where participants across both cases spoke of the need for active and passive education of participants. For instance, it was evident in Case A that the education of participant was mostly passive while in Case B, significant efforts were made to directly provide public lectures, information sessions and an opportunity to meet the scientists.

The use of the practice is also consistent with the use of the practice by funding agencies in other aspects of education and public engagement (EPE) works (Irwin, 2006; Tetroe, Adily, et al., 2008). Furthermore, the practice of educating participants is also consistent with crowdsourcing research in other domains. For example, Wu states; "*In some software crowdsourcing competitions, organizers are not interested either in the solutions submitted, or in identifying talents, but they are interested in teaching those contestants new knowledge or skillsets via competitions*" (Wu et al., 2013).

The desire to educate participants over and above keeping them simply informed is also consistent with research on technology-mediated learning (TML). TML represents a major trend in education which integrates the strengths of traditional-and IT-based learning activities (Alavi and Leidner, 2001; Söllner et al., 2018). The findings revealed that funding agencies are building capacity in the practice through the area of EPE generally and are attempting to use similar practices in call processes. Crowdsourcing can be used to directly facilitate the learning on the part of stakeholders (Ahmad and Widén, 2018).

8D - V. Removing barriers to participation

The findings show that managers are seeking to make call processes more accessible to diverse participants. Research supports the use of the practice where contemporary crowdsourcing systems also show evidence of the removal of various barriers. For example, in both cases managers described avoiding the use of scientific jargon in call processes. From research it is evident that science communicators and science writers have developed skills and tools for communicating complex concepts to the general public (Brown and Kloser, 2009; Nisbet and Scheufele, 2009). In the findings evidence described the use of social media and video across initiatives for the express purpose of lowering access barriers to diverse types of participants. Such attempts are consistent with research where exemplary forms of crowdsourcing are also using multimedia and non-text based forms of communication to increase access to call processes (Baruch et al., 2016; Zanatta et al., 2017).

It was acknowledged by both sets of experts that funding agencies were aware that certain types of participants in call processes faced difficulties in participation by virtue of a lack of domain specific skills, disability or by virtue of other impediments. The findings show that in the case studies the practice was used in various capacities to enable participation. For example, in both cases the web platforms featured the use of participation technologies to assist both deaf and blind users. The use of the practice is consistent with the research that shows participants can be restricted by virtue of a lack of access to participation technologies, insufficient skills for participation in the entire process, exposure to advertising, dissuasion against participation through conjecture and holding physical and mental disabilities. Specific research has also shown consideration to the removal of barriers to people seeking to access and participate in online systems (Itoko et al., 2014; Newman et al., 2017).

The literature differs from the findings in one aspect where research has addressed barriers in a broader context. For example, the barriers in adopting crowdsourcing in certain contexts including the product innovation domain (see for example Qin et al., 2016). In the findings it was evident that offline participants were largely excluded from the call process in case A. This point is consistent with research that has addressed the issue of the '*digital divide*' and the engagement of offline participants (Brabham, 2009; Hargittai, 2002).

Throughout the research there is also evidence of some questions remaining over the relative success of crowdsourcing due to barriers which in some instances are case or sector specific (Simula, 2013; Simula and Vuori, 2012). It follows that barriers to participation are larger than issues such as disability alone where participants can be hampered by lack of access to the online ecosystem or by virtue of restrictions specific to their industry sector or domain.

8D - VI. Developing problem portfolios

In the findings experts highlighted the importance of the practice in ensuring that organisational goals were categorised and addressed in specific silos across call processes. Evidence was also available, predominantly in one case study, of the agency developing problem portfolios for management purposes. This practice was used where agencies had to ensure coverage of various societal challenges and strategic issues in their programmes.

The use of the practice is also consistent with research where organisations show examples of strategic portfolio management (Alkhatib, 2009; Howard et al., 2012). For example, the literature in the area of portfolio management bears close similarity to funding agencies where for example, Vorvoreanu, (2015), speaks of a general need to understand portfolios broadly in tracking the evolution and impact of ideas. This also coincides with the views of managers across both case studies who spoke of the need for agencies to give consideration to the categories and types of problems facing the general public that are in need of resolution through scientific research.

In case B, call process managers were aware of and spoke of the need to address a broad church or portfolio of challenges and problems through design of call processes. Some discussion of portfolios in commercial crowdsourcing is presented in research where for example, Howard et al. (2012) argues that "*crowdsourcing strategies should be developed alongside both the company's design and development process and their approach to portfolio management*". The findings are also supported by innovation portfolio research (see for example, Klingebiel and Rammer, 2014; Kock and Georg Gemünden, 2016).

However, while research does not shed substantial light on portfolio approaches in crowdsourcing, information systems research has by contrast has long examined the strategic implications of portfolio approaches in areas such as software development and innovation (Cullen et al., 2005), prioritisation considerations (Karhade et al., 2015) and the fit between strategy and resource orchestration (Cui et al., 2017). However, despite the express need to adopt portfolio approaches, limited evidence was provided by study participants of substantial planning used to manage portfolios of problems.

8E. Management of stakeholder relationship

The findings confirm that funding agencies are using new practices for managing stakeholder interactions. For example, engaging diverse stakeholders in in call processes is largely a new departure for funding agencies. This departure coincides with evidence from research regarding the creation of both online and offline social space for stakeholders to interact in crafting solutions to challenges. In this section, the following existing practices are examined namely: moderating participation (Section 8E-I), facilitating communication (Section 8E-II) and compelling participation (Section 8E-III). In addition, two new practices of: creating social space (Section 8E-IV) and facilitating transparency (Section 8E-V) are also examined. A summary of the practices used in the management of the Stakeholder relationship are presented in *Table* E at *Appendix* A.

8E - I. Moderating participation

The findings reveal that although the practice of moderation was used by the funding agencies in managing stakeholder relationships, the use of the practice remains largely passive in call processes. This finding is inconsistent with research that shows substantial and active use of moderation practices in crowdsourcing (Ghosh et al., 2011; Xu et al., 2016). However, from the case studies there is some evidence of call process managers setting or balancing access levels to participants via moderation. Indeed, this finding is consistent with research into online communities and forums where there is evidence of moderators punishing or blocking misbehaviour (Blohm et al., 2018) and regulating access levels to users in online communities (Lampe et al., 2014).

However, the findings also highlights that funding agencies face a specific challenge in moderating participation where no substantial previous use of the practice is described on their part. Although no evidence was presented across both cases of specific instances of misbehaviour, the ability to remove or censure participants within the platform was apparent in case A, as a *pro forma* standard feature included with software. One call process manager in the expert interviews also described a form of moderation in restricting staff visibility of expert reviewer names and contact details. However, several participants highlighted that moderation was not an area with which the agencies held much experience. This could be due to the fact that funding agencies have not traditionally adopted the management of online communities as a core part of their operations.

8E - II. Facilitating communication

The findings confirm the use of the practice of facilitating communication. However, a knowledge gap exists for funding agencies as to how to utilise the new types of communications practices evident in crowdsourcing and other online communities. In this regard, the findings reveal that traditional communication practices used in call processes are substantially different to those used in contemporary crowdsourcing and online communities. For example, where more complex two-way communication systems are required over and above the simple sending of messages to participants.

Crowdsourcing experts expressed the need for various types of communication within call processes in forming community and creating a shared sense of understanding including electronic messaging, face to face engagement and the use of social media. The need for such types of communication are consistent with research which shows that knowledge networks enabled by IT can improve worker performance (for example see Aral et al., 2012). This is also consistent with research into the domains of crowdsourcing and crowdfunding which has shown that platforms can be used to exploit offline pre-existing communities and networks such as those that with expertise in a particular topic or domain (Gleasure, 2015; Gleasure and Feller, 2016). In both cases, participants spoke of failing to fully leverage existing communications practices available. In case A, participants speculated as to why this might have happened but concluded that for whatever underlying reason they failed to maximise their use of communications tools within the network.

For example, the increased use of social media was offered as one potential means for better communication within networks. This is commensurate with research that shows that social media communication is presented as an enabler of crowdsourcing communities (Charalabidis et al., 2012; Gao et al., 2011; Župič, 2013). Participants also highlighted that they were aware of other more dynamic forms of communication such as those used in online gaming but expressed the view that they did not know how to leverage this. Research has highlighted similar tools used in communication systems such as online gaming networks and communities (Massung et al., 2013; Morschheuser et al., 2016; Vilhjálmsson, 2004).

8E - III. Compelling participation

The findings do not support the practice of compelling participation in funding agency call processes. For example, no evidence was advanced by participants in the study as to why or how participants should or could be compelled to participate. Several participants questioned as to whether such a practice could be used. Earlier it was posited that compelled participation could be considered a practice by virtue of employment or reasons of economic duress. Some limited evidence was presented of the use of the practice where funding recipients were compelled to complete outreach works in lieu of receiving funding. However, experts expressed reticence to compel anyone to participate in call processes. In one instance, student participants were believed to have engaged with a crowdsourcing process solely because of a small extrinsic incentive for participation where one manager suspected that their participation was due to economic circumstances. Participants across both case studies expressed a similar reluctance towards the use of the practice preferring to focus on positive reasons to participate.

However, it is difficult to ascertain from the data and the greater body of literature as to whether or not it would be advisable or advantageous to compel (non-volitional actions).

8E - IV. Creating social space

The findings support the need for the practice of creating social space within call processes. However, there is a lack of awareness of the practice on the part of funding agencies as to how this is to be achieved.

Participants across both case studies provided differing levels of evidence regarding the need to grow a community around the work of the funding agencies and more particularly the call process. In particular, several experts highlighted awareness of the need to provide the space to grow and retain participants going forward. This finding is consistent with the crowdsourcing literature that has examined the complimentary resources that exist to employee ties in both online and off-line workplace communications networks (see for example, Zhang and Venkatesh, 2013). Further research has also shown that IT mediated frequent social interactions are effective in promoting knowledge sharing (Prpić, Shukla, et al., 2015; Qureshi et al., 2018).

The findings, particularly from case B, show evidence of the practice of creating social space for crowds to interact where interviewees described the complex matrix of relationships created in both online and off-line spaces inside and outside the organisation for innovation to take place. These findings are consistent with the literature where maintaining social space presents as a form of crowd retention within the digitally enabled environment (Alkhatib, 2009; Dai et al., 2015; Law et al., 2016). However, interviewees in both cases failed to provide any clear evidence of efforts on the part of call process managers to craft online communities despite (i) their desire to do so and (ii) the evidence from research supporting the practice. This may be because of a lack of knowledge as to how to curate online communities on the part of funding agencies.

8E - V. Facilitating transparency

Experts revealed the use of a new practice for facilitating transparency whereby managers altered specific aspects of existing processes to facilitate better crowd oversight. However, by contrast, reluctance was evident on the part of funding agencies where several participants stressed the need for secrecy over some aspects of decision making. The practice of facilitating transparency has long been examined through research. For example, research has examined how ICT can be used to increase transparency (Bertot et al., 2010, 2012) and open innovation/competitive processes (Collins, 2006; Weiber and Kollmann, 1998). However, the contrasting need for secrecy expressed by funding experts in the findings is also supported by research. For example, research shows that hiding the identity of the knowledge seeker or making the individual contributions obsolete faster can improve knowledge sharing and community (see for example Lu et al., 2017). Government agencies in recent years have sought to open the decision making process and provide managers with the option to engage participants in decisions previously made by senior management (Brabham, 2013; Warner, 2011). Research in innovation tournaments has examined visibility over submissions and its effect on success. For example, Wooten and Ulrich, (Wooten and Ulrich, 2013) show that for participants who submit more than once in tournaments, "*those with better prior submissions improve more when they cannot see the work of others*". Such findings show that setting visibility is not a simple choice where other factors can be taken into account in facilitating transparency. It could be argued that the need for transparency is being foisted on funding agencies. Where addressing government, Fairbanks states that the basics to a successful democracy; "*is the existence of a public informed about government actions. This requires government information to be open and accessible to the public*" (Fairbanks et al., 2007). Transparency forms one such aspect of openness towards the public and for this reason, funding agencies may be compelled to open processes.

8F. Assessment filtering of solution submissions

In this section, findings regarding practices in the filtering of solution submissions are examined. However a difference exists between the funding agencies use of the practice and those of advanced commercial and philanthropic crowdsourcing initiatives.

Practices were identified from research such as filtering with electronic tools and managing scale. However, the case studies also highlighted the use of an additional practice of mitigating bias. In this section, research regarding practices as it relates to the following challenges are examined namely: filtering with tools (Section 8F-I), managing scale (Section 8F-II), and mitigating bias (Section 8F-III). A summary of the practices used in the assessment filtering of solution submissions are presented in *Table* F at *Appendix* A.

8F - I. Filtering with tools

The findings confirm a moderate use of the practice of filtering with tools. Furthermore, the means by which submissions are filtered presents as an important task for finding agencies, in particular, a challenge in the future of managing the deluge of data received in call processes. The European Commission sets out a future vision for the greater use of such tools in science and identifies that "*open science opens up the entire research enterprise by using a variety of means and digital tools*" through activities including citizen science (Wilsdon et al., 2017, p. 6). Experts addressed the current use of automation tools in filtering and potential future use of automated or AI based search tools and categorisation facilities in call processes. This use of advanced electronic tools in filtering is consistent with research where research has examined attribute selection and text mining (Bozzon et al., 2015; Burguera et al., 2011; Chou et al., 2010).

Expert interviewees also expressed the view that the practice where applied within crowdsourcing call processes has the potential to greatly increase the quality of the filtering completed by the crowd in advancing solutions. One of the tools identified by participants in case B, was the use of semantic search and automated processes in the analysis submissions received from the crowd. The use of the practice of filtering of submissions with electronic tools is consistent with current research that has examined the use of natural language processing and machine learning in culling, verifying and categorising data received from social media networks (Cobb et al., 2014; Verma et al., 2011). Similarly, research has shown that the use of annotation tools by crowd members can lead to submissions matching the quality of an expert in markets such as MTurk (see for example Park et al., 2012).

Nonetheless, after the initial use of automated and electronic tools failed in case B, the process of categorising submissions was completed by manual groups of participants. It was evident from both sets of experts and participants in the case studies that human filtering will always be required to some extent. Furthermore, findings from the cases also suggests that although electronic tools are in use, this type of automation in crowdsourcing is in its infancy and further development is required.

8F - II. Managing scale

The findings confirm the use of practices by funding agencies in managing scale in call processes. Evidence shows that managers are cognisant of the need to manage scale within call processes in different capacities including the numbers of submissions received and the size of the submissions including application forms/documentation. In the findings experts described the IT challenge envisaged from the outset in managing numerous complex submissions received within call processes. Evidence highlights that call processes present as complex from the administrative perspective with managers completing numerous online and offline activities in the management of large call processes. In particular managers in case B spoke of the receipt of more submissions than were anticipated. The findings indicate that this caused great difficulty for the call process in question where managers contemplated late in the process the use of additional electronic tools in conjunction with cloud computing to deal with the issues posed by scale.

Research shows that with the advent of cloud computing, platforms such as Amazon Mechanical Turk allow workers to operate at scale who are geographically distributed (Corney et al., 2009; Schulze et al., 2011; Wang et al., 2017). However, managers also note that cloud computing is not a universal panacea for all scale problems. For example research in the cloud domain shows that the use of cloud technologies has in some instances stymied systems such as those used in domains such as e-government and software testing (Choo, 2010; Hashemi et al., 2013; Riungu et al., 2010). Although interviewees across both cases did not describe a substantial demand placed upon information technology infrastructure and resources of the crowdsourcing platform, the findings indicate that managers envisage future large-scale crowds could place large demands upon system resources.

8F - III. Mitigating bias

In the findings evidence was provided of the use of the new practice of mitigating bias. Parallels can be draw between the use of this practice and the practice of facilitating transparency (see section 8E-V above). However, whilst the practice of facilitating transparency concerns opening up parts of the process to scrutiny, mitigating bias involves the active use of tools and techniques in filtering to mitigate visible biases in submissions received. The use of the practice is consistent with the crowdsourcing research where, in addressing crowdsourcing for government, Liu, (2017a, p. 662), observes that "*a fair process enhances the legitimacy of participants' contributions*". From research there is also some discussion of various aspects of managing bias in systems (Malone et al., 2011; Payne et al., 2017).

In the findings several participants spoke to the express need to filter for bias with participants in case B describing the means used to identify bias in one set of submissions. In that instance, they identified a group with a political agenda who were seeking to game the system. This highlights that highly motivated intervention groups are generally not representative of the broader population which is consistent with other research (for example see Viswanathan et al., 2004). However, the findings highlight that limited guidance is available as to how to identify bias within crowdsourcing ecosystems. The findings show that from the funding agency perspective, an absence of information exists as to how bias can be managed in particular through the use of electronic tools with participants describing *ad hoc* approaches to searching for bias.

8G. Generation of potential solutions

In this section, findings regarding practices in the generation of potential solutions are examined where the findings confirm that funding agencies use practices for the generation of potential solutions. The practices surrounding the task involve setting a level of abstraction and using various mechanisms in the selection of solutions. Research regarding practices as it relates to the following challenges are examined namely: scoping the solution (Section 8G-I), and selecting solutions (Section 8G-II). A summary of the practices used in the generation of potential solutions are presented in *Table* G at *Appendix* A.

8G - I. Scoping the solution

Similar to the practice of scoping problems (8A-II above), the findings confirm that funding agencies use practices in the scoping of solutions. However, the findings also indicate that funding agencies face a difficult balancing act in managing expert and lay involvement in the scoping process with little by way of guidance available as to how to achieve same. Both case studies confirmed the use of the practice, where both skilled and unskilled crowds were assigned to topics on the basis of their relative skillsets.

Research has also established that aggregated contributions from unskilled crowds can follow close to submissions from experts (Luther et al., 2015). Despite such possibilities in case A, all final decisions as to the solution selected were left to a skilled manager. The findings confirm the strong view of funding agencies that within call processes, where scientific excellence is at issue, the opinion of experts is required in the making of certain decisions. Across both cases expert involvement in the making of decisions was integrated in various capacities. It is evident from crowdsourcing research that efforts have been made to identify and apply the specific skills of crowd members in addressing complex tasks (Ipeirotis and Gabrilovich, 2014; Staffelbach et al., 2015).

The findings present examples of the aggregation and disaggregation of submissions into solutions. Similarly, from contemporary innovation research there are examples of managers amalgamating submissions received into themes (Guinan et al., 2013) and research examined how from multiple selections, a means is necessary by which submissions can be combined (Karger et al., 2011). This is also commensurate with other research that has examined ability of experts to abstract principles in problem-solving (Chi et al., 1981; Vicinanza et al., 1991).

8G - II. Selecting solutions

Similar to the practice of selecting solutions (see 8A-III above), the findings confirm the use of practices for selecting solutions by funding agencies. The findings also highlight the types of challenges associated with selecting solutions, in particular, where agencies sought to achieve a balance in decision making power between lay persons and experts.

This difference of opinion was also evident between both sets of experts where funding agencies showed a greater reticence to allow the crowd either equal voting power or the final say in all instances as with 8A-III above. In case B, greater trust was evident in the crowds ability to make decisions. Various reasons may exist for this including the fact that decisions were being made jointly by lay persons and scientists. The findings confirm the complexity associated with selecting solutions in various capacities. The tensions highlighted may exist because funding agencies are more concerned about the scientific merit of ideas over and above public opinion.

8H. Potential rewards for solution seekers, solution providers, brokers.

In this section, findings regarding practices in the provision of awards are examined. The findings reveal that although funding agencies provide awards and incentivisation a great deal of difference is evident to the practices used in a similar capacity by corporations and philanthropic organisations. For example, funding agencies face specific challenges in motivating crowds to participate in call processes where various restrictions are in place for public sector organisations over payment for participation. In this section, research regarding practices as it relates to the following practices are examined namely: providing extrinsic incentives (Section 8H-I) and appealing to intrinsic motivations (Section 8H-II). Also new practices of fostering coopetition (Section 8H-III) and harnessing indirect advertising (Section 8H-IV) are examined. A summary of the practices used in generation of potential rewards for solution seekers, solution providers, brokers are presented in *Table* H at *Appendix* A.

8H - I. Providing extrinsic incentives

The findings reveal that research funding agencies outside of the provision of funding to applicants provide limited forms of extrinsic incentives to other stakeholders in call processes. This coincides with the fact that a substantial amount of crowdsourcing research has been conducted into extrinsic incentivisation and motivations within crowdsourcing and open innovation more broadly. However, the findings also show that providing extrinsic incentives presents as a complex challenge for funding agencies. Contemporary crowdsourcing research shows that task compensation continues to shape participants continued participation in commercial platforms such as Amazon Mechanical Turk (Alkhatib, 2009; Chen et al., 2011; Deng et al., 2016).

Research has also expressly examined the relationship between extrinsic motivation and successful participants (see for exampleee Mack and Landau, 2015). However, this research stands in contrast to restrictions placed upon many public sector agencies in paying crowds for participation as presented in the findings. In both case studies, call process managers confirmed that restrictions were in place in terms of what extrinsic incentives could be offered to the crowd and that they were aware that this had a limiting effect on their reach and success. Several participants spoke of a desire to use practices such as those used in the private sector for incentivising participation using extrinsic means. Experts highlighted that various strategies are used in the practice of providing extrinsic incentives outside of direct payment for services. For example the findings show that vouchers and smaller prizes have been offered by state agencies to encourage desired demographics to participate. The use of the practice represents a departure from tradition for funding agencies who are used to paying and retaining the services of expert reviewers alone. The findings also highlighted a view held by funding agencies that that any rate, providing extrinsic incentivisation does not necessarily answer all the needs of funding agencies, even where participants were enticed into participation for monetary reasons. This view is similar to positions established in research that money does not always drive performance (Ehrenberg and Bognanno, 1990; Morgan and Wang, 2010).

8H - II. Appealing to intrinsic motivations

The findings show that funding agencies use the practice of appealing to intrinsic motivations in securing crowd participation. However, the findings also show that the use of this practice is a new departure for funding agencies in call processes. Intrinsic motivations form an important part of many not for profit and philanthropic forms of crowdsourcing such as citizen science (Rogstadius et al., 2011; Zheng et al., 2011). Participants across both cases, but predominantly through case B, provided examples of intrinsic motivation from practice. Surprisingly, it was noted that some participants in call processes were angry and felt they should have been paid to participate.

The findings showing the increased reliance upon the practice are consistent with the literature where for the greater part, public sector crowdsourcing initiates are seeking to appeal to intrinsic motivations.

Research into the use of crowdsourcing by governments and the third sector (Brabham, 2013; Heinzelman and Waters, 2010; Hilgers and Ihl, 2010; Koch et al., 2011; Zook et al., 2010) shows evidence of supporting the practice. This corresponds with research that shows support received in crowdsourced scientific initiatives is based upon contributions from citizen scientists where no extrinsic rewards are available (Shirk et al., 2012; Wiggins and Crowston, 2011). The findings and the research are consistent with a mutual desire evident on the part of crowdsourcing initiatives and funding agencies alike to appeal to the altruistic nature of contributors. Research has suggested that for public sector initiatives intrinsic motivation and intangible rewards seem to be enough to motivate many participants (Kaufmann et al., 2011; Royo and Yetano, 2015).

8H - III. Fostering coopetition

Findings confirm, to a limited degree, the presence of a new practice of fostering coopetition where crowd members can compete and collaborate at various parts of the process. However, support from the findings for the practice provided was mostly theoretical in nature with only limited examples evident from the findings. Research has presented that traditional crowdsourcing initiatives seek a vast general crowd where each participant offers a potential simple solution such as in the case of micro-tasks (Dow et al., 2012; Kittur et al., 2008a, 2012). This stands in contrast to the newer types of interaction evident in contemporary crowdsourcing, where the crowd interacts with each other, collaborates and competes to provide better solutions to problems. This type of activity corresponds with the type of interactions evident in online tournaments and gamified crowdsourcing (Glaeser et al., 2016; Morgan and Wang, 2010; Morschheuser et al., 2016). Various combinations of competition and collaboration are evident where other research highlights the use of practices to promote collaboration over contention within systems (see for example Malhotra et al., 2017).

The findings of the limited use of coopetition by funding agencies stands in contrast to recent examples of crowdsourcing from commercial and philanthropic practice. Recent research, has investigated the crowds ability to find motivation from competing and collaborating (Jayanti, 2012; Rusko, 2013). In case B, most of the evidence provided related exclusively to collaboration over competition.

However, in case B, some coopetition was also evident where stakeholders supporting topics competed to have their suggestions represented in the overall solution. Research has examined the complex motivations of crowds in engaging with crowdsourcing where research has shown that crowds are motivated by personal collective and external factors that change over time (Alam and Campbell, 2017; Paulini et al., 2014). The findings indicate that various explanations exist as to why organisations use coopetition and gaming within activities. For example, expert participants described the use of a card game in a crowdsourcing initiative to surface views on a sensitive scientific topic. Benefits from the use of such approaches have been shown to include improving employees motivation and performance (Liu et al., 2013; Schlagwein et al., 2014). The satisfaction derived from competition and collaboration presents as a form of reward for participants and can be fostered by the funding agencies. However, the findings show that despite support for the use of the practice from the literature only a limited use of the practice with funding agencies not holding substantial capacity in the use of the practice.

8H - IV. Harnessing indirect advertising

The findings indicate that funding agencies are cognisant of the practice of harnessing indirect advertising. The use of the practice is consistent with literature which shows the prospective marketing benefits associated with the use of crowdsourcing (Brown, 2019; Whitla, 2015). However, investigations confirmed that funding agencies have yet to build substantial capacity in the use of the practice. The findings indicate that a major challenge is faced by funding agencies in communicating the message of science both passively and actively. Research supports the use of the practice where science faces the major challenge of reaching and informing public opinion in the "post truth" era (Sismondo, 2017; Vernon, 2017). Support for the desire expressed by participants in the findings can be found in the research surrounding scientific outreach. For example, Couvet et al., (2008) states that a "*key asset of citizen science is that participating citizens disseminate the information they gain, thereby increasing the profile of issues being researched*". Many experts and participants were vocal as to the present challenges in achieving a connection with the general public as to science. Commensurate with this was a strong desire to harness viral media and social media used by commercial enterprise and philanthropic organisations.

However, a major challenge is faced in the fact that many fundamental aspects of science are complicated and are only understood by a select community of experts. It can be difficult for funding agencies to sanction public funding for research whose value is not known or understood by the public. In case B numerous attempts were made to harness indirect advertising using TV, local events and internet advertising. Funding agency documentation shows that there are many means to communicate research outside of publication including; "*science festivals, debates, discussions, and consultation with public audiences*" (EPSRC, 2017). The increased reference to such practices in funding agency literature and support documentation including both case studies shows the desire of the funding agencies to harness indirect advertising, even where guidance as to how to achieve this is limited.

8I. Broader socioeconomic impacts (rewards for the marketplace and society

The findings confirm that funding agencies use practices to measure the impacts arising from crowdsourcing call processes. Research supports the increased use of such practices where understanding what to measure forms part of a larger debate in science metrics concerning what to measure (Barnes, 2015; Lane, 2010; Wilsdon et al., 2017). In examining the practices in measuring crowd impact, research supports the existence of the practice of using web and social media metrics. Evidence is also available of support for the two new practices identified of establishing crowd impact metrics and facilitating real-time oversight. In particular evidence is available from expert interviews and case studies of the insufficiency of existing metrics used by funding agencies to measure the broad outcomes of call processes and the associated need for new measures to be created. Research regarding the following practices are examined namely: using web and social media metrics (Section 8I-I), establishing crowd impact metrics (Section 8I-II) and facilitating real-time oversight (Section 8I-III). A summary of the practices used in measuring the broader socioeconomic impacts (rewards for the marketplace and society) are presented in *Table* I at *Appendix* A.

8I - I. Using web and social media metrics

The findings confirm that funding agencies, like commercial crowdsourcing initiatives have resorted to using web and social media metrics to measure the impact of platform performance.

Experts confirmed the substantial use of web and social media metrics in contemporary funding agency call processes. Evidence was also presented across both case studies of initiatives increasingly using web and social media metrics. In both case studies, call managers spoke of the use of web and social media metrics for measuring the success of their platforms. Research supports the use of the practice in various capacities. By way of example, in examining the use of such metrics in the health care promotion domain research has established the suitability of these metrics for measuring participant communication, information dissemination and partnerships (Neiger et al., 2012). Similarly, the use of social media metrics has also extended to the prediction of impact (Eysenbach, 2011; Peters et al., 2013).

Research confirms the suitability of using web and social media aspects for various parts of similar online activities and pursuits. Research has also shown that social media metrics in certain instances can be more effective than standard online behavioural metrics (see for example Luo and Zhang, 2013). The practice identified from the research is supported in both of the cases where the use of social media metrics are evident. However, it was highlighted in the findings that these metrics did not successfully address all aspects of the call that required measurement and that other metrics are required in addition.

8I - II. Establishing crowd impact metrics

The findings support the need for a new practice of establishing crowd impact metrics for funding agency call processes. Both sets of experts cited the need for specific metrics to measure the impact of crowd involvement in funding agency call processes. However, crowdsourcing experts highlighted (i) the challenge faced in identifying what constitutes impact and (ii) no instances of the creation of impact metrics were cited across both case studies. In addition, funding experts observed that funding agencies hold a substantial number of metrics for impact arising from funded research. However, experts suggested that few of these bear application to the use of crowdsourcing in funding agency call processes. Similarly, across both case studies there was evidence to support the need for the practice without specific examples presented. The need for the practice identified from the findings is supported from research.

For example, crowdsourcing research has called for the creation of specific and suitable metrics for processes (Aroyo and Welty, 2013; Buchholz and Latorre, 2011; Ranard et al., 2014). For example for the purpose of ranking the performance of web based crowdsourcing workers (Wang et al., 2017; Whiting et al., 2017). Also, research has identified proxy metrics in crowdsourcing covering performance aspects such as the reputation of participants (Allahbakhsh et al., 2012; Whiting et al., 2017). Open innovation projects have also used similar types of metrics that are appropriate in terms of measuring aspects of industrial technologies (Erkens et al., 2012; Michelino et al., 2015).

Several participants highlighted the difficulty involved in measuring impact and deciding what impact means for funding agencies. However, research has examined the creation of other types of metrics that may be applicable to measuring crowdsourcing success (Walter and Back, 2009). Also, by way of example, in one initiative regarding the public use of defibrillators, impact metrics were constructed covering "participation demographics" and "motivations for participation" (Merchant et al., 2014). Other research has examined metrics for performance that are used in a broad number of domains such as e-commerce success, design and security (Delone and Mclean, 2004; Palmer, 2002; Swanson et al., 2003). Research was previously presented that addressed the similar challenge of measuring innovation outcomes in similar 'input, process, output' style processes (Erkens et al., 2012; Manoochehri, 2010). Although managers expressed a need for new metrics, no evidence was presented of attempts to design new metrics to measure crowd impact across both cases.

8I - III. Facilitating real-time oversight

The findings provide only limited support for the facilitation of real-time analytics oversight in call processes. Participants described the use of analytics features built int both platforms that were limited in scope. Several participants also spoke of a desire to use the practice driven by knowledge of similar approaches used in other domains. The lack of evidence stands in contrast to research on contemporary web and social media platforms that presents the desire of managers to integrate dashboard reporting to visualise metrics and progress (see for example Fan and Gordon, 2014).

Facilitating real-time oversight presents as a contemporary focus in research where the real-time mapping of crowdsourcing performance and the design of crowdsourcing metrics has been identified as an area in need of progress in research (Frigerio et al., 2017; Gao et al., 2011). The desire for real-time oversight is commensurate with the popularity and push towards the use of analytics in management information systems. Accordingly, the discussion of the need for real-time oversight could be as a result of funding agency mangers exposure to other industry trends over and above a pressing need for real-time oversight.

Managers in case A, confirmed that a pro-forma dashboard accompanied the open source platform used, however it was acknowledged that it was limited in terms of the information and insights provided. This dashboard was combined with other social media metrics available from the different platforms used. In case B, participants spoke of the limited dashboard reporting available and that better insights were required in future. Evidence from research supports the prospective benefit arising from the practice of providing dashboard oversight of performance in call processes.

8.2. Summary

The discussion and observations in respect of the practices above (Sections A - I) are compared and contrasted against the data and research presented in previous chapters (see *Tables* 8A – 8I at *Appendix* A). In the next chapter (Chapter 9), the contributions arising from the research and recommendations for future research are presented.

Chapter 9. Conclusion

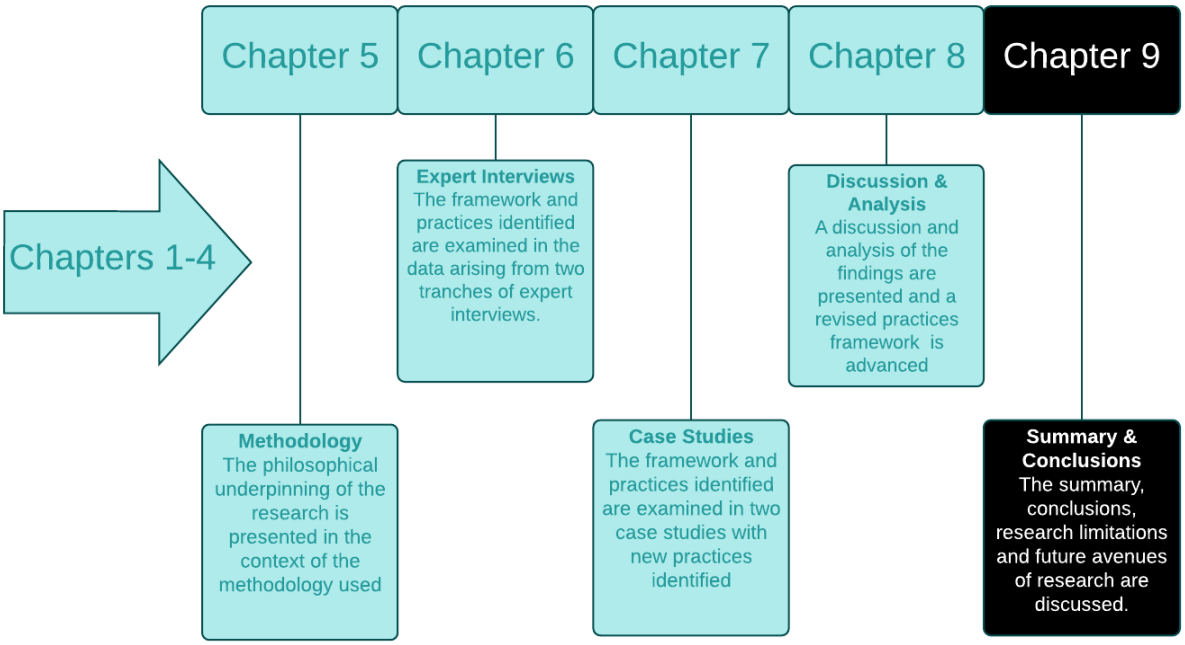


Figure 9.1 - Chapter structure - Chapter 9

9.1. Introduction

In Chapter 1, it was highlighted that by virtue of the push towards open science, public research funding agencies are increasingly under pressure to increase transparency over processes while at the same time engaging and informing diverse stakeholders. Research has shown that public research funding agencies have turned towards the use of crowdsourcing in call processes. In conclusion, this chapter reflects upon the contributions to research and practice arising from this study over the previous chapters (see *Fig.* 9.1 above). After the introduction (Section 9.1), a review of the research objectives is completed (Section 9.2). Subsequently, an examination of the contributions made to both research and practice are presented (Section 9.3). Thereafter, recommendations for science policy arising from the research are advanced (Section 9.4). Last, the chapter concludes with the limitations of the study and considerations for future research (Section 9.5).

9.2. Review of the research objectives

The means by which the research objectives are addressed is now presented (see RO1.1 – RO1.2 and RO2, RO2.1 - RO2.3). As presented in Chapter 1, (Section 1.6), research has explicitly called for further investigations in the crowdsourcing domain (Alam and Campbell, 2013a; Majchrzak and Malhotra, 2013; Marjanovic et al., 2012; Saxton et al., 2013; Zhao and Zhu, 2012).

This study presents an adapted crowdsourcing practices framework, in response to calls for further research in the domain. In particular, where limited guidance is available from research for funding agencies as to the use of crowdsourcing in call processes. An interpretivist approach was adopted featuring (i) expert interviews with funding agency and crowdsourcing experts and (ii) two case studies with two research funding agencies. This research identifies that crowdsourcing practices are available for use by funding agencies in addressing challenges.

RO1.1 To explore the crowdsourcing research and identify key the practices that form part of the crowdsourcing process.

The crowdsourcing literature was examined and the practices that form part of the crowdsourcing process were identified. Also, a suitable definition for crowdsourcing was identified.

RO1.2 To select and adapt a crowdsourcing practices framework for public research funding agency call processes.

Through these evaluation criteria the Marjanovic et al., (2012) framework was identified in Chapter 3, (Section 3.4) for the purposes of adaption to funding agency call processes. Many of the competing crowdsourcing frameworks examined displayed a lack of applicability to public research funding call processes and the types of tasks completed. The Marjanovic et al., (2012) framework was subsequently adapted to contain thirty-two categories of crowdsourcing practices, (thirteen new), under the nine tasks delineated in the framework of Marjanovic et al., (2012) (see Chapter 6, Fig. 6.2). This objective was completed so as to provide a foundation for the examination of the use of crowdsourcing by funding agencies in call processes.

RO2. To apply the framework as a lens to public research funding agency call processes in:

RO2.1 highlighting challenges faced

The crowdsourcing framework identified in Chapter 3 was applied as a lens to funding agency call processes in Chapter 4 in highlighting challenges faced by funding agencies. As outlined in Chapter 4, (Section 4.4), funding agencies seeking to use crowdsourcing in call processes face numerous challenges. The framework was used to contextualise the types of challenges faced within the stages of the framework. This objective was completed so as to highlight potential challenges for funding agencies and to inform call process managers.

RO2.2 examining crowdsourcing practices used

Crowdsourcing practices identified from the literature in Chapter 3 were compiled within the framework. The crowdsourcing framework was applied as a lens to examine the use of crowdsourcing practices first, through expert interviews (Chapter 6) and second, through two case studies (Chapter 7).

RO2.3 identifying new crowdsourcing practices

When the crowdsourcing framework was applied as a lens in Chapter 6, thirteen new crowdsourcing practices for use by the funding agencies in call processes were identified. These practices were added to the framework subsequently applied in Chapter 7 to two case studies.

In the next section, (Section 9.3) a review of the contributions of the study is presented.

9.3. Contributions of the study

In Chapter 1, (Section 1.6), the rationale for the study was presented. Following from the research objectives, the framework presented herein is a first of a kind. To the best of my knowledge no other similar crowdsourcing framework is in existence for use by the funding agencies.

This study makes contributions to research/theory and practice and discussed in the subsequent sections (see Sub-section 9.3.1 – Sub-section 9.3.2 below.

9.3.1. Contributions to research & practice

This study makes a contribution to practice by advancing a first-of-a-kind crowdsourcing framework for use by public research funding agencies. This research has shown that existing frameworks in use are not bespoke and not fit for addressing the unique types of challenges faced by public research funding agencies. As such public research funding agencies play a critical role in driving research, innovation and societal change, it follows that crowdsourcing practices used in the management of their call processes require closer scrutiny. The adapted Marjanovic et al., (2012) framework provides practical guidance for call process managers on where and how stakeholders can be engaged in the crowdsourcing process and the types of challenges that can be addressed. In particular the following thirteen new practices were identified and examined in the context of two case studies;

A-IV Aligning with Strategy, B-II Integrating advertising channels, B-III Retargeting previous participants, D-IV educating participants, D-V Removing barriers to participation, D-VI Developing problem portfolios, E-IV Creating social space, E-V Facilitating transparency, F-III Mitigating bias, H-III Fostering coopetition, H-IV Harnessing indirect advertising, I-II Establishing crowd impact metrics, I-III Facilitating real-time oversight

This study has also made a further contribution to practice where a limited body of research addresses the involvement of diverse stakeholders in funding agency call processes. This study has made a significant contribution in addressing this gap through examining the literature on funding agency call processes, highlighting challenges faced and advancing science policy based actions to support the use of crowdsourcing in public funding agency call processes (see Section 9.4 hereafter). This study highlighted tensions in existence between competing crowdsourcing definitions and frameworks through comparing and contrasting the extant crowdsourcing literature. This study contextualises crowdsourcing practices within a process framework. In response to calls for further research in the crowdsourcing domain (see for example Geiger, Rosemann, et al., 2011; Majchrzak and Malhotra, 2013; Marjanovic et al., 2012; Saxton et al., 2013) this research has utilised theory to inform the process of selecting and adapting a crowdsourcing framework for use by public research funding agencies.

The study presents a qualitative approach to examining the crowdsourcing phenomenon which may be used in the future by researchers. A contribution to the body of knowledge surrounding research methods is advanced whereby a combination of expert interviews and case studies were used in this research. This combination is not an approach that is widely used in the information systems literature at present.

Several publications, as listed in the introduction of Chapter 1, have also arisen from this research and have been presented at workshops and conferences. These present as a specific contribution to research in the crowdsourcing domain. While this study does not provide the means by which expert and lay contributions can be balanced, it does offer insight into the practices through which diverse crowds can participate in the decision-making process. The study provides insights for practitioners seeking new means to engage the general public and other stakeholders in call processes. Research shows that the practices can be used for the provision of active and passive education through call processes. This study has also shown a means by which the core strategic objective of actively and passively educating crowds can be achieved through the use of crowdsourcing practices.

9.4. Recommendations for science policy

The next steps of the research will involve the preparation of the research for publication in select science and research policy journals where the research in question is specifically aimed at public scientific research funding agencies. It is anticipated that within the near future will be an opportunity to pilot the study where two funding agencies, have offered previously to pilot the framework arising from this study. In Chapter 8, the practices within the framework were compared across the expert interviews, case studies and contemporary literature. The recommendations for funding agencies below (Sections 9A-9I) are advanced from this research.

9A. Problem definition and specification

In defining and specifying problems, public research funding agencies may consider how:

- problems/challenges can be broken up so as to make them more accessible to the crowd;
- decision making mechanisms can be balanced and distributed between skilled and non-skilled participants so that the voice of the stakeholders can be incorporated into the process while maintaining scientific excellence;
- strategic considerations important to the organisation and stakeholders can be integrated into public research funding agency call processes.

Table 9.1- Considerations for funding agencies in problem definition and specification

Practices	Opportunities	Desired outcomes
9A-I Restricting submissions	To standardise submission formats in call processes through limiting what and how the crowd can submit	To serves the dual purpose of reducing confusion for participants in terms of what to submit but also makes the process of assessing submissions easier, with standardised submissions.
9A-II Scoping problems	To invest resources and time in setting the information and granularity surrounding the problem from the start so as to leverage expert and lay participants in selecting better problems	To foster a better relationship between stakeholders so as to include public voice in the scoping process whilst maintain scientific excellence
9A-III Selecting problems	To devise strategies around weighted voting at different stages of the process depending on the skill requirement and stakeholder interest in tasks.	To provide all stakeholders with the opportunity participate in the decision making process whilst providing scientific input in decisions
9A-IV Aligning with strategy	To give consideration as what are the agencies overriding strategic concerns and how these can be balanced with the needs of the crowd	To connect the strategic needs of the funding agency with the public need for research

A summary of the associated opportunities is presented above (*Table* 9.1). Funding agencies could consider breaking up problems into different levels of granularity so as to make them accessible to different skillsets within the crowd. While this research does not specifically resolve the problem of what level of abstraction to set a problem at, it does highlight that agencies may consider the quality and type of information provided to participants where abstracting a problem.

Funding agencies might also consider exploring the use of weighted approaches in voting and decision making mechanisms. Although crowdsourcing has been shown to have strategic considerations and applications, little by way of consideration has been afforded from research as to how funding agencies could use crowdsourcing to achieve strategic objectives. An opportunity exists for funding agencies to investigate the strategic applications of crowdsourcing in future research.

9B. Advertisement of innovation challenge

In targeting crowds in the advertisement of the innovation challenge, public research funding agencies may consider how to:

- manage online and offline advertising channels to target desired participants;
- access online and offline stakeholders and existing communities;
- advertise throughout call process and retarget participants between call processes.

Table 9.2 - Recommendations for funding agencies in the advertisement of the innovation challenge

Practices	Opportunities	Desired outcomes
9B-I - Targeting participants	To move beyond the deliberate targeting of specific participants and seek diverse crowds who can provide novelty	To enable novelty that provides the basis for creating a diverse community surrounding a call process.
9B-II - Integrating advertising channels	To coordinate and manage advertising channels in a strategic manner where existing approaches are incompatible with new open processes	To maximise the leverage available across advertising channels so as to increase the strategic reach of funding agencies and awareness of research
9B-III - Retargeting previous participants	To retarget and reengage participants in ecosystems as a part of a community building strategy	To transition towards building and retaining communities, unlike existing review processes where reviewers and stakeholders are engaged on an *ad hoc* basis

A summary of the associated opportunities is presented above (*Table* 9.2). From crowdsourcing research and the observations of crowdsourcing experts it is apparent that the approaches to advertising in crowdsourcing call processes differ to those of traditional funding agency call processes. Contemporary advertising practices such as those used in crowdsourcing present funding agencies with an opportunity to capture not only crowds of a given skill but also generic crowds and crowds that meet certain demographic requirements.

It follows that call process managers may consider how to attain greater reach in their online and offline advertising channels to attain skill sets necessary for the completion of challenges. Research shows the use of both online and off-line advertising approaches in maximising access to diverse demographics and skill sets. Funding agencies could also adopt strategic approaches to the management of integrated advertising channels for the purposes of maximising crowd participation.

9C. Identification of potential solution providers

In the identification of potential solution providers funding agencies may consider how to:

- gather and filter skill and demographic data from stakeholders up-front;
- identify and categorise stakeholders with appropriate skills;
- identify and categorise stakeholders meeting desired demographic criteria;
- enable stakeholders to self-select for the completion of tasks appropriate to their skill sets/interests.

A summary of the associated opportunities is presented below (*Table* 9.3). Research has also shown that participants from outside the main research domain can provide novel solutions. Accordingly, funding agencies hold the opportunity to explore how participant categorisation and self-selection can be facilitated in an environment where specific skills can be required in the assessment of scientific research. In particular, where evidence points to various potential benefits arising from self-selection and self-organisation within crowdsourcing ecosystems.

Accordingly, funding agencies may consider what roles participants fulfil in self-selecting to complete tasks. In particular, those that are complex in nature or require scientific expertise. Funding agencies could also examine present practices used for matching participants or categories of participants to challenges. In balancing participation funding agencies could harness the full effect arising from expertise and diversity in the system thereby obtaining novelty. Through the use of the practice funding agencies can identify, up-front, the characteristics of solution providers so as to ensure fair representation across desired demographics.

Table 9.3 - Recommendations for funding agencies in the identification of potential solution providers (filtering the crowd)

Practices	Opportunities	Desired outcomes
9C-I Identifying participant categories	To categorise participants early in the process based on various criteria covering skill, disciplines and demographics	Retaining categorisations of participants can facilitate funding agencies in distributing bespoke crowds to different tasks at different stages of the process
9C-II Facilitating self-selection	To incorporate various checks and balances to assess participant skill so as to facilitate self-selection in call processes	Such checks could assist the maintenance of scientific excellence while facilitating participant involvement

9D. Management of innovation process

In the management of the innovation process funding agencies may consider how to:

- access upside risk and mitigate downside risk;
- provide training appropriate to the different types of stakeholders in the process;
- leverage iterative process cycles;
- educate participants as to research and the work of funding agencies;
- lower or remove barriers to participation for certain types of participants.

Across the expert interviews and case studies it was apparent from the crowdsourcing perspective that funding agencies have an opportunity to change approaches to the management of call processes (see *Table* 9.4 above). Research suggests that existing funding agency structures are hierarchical in nature and different to those in use within open innovation or crowdsourcing processes. This study also shows that crowdsourcing initiatives and funding agencies hold different perspectives on risk. Funding agencies, like crowdsourcing initiatives could leverage crowdsourcing to access upside risk. Funding agencies may explore the use of iterative or cyclical processes similar to those used in software development, design science and other domains. Research suggests the need for organisations to adopt the use of training for the management of crowdsourcing processes. Funding agencies also have the opportunity to develop new skills and capabilities around educating participants and removing barriers to participation for various types of participants.

Last, the research also shows that agencies could follow industry in developing portfolios of problems and challenges in line with strategic objectives.

Table 9.4 - Recommendations for funding agencies in the management of innovation process

Practices	Opportunities	Desired outcomes
9D-1 Managing risk	To implement practices for managing downside risk and accessing potential upside risk	To access potential novelty from risky science whilst removing downside risks in call process
9D-IITraining	To provide training specifically focused upon crowdsourcing processes and the use of crowdsourcing for managers and participants	To improve the quality of contributions and interactions in crowdsourcing call processes
9D-III Creating a feedback loop	To integrate iterative or cyclical stages in crowdsourcing process stages to improve the quality of submissions	Similar to agile software development and design science research to improve iteratively the quality of submissions/decisions
9D-IV Educating participants	To educate stakeholders as to the work of funding agencies and the scope of the research that is being funded	To create an informed participative society and create communities around call processes
0D-V Removing barriers to participation	To identify and remove barriers to participation that are present in the call process and/or mitigate their effect	To facilitate a more diverse and inclusive ecosystem surrounding the call process and access novelty
9D-VI Developing problem portfolios	To strategically manage the types of scientific problems and societal problems they are trying to address	To enable funding agencies to measure progress and compare performance across project portfolios

9E. Management of stakeholder relationship

In the management of the stakeholder relationship funding agencies may consider:

- training moderators/leveraging the use of moderation in call processes;
- improving the nature and type of communication in call processes through professional assistance from science communication experts;
- creating a social space to enable both internal/external, online/offline interaction;
- facilitating greater transparency over call processes even where some aspects are kept from public view.

A summary of the associated opportunities is presented below (*Table* 9.5). Research shows that through crowdsourcing, funding agencies could potentially access different types of stakeholders over and above the traditional peer reviewers.

The study shows that funding agencies could also, similar to commercial crowdsourcing practice, adopt the use of moderators in call processes. In particular, where experts highlight the prospective use of the practice. This study shows that moderators provide management, clarification and guidance that can assist stakeholders. Funding agencies also hold an opportunity to facilitate communication practices for building community around call processes and stimulating stakeholder engagement. Research shows evidence of funding agencies retaining communications specialists and science writers for the purposes of translating complex research into a more digestible format for citizens. Both the tools for communication and the means by which communication is provided such as social media presents as an important opportunity for funding agencies.

Several agencies described using partnerships with other government agencies in the operation of specific calls processes. Funding agencies, like crowdsourcing initiatives can consider how a social space can be created through which stakeholders can interact. Research also supports the position that in transparent open call processes participants are empowered to make innovative changes and selections which stands in stark contrast to the often secretive nature of selections made in agency call processes. Agencies can give consideration as to how transparency can be facilitated in call processes.

Table 9.5 - Recommendations for funding agencies in the management of the stakeholder relationship

Practices	Opportunities	Desired outcomes
9E-I Moderating participation	To give consideration to what constitutes moderation within call processes and as to how it can best be applied	Moderation and facilitation in managing crowd interactions and submissions in call processes
9E-II Facilitating communication	To move away from one-way towards two-way communications channels in enabling the crowd to interact in crafting solutions	To enable the dynamic forms of interaction and communication visible in leading crowdsourcing communities
9E-III Compelling participation	Funding agencies could compel funding applicants to participate in call processes	To increase the profile of the agency, the profile of research generally and increase participation
9E-IV Creating social space	To create a sustainable social space both online and offline where participants can interact and craft solutions	To foster and maintain a long term ecosystem within which stakeholders can interact
9E-V Facilitating transparency	To provide transparency for participants over the process and procedures	To facilitate communication, openness and trust in the growth of crowdsourcing for research funding agencies.

9F. Assessment/filtering solution submissions

In the assessment and filtering of solutions funding agencies may consider:

- using electronic tools such as search function and semantic analysis in filtering submissions;
- leveraging cloud computing in facilitating scale;
- applying machine learning and AI techniques to funding agency data sets;
- using electronic tools in identifying/mitigating biases within submissions received.

A summary of the associated opportunities is presented below (*Table* 9.6). In this instance, it is envisaged that technologies could assist the crowd in aspects of call processes. Accordingly, funding agencies can make provision for the management of scale in call processes. Funding agencies can consider the use of various electronic tools in the identification of potential biases in the design of call processes. While traditional peer review processes use predominantly human skills for filtering submissions, the research has identified that various electronic tools and systems are currently used to assist in the filtering process.

While technology at this point in time does not purport to replace the role of peer reviewers, research shows that technology can assist in similar innovation call processes. In particular, evidence shows the substantial use of technology in crowdsourcing to assist the crowd. By contrast, the research shows some limited use of technology by the funding agencies with room available for expansion. A case is made from the evidence available for agencies to consider the use of cloud computing and semantic search technologies to assist in the assessment/filtering of solutions. The research highlights that in the future, processes such as machine learning and AI may assist in call processes. Both sets of case studies and many contemporary crowdsourcing platforms already feature the use of some electronic tools to categorise submissions and assist with the selection of winning solutions.

Table 9.6 - Recommendations for funding agencies in the assessment/filtering of solution submissions

Practices	Opportunities	Desired outcomes
9F-I Filtering with tools	To use advanced electronic tools similar to those in use in crowdsourcing and other open innovation systems	To improve process efficiency and present funding agencies with the opportunity to learn from the data/develop new processes
9F-II Managing scale	To use cloud computing to manage scale and complexity present in call processes	To provision extra resources in reserve to cater for larger and more complex crowd participation where required
9F-III Mitigating bias	To ensure that checks and balances are installed in call processes to mitigate or remove unwanted biases	To remove unwanted biases which may lead to a loss of trust in funding agency call processes

9G. Generation of potential solutions

In the generation of potential solutions funding agencies may consider:

- enabling the crowd to aggregate and disaggregate submissions into solutions;
- providing decision making mechanisms can be balanced and distributed between skilled and non-skilled participants so that the voice of the stakeholders can be incorporated into the process;
- providing tools for scoping and selecting solutions over various stages of the process.

A summary of the associated opportunities is presented below (*Table* 9.7). Funding agencies can provide practices for involving crowds of skilled experts an laypersons in scoping solutions. There is evidence that some crowdsourcing processes provide a means for enabling weighted voting or selection, where the votes of one participant are given priority or greater weight than other participants. From research on open innovation and crowdsourcing it is evident that the practices that facilitate the shaping the problem at the start of the process can also be used in the selection or amalgamation of solutions at the end of the process. Furthermore, from crowdsourcing research it is also evident that crowds can be provided with a means to aggregate or disaggregate submissions into solutions. Similarly, at this stage of the process, funding agencies can consider the use of practices to integrate the voice of the crowd into the selection of solutions without running the risk of a dilution in scientific excellence in the selection process.

Table 9.7 - Recommendations for funding agencies in the generation of potential solutions

Practices	Opportunities	Desired outcomes
9G-I Scoping the solution	To consider how to involve stakeholders in scoping the solution and show consideration for how submissions can be amalgamated or disaggregated	To harness the power of the crowd to amalgamate or disaggregate submissions into better solutions through stakeholder involvement
9G-II Selecting solutions	To apply different voting weights amongst participants based upon skill and other criteria	To facilitate a fairer distribution of voting rights based upon skillsets and other considerations

9H. Potential rewards for solution seekers, solution providers, brokers

In the use of practices for providing potential rewards for solution seekers, solution providers, and brokers, funding agencies may consider:

- providing different types of extrinsic rewards to stakeholders;
- using intrinsic motivations to foster and retain community;
- fostering coopetition through the promotion of competition and collaboration;
- leveraging community communication and interactions as a form of indirect advertising for stakeholders.

A summary of the associated opportunities is presented below (*Table* 9.8). Evidence suggests that little by way of barriers are faced in funding agencies deploying extrinsic incentivisation in calls. It follows that funding agencies should consider offering certain types of extrinsic incentives for participation in certain instances. Research suggests that appealing to intrinsic motivations will always for a major part of the motivation practices used by funding agencies. However, opportunities exist to use the practice in conjunction with other forms of rewards for participation. It follows that the modern funding agency could leverage the practice of coopetition to entice participation in call processes similar to the use of the practice in gamified crowdsourcing. The study also highlights that despite some reluctance o the part of managers opportunities also exist to harness indirect advertising. Overall, practices are evident from research where both intrinsic and extrinsic motivations are used concurrently in crowdsourcing initiatives. Also, research shows that crowds do not participate solely for monetary reasons. For example, Borst notes that "*a mix of intrinsic and extrinsic motives determines the participation of online volunteers including peer recognition, satisfying own needs and pro social motivations*" (Borst, 2010). It follows that opportunities exist for funding agencies to use mixes of such incentivisation practices in call processes.

Table 9.8 - Recommendations for funding agencies in potential rewards for solution seekers, solution providers, brokers

Practices	Opportunities	Desired outcomes
9H-I Providing extrinsic incentives	To consider what funding agencies can offer participants even where monetary payment is not always an option	To motivate and incentivise demographics not traditionally attracted to participation in call processes
9H-II Appealing to intrinsic motivations	To give careful consideration as to how intrinsic motivations are leveraged through planning in call processes	To motivate and incentivise participants to engage in call processes
9H-III Fostering coopetition	To leveraging coopetition practices such as those used in innovation tournaments to enthuse participants in supporting a call process	To enable a different kind of incentivisation, not traditionally used by funding agencies but evident in the commercial sector
9H-IV Harnessing indirect advertising	To increase marketing reach by leveraging the viral nature of call processes and crowd participation	To increase crowd participation and grow stakeholder interest in call processes

9I. Broader socioeconomic impacts (rewards for the marketplace and society)

In the use of practices for examining broader socio-economic impacts, funding agencies funding agencies may consider:

- identifying and using real-impact metrics over and above vanity metrics;
- seeking out suitable proxy metrics, where real impact is measured over longer time periods;
- developing and use educational and outreach related metrics from a crowd participation perspective;
- improving processes through the use of real-time oversight via metrics and dashboards.

A summary of the associated opportunities is presented below (*Table* 9.9). Research shows that funding agencies have yet to establish what metrics best reflect crowdsourcing impact. Some evidence was available from crowdsourcing experts in Chapter 6 and case study participants in Chapter 7 that new forms of measures are evident in call processes. The absence of metrics available for the measure the impact arising from the use of crowdsourcing has been highlighted in both case studies. However, funding agencies hold a substantial amount of experience in developing metrics for measuring research impact and performance.

Accordingly, opportunities may exist to create new metrics aligned with the strategic goals of funding agencies. In the interim, metrics from other related domains where crowdsourcing is used could be also be leveraged as is evidenced in both case studies.

Table 9.9 - Recommendations for funding agencies in broader socioeconomic impacts (rewards for the marketplace and society)

Practices	Opportunities	Desired outcomes
9I-I Using web and social media metrics	To leverage contemporary web and social media metrics in evaluating crowdsourcing platform performance	To better evaluate/measure platform performance so that platforms and processes can be improved
9I-II Establishing crowd impact metrics	To evaluate what types of impact they are seeking to achieve through the use of crowdsourcing and assign associated metrics for measuring impact	To measure other aspects of crowdsourcing performance that may be new antecedents to impact or improved performance
9I-III Facilitating real-time oversight	To use analytics packages including various dashboard visualisations in measuring real-time performance in call processes similar to those used in crowdsourcing systems	Evidence has identified that on occasion call process managers need to change or adapt certain tasks in call processes based upon unforeseen or unexpected changes or events

9.5. Limitations of the study & future research

This research faces several immediate limitations related to the prospective use of crowdsourcing by public research funding agencies.

From the outset, the framework of Marjanovic et al, (2012) was utilised as a lens in examining the data from both the expert interviews and case studies. Although this research would argue that this framework is appropriate under the circumstances for examining the data in question, it is foreseeable that future research could utilise a different type of crowdsourcing framework.

Due to the exploratory nature of the research in question the framework offered from this study is broad in nature and operates at a high level of abstraction. Future deeper examinations of the framework might result in the application of practices from one stage of the process, at a different process stage, or, in different domains.

Due to the nature of the setup of the research project and its associated funding it was not possible to consider other rival processes to crowdsourcing as alternatives. Accordingly, this research does not seek to present crowdsourcing a universal panacea to all the needs of the public research funding agency.

This research represents an early step in the examination of the application of crowdsourcing in public research funding agency call processes. Also, This adapted framework is not presented as a holistic solution to the needs of every type of funding agency, including commercial foundations, by virtue of the fact that there are many different types of call processes offered by many different types of research agencies. Accordingly, the research at the centre of this study applies to a limited category of funding agencies and call processes highlighted in Chapter 4.

As presented at *Table* 9.9 above, this study shows that funding agencies have yet to establish what are the best metrics through which crowdsourcing impact can be measured. Future research may examine classes of metrics under the practices identified in this study.

The unit of analysis selected in this instance was the call process, however, subsequent reflections on the research might lead to a call process management team being or a member of the public being selected as the appropriate unit of analysis. The research in question has taken cognisance of the fact that many existing call processes are designed by experts. Accordingly, the voice of the citizen or other diverse stakeholders has not been incorporated into the findings arising from this research. By way of example, this research does not examine the prospective use of independent crowdsourcing brokerages by agencies such as Mechanical Turk over and above the use of in-house platforms by funding agencies. Accordingly, further research could also potentially examine the fit of the framework to the processes used by such actors.

Various models for public participation in scientific research outside of crowdsourcing have been identified where existing models facilitate participation in varying degrees "*by altering the amount of control that participants have over the different steps*" (Bonney et al., 2009). It follows that crowdsourcing is not the only way to solve challenges, however due to research constraints, it is not possible to examine all the alternatives.

There are several immediate avenues for future research highlighted from this study that can be explored:

- an examination of the tension between the need for scientific excellence and the desire to involve diverse stakeholders;
- the future balancing of artificial intelligence and human stakeholders in decision making within call processes;
- an exploration of the issues associated with the competing needs of managing risk and accessing novelty in call processes;
- an examination of the effects of different types of incentives on process outcomes

Future research may seek to incorporate further case studies. Whereas theoretical saturation was reached across both cases, the author has noted that further case studies are likely to become available in the future as more funding agencies move towards crowdsourcing. Also, a longitudinal study many be completed with both of the agencies examined in this research where an avenue to future investigations has been left open by both agencies. Various types of quantitative research approaches to confirm constructs within the framework were considered but did not present as appropriate approaches within this research at this juncture. This was due to the lack of a large number of contributors or large data sets. However, in the future research, statistical based methods and alternative methodological approaches such as surveys could be used.

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Appendix A – Summary Tables from Chapter 8

A	**Problem definition and specification**	**Practices - Ch 3**	**Challenges - Ch 4**	**Experts - Ch 6**	**Case Studies - Ch 7**	**Discussion – Ch 8**
A-I	***Restricting submissions***	Crowdsourcing literature shows reference to attempts to limit how and what crowds can submit in call processes with a view towards improving the quality of submissions received	Evidence exists of a challenge on the part of funding agencies in deciding upon what submission format to use in call processes or what submission restrictions to include	Experts provide evidence of restriction in call processes, if somewhat inadvertently arising from limitations in platforms. Despite this experts expressed a need for the practice to provide homogeneity.	Some limited use of the practice was evident where across the submission systems used in both cases participants were limited to one submission format online, however, they could provide whatever text submissions they desired	Evidence from the findings shows that the funding agencies are not actively using practices to restrict submissions and do not have guidance available as to how to standardise submission formats without restricting novelty
A-II	***Scoping problems***	The literature confirms the use of the practice in scoping the granularity of a challenge so that it is capable of being understood and processed by the crowd	Due to the nature of scientific problems, a danger arises in setting problems at level of granularity too narrow or too broad for crowd involvement	Participants stressed the importance of framing the problem correctly and the consensus view indicates that some degree of expert involvement is required in scoping problems	Various aspects to the practice of scoping were evident where both case studies featured the combination of online and offline, internal and external interactions in the scoping process	The findings show a tension between the need for openness versus the need for expert involvement in scoping of complex science problems,
A-III	***Selecting problems***	Research presents examples of mechanisms used by crowds in making decisions as to what problem to select, such as voting and expert selection	Funding agencies face a challenge as to how to integrate all stakeholders in selecting problems and also in deploying a means by which problems can be selected	Participants showed a large degree of confusion as to how selections can be made by stakeholders in call processes with some suggestion that it could be done jointly	Evidence across both cases showed the predominant use of votes and likes as a means of selecting problems, however, in case A, it was highlighted that experts made the final decisions as to the problem specification	A tension exists in the findings between the need to involve skilled and unskilled stakeholders in the selection of problems and by so doing, facilitating the voice of the crowd, and maintaining scientific excellence

A-IV	***Aligning with strategy***		A new practice emerged where experts highlighted that problems required alignment between the needs of the solution seeking organisation and the needs of other stakeholders	Across both case studies experts addressed strategy in various capacities and in case B, questions and problems were aligned with different organisational strategies and considerations	Findings show that strategic alignment presents as important for funding agencies where fostering awareness of the organisations goals and strategically aligning problems in meeting research priorities

B	Advertisement of the innovation challenge	Practices - Ch 3	Challenges - Ch 4	Experts - Ch 6	Case Studies - Ch 7	Discussion – Ch 8
B-I	***Targeting participants***	Evidence of the practice exists in attempts to target via advertising either an undifferentiated mass of generic demographics and skills or narrow group of solution providers through advertising	Research identifies that funding agencies require new means by which to target new types of participants that have not previously been sought out for participation in call processes	Evidence from experts highlights the need to engage both skilled and lay participants through online and offline advertising so as to facilitate a diverse ecosystem	Both groups of experts identified how online and offline advertising approaches were used to target both skilled and unskilled participants with a greater variety of approaches presented by participants in case B	Funding agencies through the use of advertising approaches are targeting specific and new types of participants, however further guidance is needed for agencies in using the practice
B-II	***Integrating advertising channels***			A new practice emerged where evidence from mostly crowdsourcing experts confirmed the need to manage advertising channels through a combined strategic approach and not in a piecemeal manner	Participants in both cases presented the need for integrating advertising channels for management purposes with both online and offline channels requiring management in case B	A key point evident from the findings is that funding agencies need to manage multiple advertising channels in a strategic manner so as to maximise engagement where traditional advertising approaches are too narrow
B-III	***Retargeting previous participants***			Evidence was provided that crowdsourcing initiatives retargeted previous participants unlike traditional funding call processes. However, some limited awareness was provided by funding experts	Both online and offline strategies for retargeting previous participants were used in both cases where in case A, all retargeting completed was online while in case B a combination of both online and offline was used	From the findings some evidence supports the use of the practice, however, the practice was executed largely without guidance or an express knowledge from managers as to why the practice was used

C	Identification of potential solution providers (filtering the crowd)	Practices - Ch 3	Challenges - Ch 4	Experts - Ch 6	Case Studies - Ch 7	Discussion – Ch 8
C-I	***Identifying participants***	Crowds are selected for participation based upon demographic or skill criteria collected at the INPUT stage of the process	Evidence shows that funding agencies have traditionally used a narrow approach in identifying participants based upon skill and must now engage based upon other criteria such as demographics to insure diverse participation	Experts confirm the need for managers to be able to filter through participants based on criteria such as skills or demographics for the purposes of matching them to problems	Both cases featured the categorisation of participants of specific skillsets or demographics with a greater emphasis on skilled involvement in case A, while in case B a broader class of participants were sought and categorised	Findings confirm the use of the practice however, the use of the practice is limited by the funding agencies restricted approach in categorising participants also, unskilled or diverse participants are not fully harnessed by the funding agencies
C-II	***Facilitating self-selection***	Several crowdsourcing definitions advance the concept of self-selection as a mandatory component where the crowd select tasks they wish to complete	Discussion in the research shows that the practice of self-selection presents as a challenge for funding agencies where crowds may not hold all the skills necessary to participate in call processes	Funding experts express some concern as to the crowds ability to self-select where they may not hold all the skills required to participate as opposed to crowdsourcing experts who seek broad diverse crowds	A difference of opinion was evident between practitioners in case A and case B where in the former case, participants had concerns about the ability of lay persons to self-select for scientific review or assessment works	Findings show that while self-selection presents as a point of concern for funding agencies, crowdsourcing research by contrast shows that checks and balances can assist the practice of self-selection by lay participants

D	**Management of innovation process**	**Practices - Ch 3**	**Challenges - Ch 4**	**Experts - Ch 6**	**Case Studies - Ch 7**	**Discussion – Ch 8**
D-I	***Managing risk***	The management of risk presents as a key concern for organisations engaged in the use of crowdsourcing and to a degree the practice is used by funding agencies	Managing upside and downside risk is of critical importance for funding agencies in particular, where scientific excellence is at issue. Agencies face a challenge in managing this risk	Experts presented a difference of opinion as to risk with funding experts concerned with mitigating downside risk, by contrast, crowdsourcing experts were seeking to leverage upside risk and novelty	In case B, participants confirmed an awareness of the need to access upside risk, where in case A managers were concerned about the negative risks associated with public engagement in call processes	The findings show the use of the practice and a significant difference between public funding agencies and commercial crowdsourcing initiatives vis-à-vis attitudes to risk and the practice of risk management
D-II	***Training***	Research supports the idea that training can assist crowds in providing better participation in call processes where similar training examples are evident across research	Evidence shows that funding agencies use training to cover various aspects of their operations, however, a challenge is faced in upskilling for the use of crowdsourcing	Both groups of experts confirmed the need for training in various capacities, however, crowdsourcing experts highlighted the need for specific training around open processes	Some limited training was evident however, managers across both cases described a need for training in various capacities with participants expressing a need for training in crowdsourcing	While the evidence shows that some training is provided by funding agencies the consensus shows that there is an absence of training as to managing the crowdsourcing process

D-III	***Creating a feedback loop***	Some limited evidence is apparent of the use of iterative cycles or feedback loops in crowdsourcing which are used to iterate better results	Although certain funding agencies have used iterative processes an absence of knowledge on how to use iterative cycles remains in the research	Limited examples of iterative or cyclical processes were presented by the two groups with funding experts describing policy feedback loops and crowdsourcing experts describing the use of iterative loops in call processes	Very limited evidence was presented of iterative or cyclical aspects to call processes in both cases with participants in case B speaking of an iterative approach to informing funding policy	Despite limited use of the practice by funding agencies other research domains and industry show the use of iterative processes in the improvement or refinement of artefact
D-IV	***Educating participants***			Both groups of experts were aware of the need for a new practice of removing barriers however, limited evidence was provided of the use of the practice	A much stronger emphasis on educating stakeholders was evident in case B, however, both cases highlighted an awareness of the need to educate participants as to the business of the funding agencies	While the practice does not present as a major occurrence in crowdsourcing processes findings show that funding agencies are using the practice in EPE works
D-V	***Removing barriers to participation***			Funding experts highlighted the use of a new practice of developing strategic portfolios of challenges whilst crowdsourcing experts did not provide substantial evidence of the practice	Very limited evidence was provided from policy documentation across both cases of an understanding on the part of managers as to what barriers to participation were faced by stakeholders	Findings show that outside of policy directions in respect of gender and disability consensus shows that other types of barriers to participation need to be overcome by funding agencies
D-VI	***Developing problem portfolios***			Funding experts highlighted the use of a new practice of developing strategic portfolios of problems whilst crowdsourcing experts did not describe the same degree of a need for the practice	Some moderate evidence was presented of a strategic portfolio approach to the development of categories of problems in line with funding agency and stakeholder needs	Although evidence showed that funding agencies consider strategic needs of the organisation other sectors and industry show an approach to portfolio management in innovation not presently used by funding agencies

E	Management of the Stakeholder relationship	Practices - Ch 3	Challenges - Ch 4	Experts - Ch 6	Case Studies - Ch 7	Discussion – Ch 8
E-I	***Moderating participation***	Crowdsourcing environments feature the use of moderators or moderation practices in the management of crowd involvement	Research addresses the use of moderation in science, however, a challenge is faced where there is an absence of guidance for funding agencies on the use of moderation	Evidence was presented of the use of moderators and moderation in various capacities over both groups of experts in a limited manner	The practice of moderation was present in both cases in guiding stakeholder interactions and in case B some limited facilitation was also evident on the part of moderators	Findings reveal that although some limited moderation was used by the funding agencies in managing stakeholder relationships, the use of the practice remains largely passive in call processes
E-II	***Facilitating communication***	Evidence shows the use of various communication tools within crowdsourcing ecosystems to assist participant interaction	Evidence shows that funding agencies face challenges in developing new means to communicate with lay persons and other stakeholders in call processes	Crowdsourcing experts highlighted the importance of communication within crowdsourcing ecosystems with evidence suggesting a degree of awareness of a need for the practice on the part of funding experts	Case B provided evidence of substantial types of interaction and communication between stakeholders, with some limited communication between stakeholders and process managers in case A	Evidence shows that although funding agencies use the practice further investments are required t match the communications capabilities of commercial crowdsourcing efforts

E-III	***Compelling participation***	Some limited evidence of participants being compelled to participate in crowdsourcing for different reasons	Research indicates that funding agencies have compelled the participation of applicants for funding in various capacities, where no guidance is available for agencies as to how to manage the practice or whether or not to use same	Outside of funding experts providing evidence of compelling applicants to do outreach work limited examples were available of the use of the practice by crowdsourcing experts	The use of compelling participation as a practice was not evident in either case and was opposed by participants save for mandating public education works and outreach in return for funding	Findings show that compelling participation is not high on the agenda for funding agencies with research participants holding no knowledge of its formal use
E-IV	***Creating social space***			Crowdsourcing experts highlighted the need to provide social space for participants to interact in crafting and assessing submissions where funding experts confirmed a need in retaining participants	Case B featured the development of an online and offline social space assisted through a platform, however, in case A, interaction was limited to discussions and voting on the platform	Funding agencies show a lack of awareness and infrastructure for the development and maintenance of social space
E-V	***Facilitating transparency***			Both sets of experts disagreed as to the extent of transparency required over funding agency call processes with funding experts expressing some need for anonymity	Case B participants described attempts to make the process more open and transparent unlike case A where reluctance was still evident in relation to decision making power	Research shows that transparency forms an important part of many crowdsourcing initiatives whereas funding agencies show concern over opening aspects of call processes

F	Assessment filtering of solution submissions	Practices - Ch 3	Challenges - Ch 4	Experts - Ch 6	Case Studies - Ch 7	Discussion – Ch 8
F-I	***Filtering with tools***	Throughout research moderate evidence is available of the use of tools to filter through submissions received in call processes	The evidence indicates that funding agencies are not equipped with sufficient electronic tools to assist with filtering complexity in submissions received	Crowdsourcing experts described the active use of electronic filtering tools with funding experts expressing a future potential need for the practice	Participants across both cases expressed a need for the future use of electronic tools in filtering submissions with moderate evidence of the use of some filtering tools in case B	A difference is evident between the filtering tools used in advanced crowdsourcing platforms and grant management systems where funding agencies have yet to substantially leverage the use of such tools
F-II	***Managing scale***	Research shows that cloud computing can assist with issues of managing scale in call processes	Discussion in the research indicates that funding agencies present as insufficiently prepared to deal with vast submissions similar to those received in large-scale crowdsourcing	Both sets of experts identified potential problems arising from the need to manage scale within call processes with confirmation of potential offered by cloud computing	At present the evidence shows that neither platform was unduly taxed by an excess of traffic/volume but managers were aware of the potential need to manage scale in the future	Like crowdsourcing initiatives, funding agencies have assessed the need to harness the power of cloud computing the findings indicate that managers envisage future large-scale crowds could place large demands upon system resources
F-III	***Mitigating bias***			A new practice of mitigating bias was highlighted predominantly by funding experts who needed to identify and mitigate bias in call processes	Participants across both cases were aware of the risk posed to the integrity of outcomes by various types of biases where substantial attempts were made to address bias in case B	The findings highlight that bias within crowdsourcing presents as a complex practice where participants highlighted a limited guidance available as to how to identify bias within crowdsourcing ecosystems

G	Generation of potential solutions	Practices - Ch 3	Challenges - Ch 4	Experts - Ch 6	Case Studies - Ch 7	Discussion – Ch 8
G-I	***Scoping the solution***	Evidence shows similarity to the practice of scoping the problem where submissions are aggregated or broken apart into solutions	Similar to the challenge faced in scoping problems, funding agencies face a challenge of integrating lay participants and experts in aggregating/disaggregating solutions	Funding experts highlighted the importance of expert involvement in scoping solutions where crowdsourcing experts also described aggregation as a part of the practice	Participants provided evidence of crowd involvement in scoping the solutions with some limited examples of aggregation of contributions into solutions	Similar to the scoping of problems this stage of the process however, the findings also indicate that funding agencies face a difficult balancing act in managing expert and lay involvement in the scoping process
G-II	***Selecting solutions***	The practice of selecting solutions uses mechanisms similar to those identified in the selection of problems where voting and other means can be used to select a solution	Evidence shows that funding agencies face challenges in deciding who gets to select solutions and how those solutions are selected	Experts across both groups confirmed that not all decision makers need to hold equal decision making power in selecting solutions within the call process	In case A, managers selected the solution after public suggestions where by contrast in case B, participants with guidance from experts selected the solutions	Similar to the selecting of problems, the findings confirm the complexity associated with selecting solutions in various capacities with limited guidance as to how to balance expert and lay selection

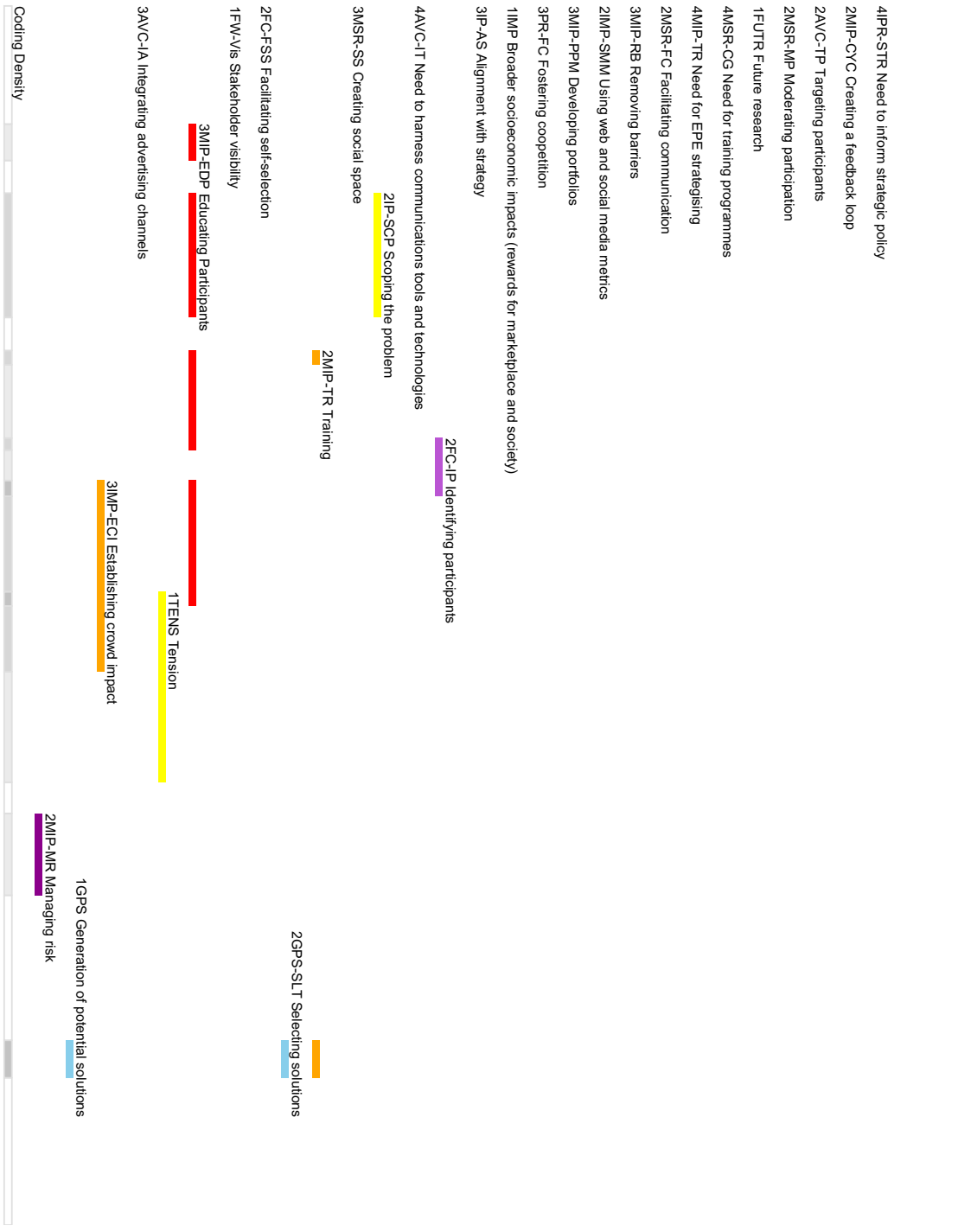
H	Potential rewards for solution seekers, solution providers, brokers	Practices - Ch 3	Challenges - Ch 4	Experts - Ch 6	Case Studies - Ch 7	Discussion – Ch 8
H-I	***Providing extrinsic incentives***	The offering of extrinsic incentives is commonplace in many commercial crowdsourcing endeavours with substantial research available on the practice	Research addresses the fact that public sector organisations are limited in terms of financial rewards they can offer for participation	Funding experts spoke of the barriers faced in offering extrinsic incentives where crowdsourcing experts described the active using of extrinsic incentivisation in call processes	Limited extrinsic incentives were paid to the crowd in case B by way of small prizes and refreshments, where by contrast in case A, no payment or physical incentives were provided for participation	The findings indicate that research funding agencies do provide limited extrinsic incentives in call processes however, funding agencies can learn from private sector uses of extrinsic incentives in crowdsourcing
H-II	***Appealing to intrinsic motivations***	Evidence shows a substantial amount of research and observations into the use of intrinsic motivations in crowdsourcing processes of various types	Research indicates that despite funding agencies seeking to engage public participants, challenges are faced in appealing to intrinsic reasons for participation	Both groups of experts confirmed the need for the practice where intrinsic motivations are identified as key reasons for community participation	Evidence was provided in both cases of participants appealing to the intrinsic motives of participants in securing continued crowd engagement however, some anger was evident in case A at the lack of extrinsic provisions	Even though evidence shows that funding agencies have relied upon appealing to the intrinsic motives of participants the case studies indicate that further development of the use of the practice is required
H-III	***Fostering coopetition***			Limited evidence was provided by crowdsourcing experts of collaboration and competition in call processes where funding experts confirmed the potential usefulness of the new practice	Examples were presented of either collaboration or competition with participants where neither process featured the use of both, concurrently, however, participants supported the potential for the use of the practice	Mostly theoretical evidence is available that coopetition could be used by the funding agencies from the expert interviews and case studies, however, individual instances of competition and cooperation were evident

H-IV	***Harnessing indirect advertising***		Both groups of experts were acutely aware of the potential reward of offer from harnessing indirect advertising with some reluctance evident of the part of funding experts	Despite concerns of participants in case A as to potential negative publicity, evidence was presented across both cases of the potential reward for solution seekers in the form of harnessing indirect advertising	Although evidence shows that rewards lie for solution seekers in harnessing indirect advertising the evidence shows that funding agencies are still concerned with potential downsides

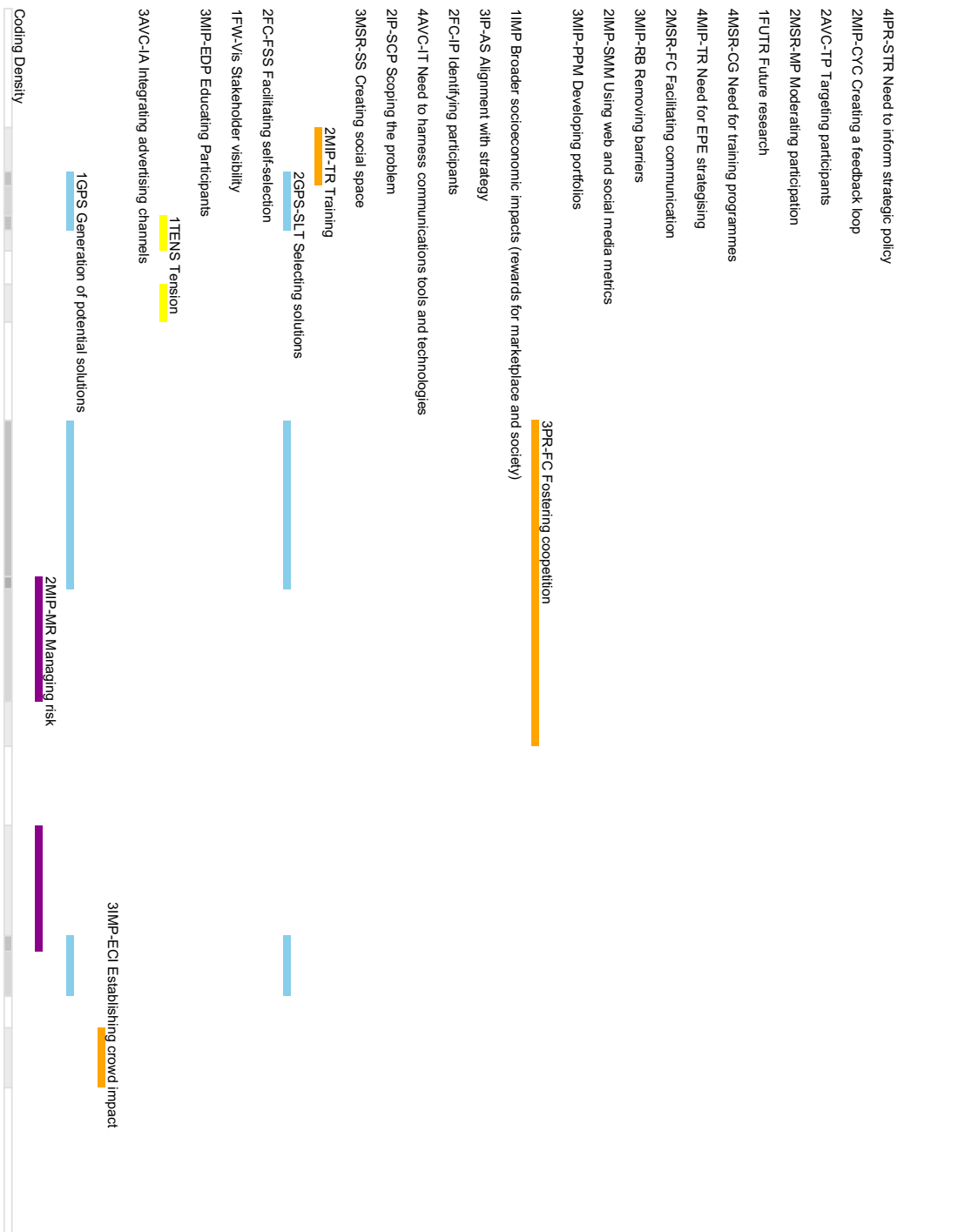
I	Broader socioeconomic impacts (rewards for the marketplace and society	Practices - Ch 3	Challenges - Ch 4	Experts - Ch 6	Case Studies - Ch 7	Discussion – Ch 8
I-I	***Using web and social media metrics***	The main body of crowdsourcing literature that relates to metrics shows the use of standard web and social media metrics in measuring impact	Evidence indicates that funding agencies, by contrast are concerned about metrics for scientific excellence and research impact with further guidance required as to what metrics should be used	Evidence was presented across both groups of the use of standard web and social media metrics as it related to the use of the platform where experts confirmed the limited scope of these metrics	Across both cases, web and social media metrics were used in measuring platform performance, however, participants highlighted that other impact metrics were required	Research indicates that web and social media metrics play an important part of measuring platform success and can be predictors of other forms of impact, but are not a universal panacea for measuring impact
I-II	***Establishing crowd impact metrics***			Evidence from both groups of experts supported the need for bespoke crowdsourcing impact metrics with a clear need expressed to understand what counts as impact from the funding agency perspective	Participants across both cases spoke of a need for metrics to measure impact where funding agencies face pressure to measure the impact arising from their processes, some limited examples were evident in both cases	Strong evidence across expert groups and case studies indicates that new measures are required to measure the impact arising from crowdsourcing with examples of metrics created for similar processes across domains
I-III	***Facilitating real-time oversight***			Both groups of experts highlighted an awareness of the potential benefits of real time oversight however, little support was evident of the use of the practice from funding experts	Evidence showed the use of some real time measurement, where participants spoke of the potential utility arising from real-time oversight of process performance and expressed a need for dashboard metrics in this regard	The use of real time measurement and visualisation systems by funding agencies is underutilised with limited support presented of the need for the use of real time monitoring

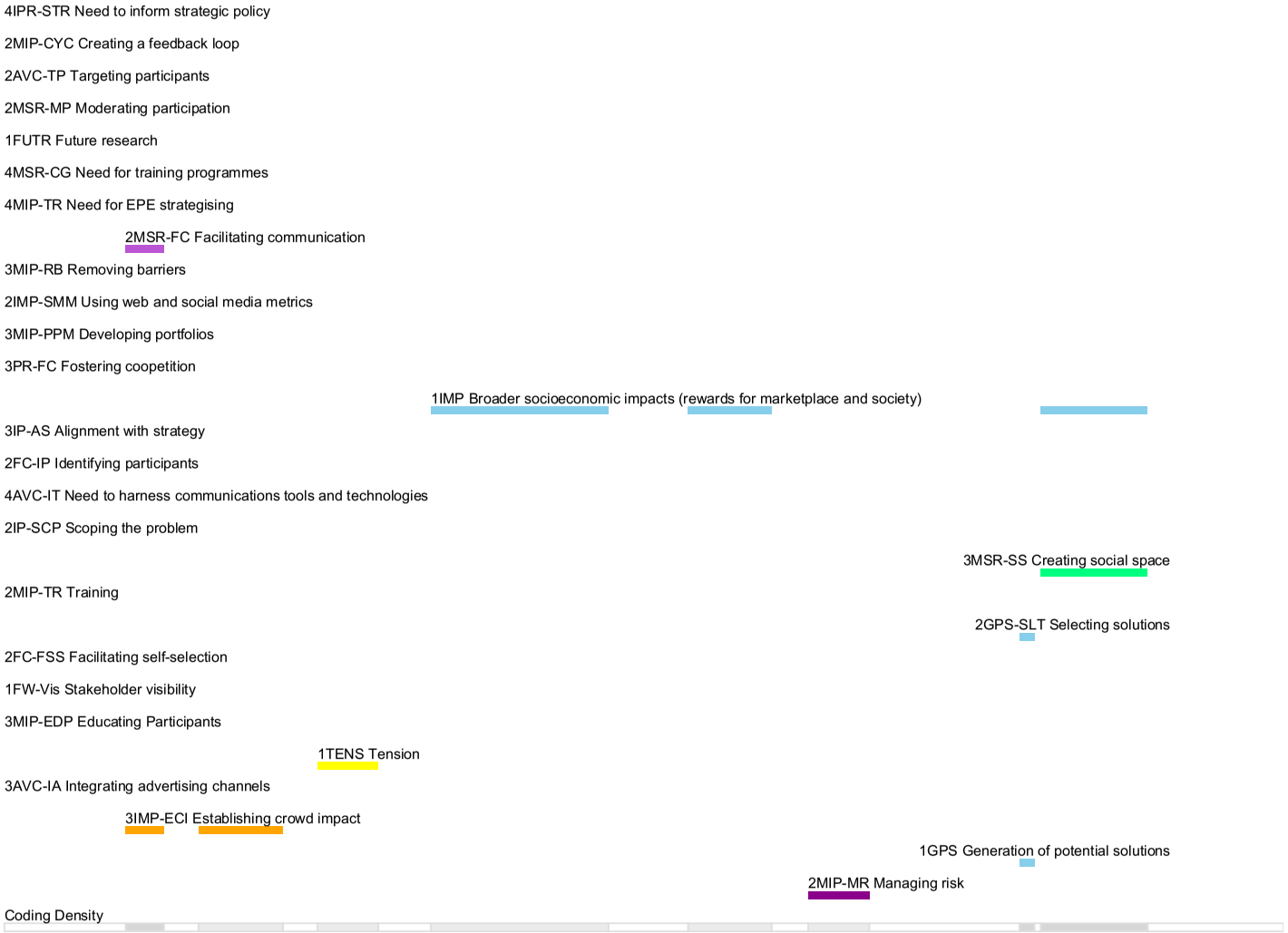
Appendix B – Sample Interview Script Coding

262 263	EC:	00:13:07	So this is all credit the reviewer holds, knowledge that they’ ve obviously amassed over a career.
264 265 266 267 268 269		00:13:11	A few of you in here are probably senior enough to know when a good problem specification in a funding application is not just contextualized in paperwork alone. It’s not just on paper but this is good and we know because of experience? Could the crowd make up for their shortfall in knowledge.
270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289	[redacted]:		If they were given good guidelines probably yes. In assessing funding application success well … it’s not always on paper. We should, and do give them (the applicants) guidance, however, to explain better what to do in their submissions.. We were so hell bent on the organisation finding peer reviewers. We do give them (the applicants) guidelines say like next month X years post Ph.D. supervise x number of Ph.D. students to completion. Then they look more like they’re an expert. X number of star* publications. And all the usual type of stuff. But again like somebody who is the most senior person in the world he’s got an Nobel prize and then there are the ones with prizes, they can be the worst person to work with. Yeah and sometimes persons in the early stages of her career can also be the first person to work because they’re fighting and they’re trying to assert themselves. And I generally find it a more later career issue. People are the easiest to work with because they get this.
290 291 292 293		00:14:09	They’ve been around the block. They’ve nothing to lose because they have their career where they continue to get to the more junior people who are also applying for grants themselves.
294 295 296 297		00:14:23	so taking that “tide me over” money at the start would probably take the edge off / the anger of them and make them a bit easier to deal with or otherwise you would be trying to fund a lot of rubbish.
298 299	EC:		How do you agree these marking systems? Do bring you bring in their reviewers and coach them?



300 301 302 303 304 305	[redacted]:		We give them advice. This is like the guidelines what 10 to 20 means what 0 to 40 means this kind of stuff. They can ring us for clarification. Yes, some parts of it could be marked by crowds of stakeholders such as the public but not all of it. Id wonder who' d make the final decision?
306 307 308 309 310	EC:	00:15:36	So, it's not something really that you want Jo / Josephine soap to do.? Pick the winning application? In other words it's a learned skill for the reviewers that they learn from being engaged with you?
311 312 313 314 315 316 317 318 319 320 321 322 323 324 325	[redacted]	00:15:48	It's not like marking an essay or marking a thesis because it's about, as I say, some researchers you've got to put a price tag on your research. You've told the X Research Organisation that your research is worth 100,000[redacted] and you're now asking us for these two investments and asking us to give you taxpayers money … and that's a decision the evaluation board has to make. A lot of them are conscious of fact that its taxpayers money and so on is that that some of the argument like this, like if this wasn't taxpayers money would it be funded you know and sometimes you have to fund what you think is going to deliver results. Would the crowd of stakeholders have a similar view. Industry maybe yes, the general public maybe not so much I' d say?
326	EC:	00:16:25	I see.
327 [redacted] 329 330 331 332 333 334	[redacted]:		You know that's maybe why the ([redacted]n) is quite different from us because it's high risk - high gain and they can afford to take up risk of diverse crowds whereas some other types of national agencies cannot afford to take that risk, that' s why we fund the excellence alone based upon expert assessment, Excellence as a criteria for example, what is excellent etc.
335 336 337	EC:		I keep hearing impact what' s it to you, what metrics do you use for involving and measuring all the stakeholder involvement? Do you measure





338		stakeholder communications in assessing impact or is it just from the project perspective?	
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340		It is you know a bit of the all the above different things such as measuring types and amount stakeholders, communications, interactions, monies spent etc?	
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344		To be blunt we are more concerned however, about the quality of the writing or grantsmanship than measuring interactions in the call. I've been on assessment boards for so many years and I'm going to go give presentations and people say the same thing. It's very hard to commit to writing, it's a number of things that's how well the proposal is written. Is it convincing? The track record is the right institutions, have they the right supervisor? Have you made the case for your research> We don't go into the impacts for Ph.D. and postdoc and also people discuss what they're going to do any books, my publications blah blah blah. These are the main targets and measures. The other measures are of less importance.	
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359	00:17:19	But we don't have societal impact as in the sense it's excellence of the research project and excellence of the person or the right person to be honest.	
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363	00:17:27	Is that not killing novelty because you might be risk adverse? Would involving the crowd not promote novelty? Because we have these people in the system. They're amazing at getting funding. They've got all the right people all the right places. They have excellent track record. But they are too safe and vanilla. Where's the novelty, and thus, how do you account for that? Do assessors discuss this?	EC:
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371	00:18:21	The crowd could certainly be involved in marking. There's all sorts of different metrics that can be used -- at the table it's part discuss them the "trickle down thing" why don't you give us 70. Why did you give it 90 here and they trash it out. I'm not sure how the crowd would do that bit?	
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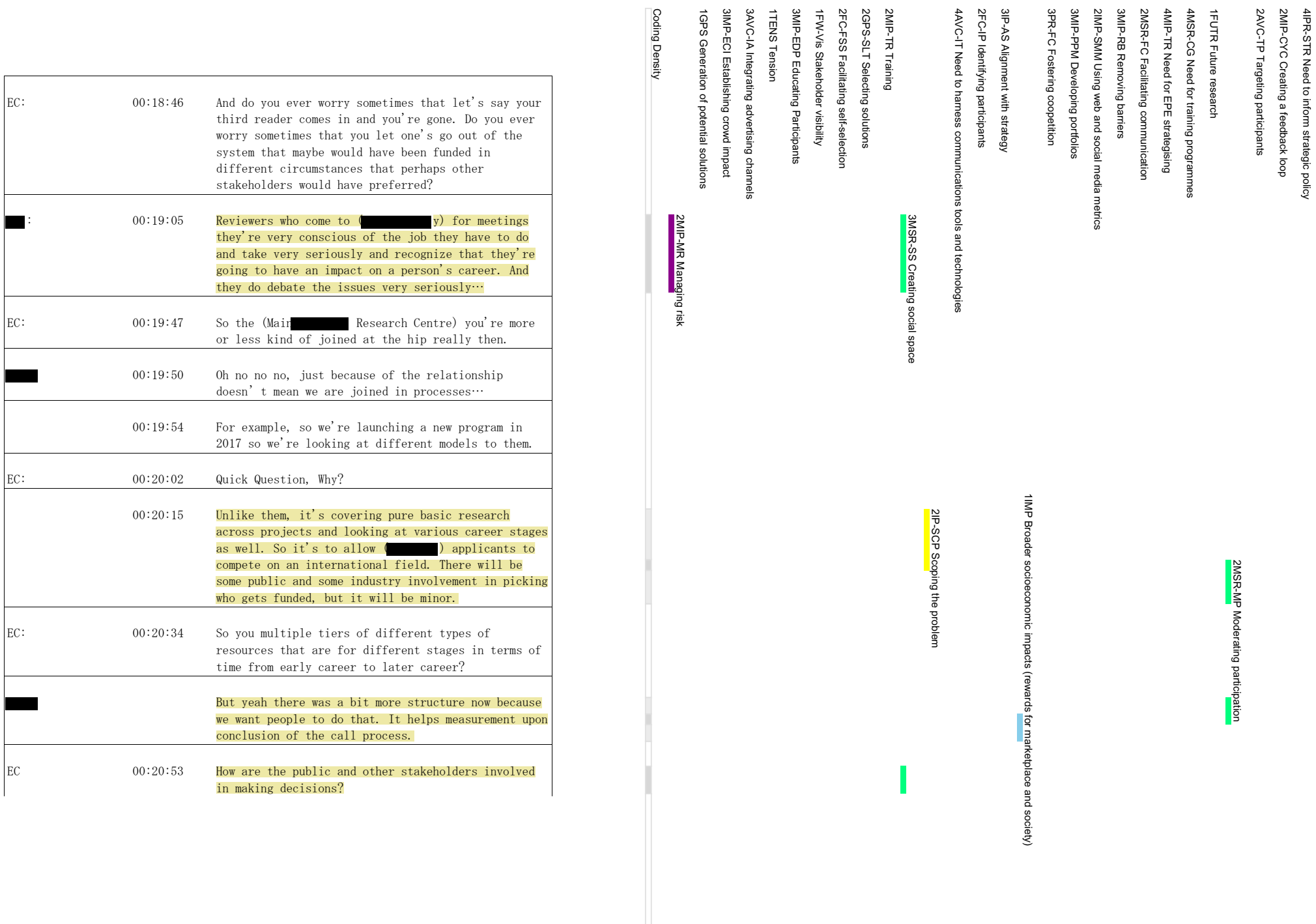
377 378 379 380 381 382	EC:	00:18:46	And do you ever worry sometimes that let's say your third reader comes in and you're gone. Do you ever worry sometimes that you let one's go out of the system that maybe would have been funded in different circumstances that perhaps other stakeholders would have preferred?
383 384 385 386 387	[redacted]:	00:19:05	Reviewers who come to ([redacted]y) for meetings they're very conscious of the job they have to do and take very seriously and recognize that they're going to have an impact on a person's career. And they do debate the issues very seriously…
388 389	EC:	00:19:47	So the (Main[redacted] Research Centre) you're more or less kind of joined at the hip really then.
390 391	[redacted]	00:19:50	Oh no no no, just because of the relationship doesn' t mean we are joined in processes…
392 393		00:19:54	For example, so we're launching a new program in 2017 so we're looking at different models to them.
394	EC:	00:20:02	Quick Question, Why?
395 396 397 398 399 400		00:20:15	Unlike them, it's covering pure basic research across projects and looking at various career stages as well. So it's to allow ([redacted]) applicants to compete on an international field. There will be some public and some industry involvement in picking who gets funded, but it will be minor.
401 402 403	EC:	00:20:34	So you multiple tiers of different types of resources that are for different stages in terms of time from early career to later career?
404 405 406	[redacted]		But yeah there was a bit more structure now because we want people to do that. It helps measurement upon conclusion of the call process.
407 408	EC	00:20:53	How are the public and other stakeholders involved in making decisions?

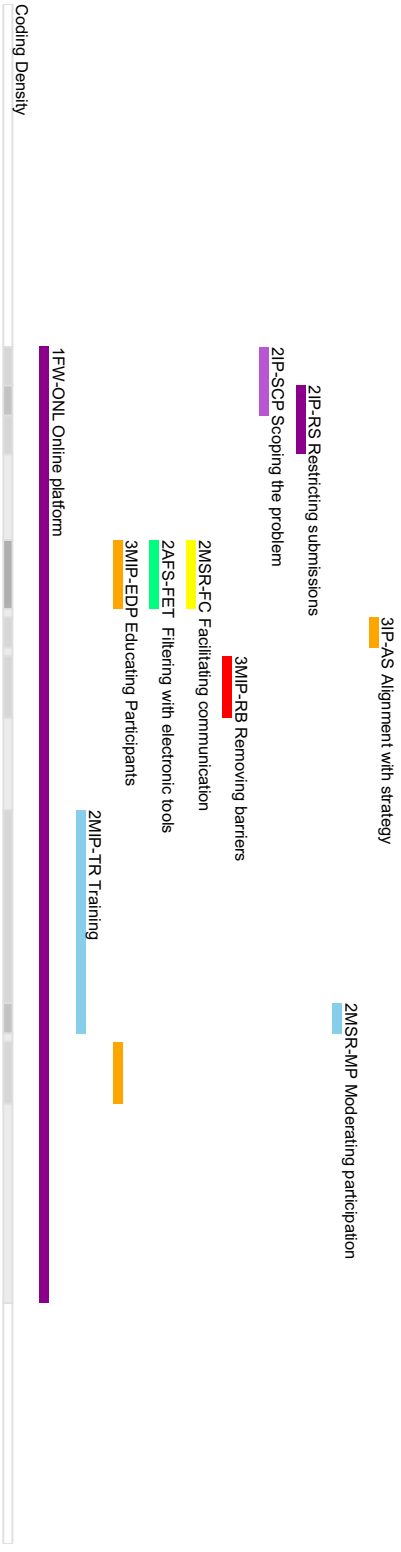


Appendix C – Sample Document Coding

The following steps are taken for the user in creating a challenge. (Refer to the GIT - [redacted])

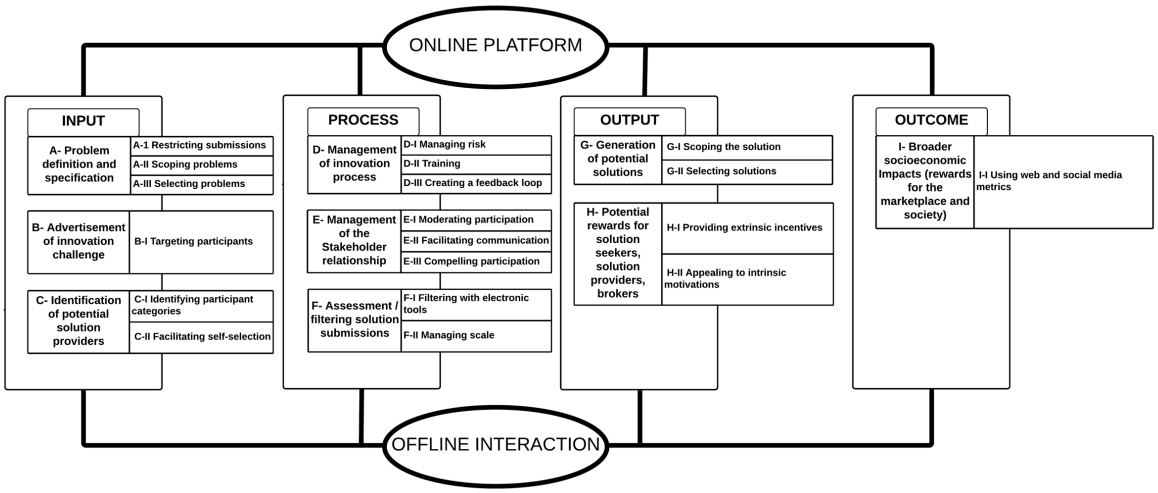
Workflow

1. Define the challenge and construct your question in a preset format. The question parameter accepts XML string or HTML string.
2. Create the challenge by opening the main window. Click the {operations} button .
3. Insert the following details including Title, Description, Keywords and Challenge Details.
4. For suggestions refer to the [redacted] document .
5. For language specific support about using [redacted] refer back to the [redacted] website.
6. Sandbox: once you have published the challenge to the developer sandbox you can view the question in the simulated environment. By clicking {end user view} you can post dummy comments and replies to the challenge.
7. By exiting the {end user view} you can also test the ability to block or remove comments from the system by clicking {moderator settings}.
8. For more information about the developer sandbox click on [redacted].
9. To make the challenge live, click on the {Main menu} and {Administrator} buttons. Under this menu click on {Turn off sandbox}. At the bottom right-hand section of the page click the {publish now} button.



Appendix D – Sample Interview Protocol

PROTOCOL – EXPERT INTERVIEWS



Public Research Funding Call Processes

Introduction;

Reminder: The recordings and interview transcripts are redacted and anonymised.

Questions:

How long have you been in your present position?

Describe the process of applying for funding, funding research projects or making decisions about funding research?

Briefly describe your role as it relates to the process. What is your knowledge of the [redacted] efforts?

- Problem definition and specification

Describe the process of problem definition and specification

Restricting submissions

Scoping problems

Selecting problems

-Advertisement of innovation challenge

Describe the process of advertising the innovation challenge

Targeting participant categories

-Identification of potential solution providers (filtering the crowd)

How do you identify solution providers?

Identifying participant categories

Facilitating self-selection

-Management of innovation process

Describe the management of the process

Managing risk

Training

Creating a feedback loop

-Management of the Stakeholder relationship

How do you manage stakeholder interactions? Describe your stakeholders.

Moderating participation

Facilitating communication

Compelling mandatory participation

-Assessment filtering of solution submissions

How are submissions filtered?

Filtering with tools

Using cloud technologies

-Generation of potential solutions

How are winning submissions picked? Can they be improved or changed?

Scoping the solution

Selecting solutions

-Potential rewards for solution seekers, solution providers, brokers.

What do rewards and incentives look like?

Providing extrinsic incentives

Appealing to intrinsic motivations

-Broader socioeconomic impacts (rewards for the marketplace and society

Tell me about impact and what it means to the organization.

Using web and social media metrics