Reducing Barriers to Dynamic Research Collaboration between UK Universities and Technology Firms

A thesis submitted towards the degree of Doctor of Philosophy

by

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DECLARATION

I declare that this thesis was composed by myself, that the work contained herein is my own except where explicitly stated otherwise in the text from other sources that have been properly and fully acknowledged, and that this work has not been submitted for any other degree or processional qualification except as specified.

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DEDICATION

This is wholeheartedly dedicated to the Almighty God for Supremacy.

I also dedicate this to the wise lady that gave her husband a plaque of the quote by Professor Albert Einstein that: “A cleaver person solves problem. A wise person avoids it”. This context is everything.

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ABSTRACT

Emerging technologies over the years have triggered several major transformations that are improving the approaches on how the global economy is addressed. Efforts to develop various technology solutions have aided changes in the management of collaborations in the delivery of projects, products, and services. The nature of ambitious improvements with pervasive digital solutions has led to new purpose and changes in key collaboration processes used for the present novel service-driven business models. The collaborative framework efforts processes for the current global industrial revolution differs from others in that it not only provides solutions but reveals novel concepts of smart and connected collaboration processes. It has also increased the need for dedicated proficient collaboration process that easily assist in managing resources and productivity that lead to the competitive influence of companies.

Universities worldwide continue to play crucial roles in achieving economic growth in today's knowledge-based societies. Collaborations between universities and industries in several countries have a long tradition in several sectors such as manufacturing. The collaboration synergies have produced integration of novel advancements in knowledge transfer, economy, services, and products have easily realised huge successes. In recent years, the synergy between academia and digital technology firms in advancements of digital technology is increasing and lead as key contributor to high-level competitive advantage. Ambitious government policies are encouraging UK universities to develop 'third missions' along with their two traditional core missions of research and teaching, to commercialise academic knowledge through collaborative digital technology projects, continuing education programmes, patenting, knowledge transfer offices, science parks or incubators.

Collaboration structure that exists however, do not comprehensively reduce the barriers in dynamic research collaborative environments. Current collaborative structures are mostly generic business processes not accompanied with techniques that can assist new digital technology firms that encourages collaboration engagement culture and maturity awareness required to support partnerships with universities on the development of innovative products and services.

Design Science Research technique was used as the research paradigm to design useful artefacts that could be used to bridge the research-practice gap presently in the field of university-digital technology firms research collaboration engagements. This research applied both survey and interviews design methods to develop an instruction, Research Collaboration Culture Assessment Instrument (RCCAI) that would encourage feedback from individual academic researchers and digital technology firm practitioners.

Findings resulted in the development of a new theoretical representation for the concept of research collaboration culture based on the Collaboration Maturity Model (CMM). The RCCAI enables research groups, universities, and digital technology firms to self-assess their collaboration positions on the CMM rubric. The RCCAI is an inexpensive, online, and tailorable model that enables companies to partner with academia allowing them to accelerate the translation of that research into new products that drive economic growth.

The evaluation of these artefacts demonstrate that they fulfil the aims of this research, that is, making the representation of research collaboration culture more dynamic promoting effective and efficient research collaborative engagements between academic researchers and digital technology firm practitioners. The RCCAI supports the need for approaches that encourages the forging of long-term collaborative relationships between universities and technology firms instead of one-off projects.

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CHAPTER ONE

INTRODUCTION

1.1. Background and Context

Research collaborations between universities and industry can be traced back many decades, such as the links between universities and the chemical industry in the late 19th century (Clark, 2004; Comunian et al., 2014). However, during the 1980s, there was a shift in several OECD (Organisation for Economic Co-operation and Development) countries to increase funding from governments to support science-based research collaborative projects (OECD, 2002; Demeritt, 2010). Furthermore, the funding of research by some OECD countries had evolved, i.e., to an era of physical process technology, such as development of specific systems needed to ensure industrial plants operate smoothly to produce goods and services (Sørensen et al., 2016). This change in rationale, according to Aagaard (2017), enabled a shift in the roles of universities through their involvement in various sectors of the economy, assisting them to address societal challenges.

The beginning of the current century has witnessed another noticeable shift in the role of universities recognised as significant catalyst in the development, transfer, and preservation of educational knowledge (Baker, 2001). The development in the new technologies has led to noticeable shifts in universities being recognised as part of the catalyst in the growth, transfer, and preservation of knowledge in various sectors of the economy (De Wit and Altbach, 2021). Within that shift, focus has been on processing development with digital technologies research to encourage global fit for beneficial purposes. Potential benefits such as those for leveraging competitiveness in business or in future warfare applications, have encouraged enormous funding, and considerable collaboration from technology firms, governments, and financial investors. Recognised as the bedrock of educational Knowledge, universities, therefore, have expanded their activities more into the organising of knowledge transfer without cost to either the academic community or the public (Altbach, 2009; Williams, 2016; Rajaeian et al., 2018). The various shifts have become profitable ventures that have contributed to universities creativity through research partnerships. Research activities in science, digital, and information technologies as well as various collaborations are seen as closely linked to universities roles. The links between universities and industry has therefore, become more explicitly important to countries with highly skilled technology talents such as the United Kingdom, Germany, and the United States of America (Baker, 2001; Sellar and Lingard, 2013).

Research in Information Systems discipline is a methodical study that identifies problem, concern, or issue with the use of scientific practices that act as guidelines for potential solutions (Aagaard, 2017). The use of standard processes to narrow the topic enough to study it within the context of a particular test have a more practical or theoretical merits. For example, social researchers, like in other sciences, focus their research on issues that applies are directly connect ed to social policy and welfare, whilst others focus primarily on refining the theoretical understanding of social processes. Subject matter ranges from the micro level to the macro level.

The first step of the scientific method of finding facts in an organised technique is by turning an issue into research questions, with the intent of the study to answer the research question. Generally, pure research, i.e., discovery of new knowledge, is generally considered to be the gold standard in terms of recognition and prestige (De Wit and Altbach, 2021); with most Nobel prizes being award to pure research discoveries. A second type of research is applied research, which is increasingly used to generate income by universities focusing on research output that will result in income from the public. Several universities, especially in the USA develop projects that give access to the knowledge transfer designed through collaboration with external partners (Debackere and Veugelers, 2005; Vick and Roberson, 2018). A third type of research is applied research which uses scientific discoveries to generic problems to create commercial products or solve related practical goals. A fourth type of research is historical research, which uses original / new data to re-analyse or extend past research work. Research in particularly the scientific fields, requires funding for physical resources such as laboratories, equipment, and expensive performance or measuring tools. Research can thus take many forms and have different purposes (Webber, 2003).

Universities are expected to be the repositories and organisers of efficient knowledge flow, yet researchers are increasingly finding the research burden to be greater than the available resources (Tandon et al. 2018). External pressures are demanding shift in the emphasis of wide-ranging set of increasing resources (from the government and the public) to fund academic research (Alexander, 2000); so, research collaboration with external partners is characterised by academics as a key strategy to gaining increased financial resources needed to support their ongoing research (Schmidt and Langberg, 2007). For this study, we define research collaboration as the process of 'working closely with others to produce new scientific knowledge or technologies' (Bozeman and Corley, 2004). From an industrial perspective, there is indication that there is increasing awareness of opportunities for the commercial uses of knowledge, and, since the time from research to industrial application has been reduced in many sectors, it is often necessary for firms to collaborate and be closely involved in academic research. In the UK, these changes have been accompanied by pressures on the government to increase the utility of research conducted in universities.

A 2017 published White Paper on the UK Industrial Strategy, set out steps to improve the country's wealth creation and social quality by harnessing its strengths in science and engineering (Fothergill, 2017). A step is to forge closer links between universities, industry, also promote knowledge transfer of technology (Silverwood and Woodward, 2018). Attempts have therefore been iteratively put in place with initiatives that provide greater incentives (and pressures) for university researchers to identify and collaborate with the users of their research (Beath, 2002). According to Kuhlmann and Rip (2018) a wide range of related policy measures have frequently been introduced to strengthen collaborative activities such as the Faraday Partnerships, University Challenge Fund, Science Enterprise Challenge, Higher Education Reach-Out to Entrepreneurs, Businesses, and the Communities (HEROBAC), Joint Research Equipment Initiative (JREI), and University for Industry.

Despite increasing interest amongst UK policymakers, academics have few attempts to encourage more of robust research collaborations between universities and digital technology firms (U-DTF) that increases economical beneficial advancements to social well-being and the environment through innovative technologies (D'este and Perkmann, 2011). Although there has been an increase in the volume of university- university collaborations, however, the growth in the importance of digital technology necessitates more research collaboration with digital technology firms (Brown et al., 2017).

This chapter introduces the research and sets out the structure of the rest of the thesis. Section 1.1 was used to introduce the domain of the research. 1.2 provides the definition of the digital technology firms as an overview of the problem space including the relevance for scientific growth. Section 1.3 set out the problem issues with the current state of collaboration between UK universities and digital technology firms while, 1.4 was used to state the aims and objectives of this research. Section 1.5 introduces the research design used to address these aims and objectives. Finally, Section 1.6 shows how this thesis is arranged to demonstrate how the research addresses these aims and objectives. This chapter is then summarised in Section 1.7.

1.2. The Digital Technology Firm

Digital technology entrepreneurship focuses on investments in technology projects that engages specialised individuals and heterogeneous assets as well as resources for the deployment of advanced scientific and technological knowledge transfer for the purpose of creating and capturing value (Hewith-Dundas, 2012; Giones and Brem, 2017). From a research perspective, digital entrepreneurship is much closer to the information systems' concepts of artefacts, platforms, and information infrastructure (Nambisan, 2017). Giones and Brem (2017) considered digital entrepreneurs as not actually interested in the specific technology behind their business model, however, the focus is usually more on the service that it is based on. Therefore, technology is regarded as an input product only such as in the coordination and connection of disruptive concepts such as communication and networking (Industrial Internet), embedded systems (Cyber Physical Systems), adaptive robotics, cyber security, data analytics and artificial intelligence, and additive manufacturing (Nambisan, 2017).

Giones and Brem (2017) described digitisation of technology as a game changer in the properties and characterisation of digital entrepreneurship while, it has also impacted its overall entrepreneurship process. First, digitisation has made entrepreneurial outcomes and processes less restrictive. This release has made solution increasingly interoperable and porous, i.e., with fluid boundaries amongst various systems or organisations (Dingler and Enkel, 2016). In terms of outcomes, results are not only with regards to software and hardware, similarly impacted are business processes or practices, structural boundaries of the product, service, etc. (e.g., the features, scope, and market reach of an offering) (Nambisan, 2017). In terms of processes, this relates to the spatial and temporal boundaries of entrepreneurial activities (e.g., when and where activities are carried out) (Iglič et al., 2017; Fernández-Olmos and Ramírez-Alesón, 2017). Digitisation of entrepreneurial processes has helped to break down the boundaries between different types of groups and institutions while, instigating greater levels of collaboration and enhanced beneficial relationship unfold (Awan et al., 2018; Ma et al., 2020).

Second, digitisation has led to less pre-determination of the locus of entrepreneurial organisations, i.e., the ability to where they garner entrepreneurial ideas and resources to develop them is situated. Companies increasingly have a broader, more diverse, and often continuously evolving set of actors and a shift from a predefined, focal agent to a dynamic collection of agents with varied goals, motives, and capabilities. For example, new types of digital infrastructures, such as crowdfunding systems (Mollick, 2014), digital 3D printing systems and digital makerspaces (Sabine et al., 2013), and social media platforms (Fischer and Reuber, 2011), have led to a more collective ways of pursuing entrepreneurship (Aldrich, 2014).

The two afore-mentioned descriptions are both closely related to changes that portrayed the limiting of the significance and value of prior insights from existing research in digital technology. Novel current demands on both entrepreneurs and how entrepreneurial opportunities are formed and enacted through research collaboration are changing the view of the digital world (Rayna et al., 2015). Given the unique evolving characteristics and aspects of digital technologies to encourage rapid changes, it is proposed that a novel explanation will need to be informed because of a new research collaboration digital technology perspective. This should incorporate digital technology related collaborative opportunities (Mueller and Shepherd, 2016), concepts, and constructs (Arthur, 2009). For example, considering the effect of having enough information on the self-assessment levels of some technology entrepreneurs (ventures) (Nambisan, 2017) that enables them to improve their research collaborative capacity to having competitive advantage over others in acquiring entrepreneurial resources from partnerships and improved collaboration process (Rippa and Secundo, 2019).

This thesis will not explicitly theorise on digital technologies, their characteristics, the role of digital technologies in entrepreneurial pursuits, or integrating such as digital technology perspective in existing theories and concepts on entrepreneurship despite its contemporary significance. Various prior research on technology entrepreneurship (Beckman et al., 2012; Zupic, 2014; De Wit-de et al., 2019) have already focused copiously on entrepreneurship as practiced in technology-intensive environments (including digital technology). In the previous research, technology was treated in the context of empirical work (Bingham and Haleblian, 2012) and the role of specific aspects of digital technologies in shaping entrepreneurial opportunities (Mueller and Shepherd, 2016), decisions, actions, and outcomes have been considered (Giones and Brem, 2017).

As a result, the concept of digital technology entrepreneurship, in this thesis, combines elements of technology and digital entrepreneurship, relating to research collaboration. Therefore, this research adopts an enriched Bailetti's (2012) description of technology entrepreneurship considered by Nambisan (2017). A description includes involvement of additional digital technology entrepreneurship aspect. This relates to the identification and exploitation of opportunities based on scientific or technological knowledge transfer through the creation of digital artefacts. Digital technology entrepreneurs build firms based on technologies on the one hand and on services on the other hand. The extension of the definition implies that a profile of digital entrepreneurs not only experience the challenges of engineering or scientific development, but also the complex dynamics of external partnerships for the development of varying outcomes in digital platforms and infrastructures (Enkel and Gassman, 2010; Nambisan, 2017). Entrepreneurs involved in digital technology rely on collaborative efforts with external partners within an innovation ecosystem that strategically combine technological knowledge ("technology push") with collaboration know-how ("relationship pull") (Giones and Brem, 2017).

From an academic perspective, researchers in the universities could use the different classifications and terminologies of entrepreneurship to learn more about the research collaboration awareness level of digital technology entrepreneurs, personal motivations, their founding behaviours, and financing preferences, etc. One may have the view that all the labels by academics might not be relevant to the entrepreneurs themselves. However, it is the belief that, when it comes to entrepreneurs aspiring to start a business, it might help them to make a conscious decision, from an informed position, on how to collaborate with universities for competitive advantage and value (Rothaermel et al., 2007).

1.3. Problem Statement

There is limited explicit UK government innovation policies that focuses on encouraging University (U) and Digital Technology Firms (DTF) to collaborate on research that focus on science-based advances through specific knowledge economy breakthroughs (Kuhlmann and Rip, 2018). There has always been some confusion to the role that universities including those in the UK should play in i) digital technology firms' development, and ii) dynamic research collaboration of with digital technology firms (DTF). De Wit and Altbach (2021), amongst others, argued for increased university involvement in the 'UK digital economy'; as the current state of collaboration is inadequate. Bozeman and Corley (2004), for example, highlighted the need for clearer dynamic U-DTF links that positively contribute to science-based research and increase the value of UK universities. This reflects a widespread lack of clarity on how useful, and to what extent, commercial value can be gained from UK academic research.

The traditional linear frameworks that guided government authorities and public policies on industrialising, fostering knowledge-based economic, and social development does not focus on the future of university research involvement in the increasing regime of knowledge transfer (Calvert and Patel, 2003). The global evolutionary digital revolution is reshaping the world with infinite projections to unlock new boundaries for human life (Haddara and Elragal, 2015), and it is significant that academic research perspectives in like manner equally evolves. New knowledge has been introduced through digitisation and co-evolution of universities, digital technology firms, governments, and digital technologies (Hong and Kim, 2018). Sociological studies have hence, highlighted the need for novel institutional dynamics frameworks in academic-industry relations (Giones and Brem, 2017). Current academic frameworks focus mainly on downstream expenditure, which is one of the inputs in applied internal R&D, i.e., the journey from the initial need for research projects to deliver commercial value and research results into useful products (Calvert and Patel, 2003) while, there are few frameworks that on the current evolution towards improving the links between parties in research discovery and application to create valued products and employment opportunities (Loosemore, 2016; Mueller and Shepherd, 2016).

Similarly, the mainstream economists' models on practices that can facilitate knowledge transfer between academia and industry research partnerships, have been stuck (for decades) in the groove of minimal research input, yet with high expectations of abundant output; essential as an important driver of innovation and economic growth, i.e., the commercialisation of new scientific knowledge within firms (Bercovitz and Feldmann 2006; de Wit-de Vries et al., 2019). Existing frameworks neglect approaches that can inspire new research directions and provide additional funding through the dynamism of the collaborations (D'Este and Perkmann, 2011).

Over the past two decades, there have been an increased level of research considering the academic engagements that occur between universities as well as partnerships with development of business process for various industries (Dumas et al., 2018). Most of this research are often viewed as academic entrepreneurship (Giones and Brem, 2017); areas which include patenting, licensing, joint ventures, as well as product and service spinoffs. There are differences however, in practice on how academics engagements with industries are prepared, such as the differences in goals, focus, and process that exist based on different institutional cultures (de Wit-de Vries et al., 2019). However, academic engagements should be straightforward with intent in removing ambiguities and problems, focusing predominantly on knowledge exchange with knowledge absorption while, de-escalating the difficulties of dynamic collaborations with the application of knowledge (Alexander and Childe 2013; Giones and Brem, 2017). The academic engagements or partnerships between universities and industry are often referred to in literature (e.g., Perkmann et al., 2013; Giones and Brem, 2017) as with significantly different characteristics and socio-economic impacts. In this research, the focus will be placed on academic engagements, defined as research partnerships that involves a high relational collaboration, i.e., where individuals or teams from academic institutions and relevant stakeholders from digital technology firms work together on specific projects and/or to produce a common output (Perkmann and Walsh, 2007). The focus, therefore, will be on dynamic research, contract research, and consulting. Collaboration that requires limited interaction and / or no new research are excluded.

Additionally, reviews of academic engagement by Godin and Gingras (2000) and Schein (2017) are critical of traditional university research strategies with primary focus on inter-academic research collaboration that result mainly in publications of articles in top academic journals. Such critical views make the argument that a replacement approach is needed that supports dynamic research collaboration, focuses on the challenges facing society, and provides effective policies that encourage the development of valued Vick and Roberso, 2018). Collaboration being dynamic, balanced, there is increasingly a need for tools and frameworks that will assist a contingent of timely and accurate information on the state of the research collaboration, the maturity levels of the research teams, and the extent of research collaboration that exists between universities and technology firms (Giones and Brem, 2017).

Various research collaborations have resulted over the decades in some form of values in areas such as new prototypes, instrumentation, methodologies, patents, product spin-offs, and extant seminal co-authored academic papers. To review the lack of balance in research collaboration, Mollas-Gallart et al. (2002) made a list of the forms of research collaborations that should be considered, which includes:

- maturing revolving and spinoff partnership research projects,
- organisation employees jointly working with universities on research projects,
- university research scientists working in firms,
- university scientists undertaking short-term research consultancies,
- participation in formal and informal research networks

A proven evaluative tool for a dynamic research collaboration, therefore, should be considered as an assistance for improving the research collaboration process, practice, and value.

A method often used for measuring university and industry collaborations is stakeholder surveys (Gibson et al., 2019; Fernandes et al., 2019). Several such surveys were sponsored by the Higher Education Funding Council for England (Rantala and Ukko, 2018). The surveys, aimed at mapping a broad range of academic–industry linkages in the UK, provided data on patterns of linkages, motivation for such linkages, and overall scale of research activities such as in the higher-education sector (Charles and Conway, 2001). Although covering a broad range of factors, various studies missed the measure for dynamic research collaborations which can be used to improve co-values through the understanding of the significance of interactions, process, and practice during research collaborations between universities and digital technology firms.

Although income from academic collaboration by universities outranks the income derived from selling intellectual property (IP) (Perkmann et al., 2011), which is highly valued by industry (Cohen et al., 2002), researchers into university–industry interactions have for a long time ignored the dynamic process of collaboration. Research into academic engagement is increasing (Perkmann et al., 2013), yet the field is lacking in consideration of theoretical perspectives. As such we propose that research process and practice into academic engagement with digital technology firms would benefit from the development of a tool that will assist in measuring collaboration maturity and guideline during knowledge transfer to fill this gap. Academic research collaboration, after all, aims to develop novel knowledge that benefits the academic and industrial partner during academic engagements. This will require bidirectional knowledge sharing to identify relevant problems, share and develop new insights, and the transfer and implementation of knowledge and/or digital technology.

In this thesis, we aim to map extant knowledge and perspectives on knowledge transfer in academic engagement through a systematic literature review. Additionally, we identify open questions for future research. Besides our aim, i.e., to develop a comprehensive new tool with guidelines, the focus on the theoretical perspective of academic engagement with digital technology firms adds value to the research domain concerning academic engagement with industry. Prior academic studies, considering collaboration between universities and industry, focus primarily on the characteristics of researchers and institutions that go into various types of collaborations (Perkmann et al., 2013); factors affecting collaborative engagements, management of knowledge transfer (Ankrah and Burges, 2013; Ankrah and al-Tabbaa, 2015); the definition/classification of academic engagement (Perkmann and Walsh, 2007); and academic engagement guidelines (Guo et al., 2019).

Mapping the extant knowledge and perspectives gained through knowledge transfer in collaborative academic engagements is of significance in this research. Furthermore, a comprehensive new tool with guidelines, the focus on the theoretical perspective of academic engagement with digital technology firms adds value to the research domain concerning academic engagement with industry. Prior academic studies, considering collaboration between universities and industry, focus primarily on the characteristics of researchers and institutions that go into various types of collaborations (Perkmann et al., 2013); factors affecting collaborative engagements, management of knowledge transfer (Ankrah and al-Tabbaa, 2015) the definition/classification of academic engagement (Perkmann and Walsh, 2007); and academic engagement guidelines (Guo et al., 2019).

Previous research is focused on factors and enablers that drive academic collaboration such as access to skills (Bozeman and Corley, 2004); academic resources and access to funds (Beaver, 2001); obtaining academic prestige or visibility (Thorsteinsdottir, 2000); access to pools of knowledge in academic collaboration for tackling large, complex problem, and improving academic collaboration productivity (Ankrah and al-Tabbaa, 2015). Ankrah and Omar (2015) stressed the importance of socio-cognitive evaluative approaches in intellectual partnerships, i.e., understand the organisation's social and intellectual environment that stimulates improved research collaboration. Perkmann and Walsh (2007) introduced the view that social and intellectual factors arise from the strategic positioning / managing of factors, therefore, there is a need to use evaluative or measurable approaches to undertake research collaboration for higher competitive and economic advantage.

There are several studies relating to university and industry partnerships that indicated measurable collaboration activities often begin informally from meetings and social conversations, which can evolve into a co-value partnership (Gaughan and Bozeman, 2002). Academic collaboration processes and activities, therefore, need to be a targeted activities with necessary support i.e., from its initial informal point of contact, to support of advanced characteristics of joint development of a productive / beneficial outcome for both UK universities and digital technology firms (Link et al., 2007; de Wit-de Vries et al., 2019). Part of the support are tools that will assist stakeholders in self-assessing of their effectiveness and the capabilities they need to acquire to improve their collaboration performance. Such a support tool should be simple to use, and should not be document-laden, plan-driven strategy, and / or should not require users to have extensive associated certification or training. For a collaboration process strategy that is plan-driven based, there is the need for the understanding of the process used by the actors, and awareness of a good fit evaluative framework to self-assess the capacity of the organisation on navigating its way when it takes part in a collaborative effort. For example, understanding a process will assist in improving it with the intent of making it to be dynamic that is supported in all the activities and actions that will lead to the success of the collaborative effort.

For self-assessment by stakeholders in research collaboration, the absence of a detailed tool and guidelines currently results in ambiguity and problems with knowledge transfer absorption between UK academia and digital technology firms i.e., there are difficulties with the application of new digital technology knowledge which is considered an important driver of innovation and economic growth (Bercovitz and Feldmann, 2006). Stakeholders in academic can benefit from more interactions with industry as it can inspire new research direction and provide additional funding stream (D'Este and Patel, 2007; D'Este and Perkmann, 2011).

1.4. Aims and Objectives

The aim of this research is to develop a prudent artefact that can i) present the organisational maturity dynamic in research collaboration, ii) help to determine the existence of research collaborative engagement, and iii) facilitate research collaborative engagement activity between UK universities and entrepreneurial digital technology firms. A new representation will enable digital technology firms and/or UK universities, to assess, and guide change, the culture of current research collaboration, with the intention to assist stakeholders to measure their maturity progress over time, and compare against, and learn from others.

The second aim is to also develop a numeric measure of research collaboration culture to make the difficult-to-measure performance assessment more easily measurable and so promote wider engagement of the concept by UK universities and digital technology firms.

The objectives to achieve these aims in this research are to:

1. design an artefact to represent and characterise the awareness of organisational maturity dynamic research collaboration culture,
2. produce an inexpensive instrument to enable a digital technology firm, and/or university, to self-assess their research collaboration maturity level,

3. evaluate the artefacts produced in the research to demonstrate whether the developed model and instrument would help decision-makers within digital technology firms and universities engage with the idea of research collaboration culture.

Developed artefacts are intended to be useful; resulting in a method of changing the representation of the concepts to make clear what was previously obscured, and to make measurable the previously un-measurable (and uncontrollable).

1.5. Research Methodology

The aim and objectives of this research strongly determine the research methodology used throughout this research. Firstly, the aim of the research is to devise a course of action aimed at changing an existing situation into a preferred one; it is concerned not with how things are, but with how things should be. Secondly, the research will devise artefacts as a means of achieving the aim and objectives. Thirdly, the solution to the research questions and problem is derived from the experiences of actors, and the extension of identified factors from literature. Crucial assessment of the success of the research is the utility of the developed instrument.

Methodologies, such as, natural science research or behavioural science research are unable to address this type of phenomenon. In both methodologies, the ontological problem is a discrepancy between the available knowledge and the known facts. The purpose of the process is the adaptation of knowledge to the facts that "bring about a change in the realm of the mind" (Eekels and Roozenburg, 1991, p.198). This research follows this statement by assisting to bring about a change in the realm of the external material world. Correspondingly, if the problem cannot be stated *a priori*, inductive, or deductive reasoning cannot be used to define the required outcome as logic can only apply to evaluative and analytical activities (Gregor and Jones, 2007; Hevner and Chatterjee, 2010; Gregor and Hevner, 2013).

Design science research (DSR) offers an alternative science research methodology with quiddity that suits the phenomenon. The DSR methodology is novel in higher education collaboration or partnership with external partners becoming stakeholders, although it is often used in related disciplines such as information systems. DSR is an outcome-based information technology research methodology, that offers significant guidelines on the research paradigm: ontology, epistemology, methods, and ethics for evaluation and iteration within research projects (Peffers et al., 2008).

The rigor of the iterations during the research projects provides past knowledge to ensure its innovation thereby, broadening of scholarly explanation interest beyond the explanations of existing phenomenon (Baskerville and Pries-Heje, 2010). For example, valuable utility of the artefact is created in the successive developmental phases which ensures: an innovative practical artefact (Friedman, 2003); opportunity for the initiation of a novel theory (Beck et al., 2013); and provision of evaluation and governance process in the iterations that facilitate solution tool to an incomplete, contradictory, and changing problem often difficult to recognise and describe as "wicked" (Hevner et al., 2004; Gregor and Hevner, 2013; Mandviwalla, 2015).

It is contingent on researchers to thoroughly research, reference the knowledge base, and apply appropriate methodology processes that guarantees outcomes that contributes to both knowledge and practice (Hevner et al., 2004). Rigor in DSR is predicated on appropriate methods for constructing and evaluating artifacts that solves the "wicked" problem in the barriers to research collaboration between UK universities and digital technology firms. Following Cross (1994), the five characteristics of the "wicked" problem are:

1. There is no definitive formulation of the problem in the existing literature.
2. The problem formulation gives visible inconsistencies in the problem space.
3. The formulation of the problem is solution dependent.
4. Solutions are proposed as a means of understanding the problem.
5. There is no definitive solution to the problem.

The above characteristics of the issues in this research match the characteristics of DSR and characteristics of the research methodology that will be required in this research:

1. Design science operates at the interface between the problem space and the solution space, both of which should be explored as part of the research,

2. The chief concern of design science is utility i.e., “the state of being useful, profitable, or beneficial” (Hevner et al., 2004; Goes, 2014),
3. Design science is creative, iterative, and evaluative. It is not sufficient for the research to produce a novel solution; that solution must be evaluated for utility and must be improved upon until the desired level of utility is reached, with this desired level defined by requirement gained,
4. Design science is concerned with devising artefacts to attain goals.

At the heart of any design science research project is the internal design iteration. This cycle of research activities iterates more rapidly between the construction of an artifact, its evaluation, and subsequent feedback to refine the design further (Hevner, 2007). Goes (2014) describes the nature of this cycle as generating design alternatives and evaluating the alternatives against requirements until a satisfactory design is achieved.

Design Science is therefore, the most appropriate research methodology to apply to this research.

1.6. Thesis Structure

This thesis uses the structure of the design science research to structure the presentation of the research. It focused on ‘scientific’ research papers that arranges the structure of scientific research into well-defined process (problem definition, literature review, hypothesis development, data collection, data analysis, results, discussion, and conclusion). Every researcher trained in the cultures of natural science or behavioural science research have a mental model of their paradigm, “a constellation of beliefs, values, and techniques” (Chua, 1986, p.602), which enables them to recognise, understand and evaluate the work of others. This is a skill learnt early in IS research that fundamental it becomes implicit. This contrasts with the assessment of behavioural science research that researchers only have a mental model of what constitutes ‘proper research’ that may result in conflict and misunderstanding. This summary of Chapters Two to Seven explains the structure to avoid such confusion by the reader unfamiliar with the presentation of design science research.

Chapter Two presents the problem identification and motivation through a review of the relevant literature as it existed at the start of this thesis. Three broad bodies of literature are presented in this study, Collaboration Management, Collaboration Culture, and Application of Maturity Framework in Research Collaboration.

Collaboration Management is an integrative philosophy of management, which aims to provide value and achieve long-term benefits by continuously improving the quality of the processes, services, and outcome to ensure stakeholders meet the organisations' goals. In a Research Collaboration Management effort, arguably all members of an organisation participate in some way to improve the maturity of the processes, outcomes, services, and organisation culture in which they work. It is hailed as a powerful tool for maintaining customer satisfaction in a rapidly changing digital economy environment. Collaboration Management has been extensively discussed and applied in the business and industry sectors, and to a lesser extent in the digital technology sector. Collaboration Management is discussed in the research and information science literature, where it is felt to be particularly suited to the needs of UK university and information technology services, for example, to improve their processes. However, further reading of literature uncovers the lack of application of Collaboration Management techniques for research in the design and development of information technology services in practice.

Chapter Three details the design science research methodology introduced by Peffers *et al.* (2008), and its application in this research. The aim of this chapter is to provide a mental model to enable the reader to assess the rigor of the research. The chapter presents the justification for using a design science paradigm when it has not previously been used in research collaboration and Information Science research, specifically its concentration on utility. The Design Science Research Methodology, as described by Peffers et al. (2008), is presented as the framework used to plan, undertake, evaluate, and describe the iterative nature of design and its adaptive characteristics, with the evaluation of the artefact generated from each iteration feeding back into the objectives for a solution for the next. This framework is used to direct the three design iterations that are presented in Chapters Four, Five, and Six.

To initiate the first design iteration, Chapter Three identifies the objectives for a solution derived from the literature review in Chapter Two. A maturity model is presented as the reference model for the solution while, an initial case study is used to evaluate the appropriateness of this reference model is summarised.

Chapter Four presents the first design iteration, individual elements of collaboration culture in universities and industry are clarified from existing literature and current practice both in UK universities and other universities in developed countries. This iteration is developed incrementally, first using the interpretative synthesis method to analyse the literature, then grounded theory techniques to analyse interviews with staff from four case studies. Finally, the output from this increment is integrated the with the reference model. Evaluation of the demonstration of the resulting artefact confirms the utility and effectiveness of the outline Collaboration Maturity Model and provide additional objectives for a solution.

Chapter Five presents the second design iteration, which also used the grounded theory method to design the artefact from the responses from researchers and entrepreneurs in digital technology firms on research collaboration culture. This data was used to populate the Collaboration Maturity Model using a rubric derived from both the literature and interviews collected in Chapter Four. Evaluation of the demonstration of the resulting artefact confirms the utility and effectiveness of the Research Collaboration Culture and the Collaboration Maturity Model provides additional objectives for a solution.

Chapter Six presents the third design iteration, which develops an assessment instrument that enables universities, research groups, researchers, and entrepreneurs to self-assess their location on the Collaboration Maturity Model. The standard survey design method is detailed, and its application to this iteration described. The three iterations of instrument testing are documented, and both Collaboration Maturity Model and the Research Collaboration Culture Assessment Instrument are applied in two UK universities, and several digital technology firms. The evaluation of these demonstrations indicates that the solution developed through this research is successful in achieving the research aims. Finally, the artefacts are communicated to the practitioner and research communities.

Chapter Seven summarises the research undertaken and presents the research conclusions and contributions. This is done in the form of the contribution to knowledge with consideration of the value of the design science research paradigm and sets some themes for further research. The thesis concludes with some personal reflections by the researcher on the doctoral research process.

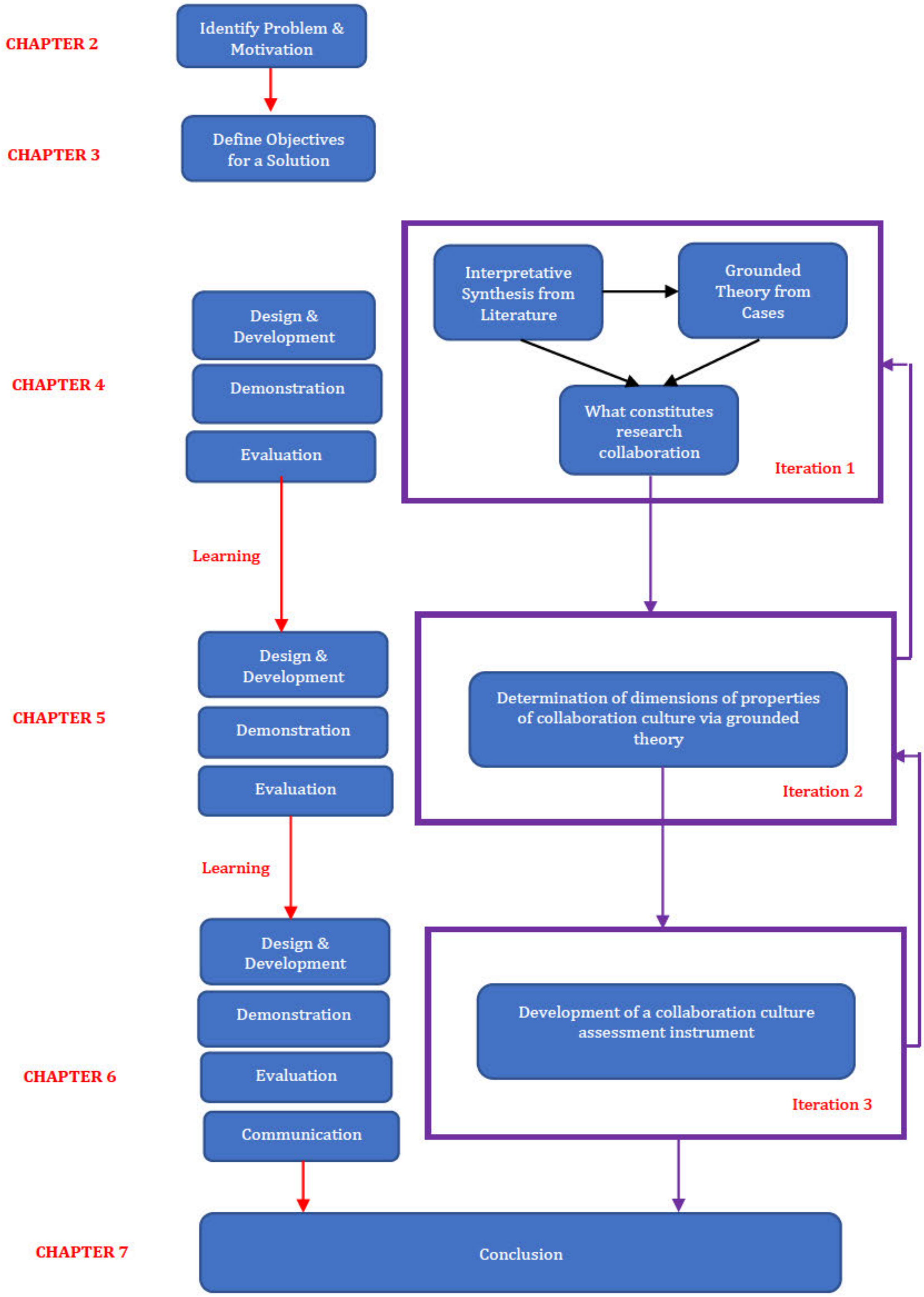


Figure 1.1: Structure of Thesis

Figure 1.1 below presents a diagram of the research process, including the direction to where each stage of the process is detailed in this thesis.

1.7. Summary

This chapter introduces the research domains relevant to this research, specifically, Collaboration Management, Collaboration Culture, and Collaboration Maturity in both UK universities and tech firms. The research aims and objectives are derived from this high-level exploration of the literature. Design science research is introduced as an appropriate paradigm for the research, and an overview of this research methodology is presented. The chapter concludes with a summary of Chapters Two to Seven, and an illustration of how the thesis structure, research methodology and research method interact.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter presents a review of existing literature concerning research collaborations with universities and the issues of research engagement processes. This review forms a discrete discussion in the design of the university research collaboration process and serves the specific purpose of exploring the symmetric and asymmetric collaborations at a high level of granularity, i.e., defining the starting point for the design of a solution that effectively address its complexity.

In the last decade, there has been an increase in the development of digital technologies such as the internet of things (IoT), human-computer interaction/integration, semiotic engineering (conversation between users and systems), and intellectual artefacts driven mostly by changes in user needs, customer requirements, expectations, competitions, and global economic situations (Christensen et al., 2015). The increase in choice and investment has facilitated a market where users and customers can go elsewhere in the digital economy if service is not deemed excellent. This drive to excellence puts a huge pressure on digital technology firms to be dynamic and regularly update their digital designs and tools to be relevant, engaging, and consistent (Apa et al., 2018). The drive to keep up with the "evolutionary" digital technology race, cyber security threats, and global digital supremacy has introduced the need for new processes and funding assessments on the value of research collaborations between universities and industry (Etzkowitz et al., 2000). These competing cyber space vision for the future, increasing reliance society on digital technology, and exploitation of radical changes have varying implications for the policy development of the UK government on technology development and the maturity of UK universities / digital technology firms' year-on-year.

To survive in a fluid digital economic environment that is rapidly developing competence in the areas of Information System (IS), Artificial Intelligence (AI), Human Systems Integration (HSI), Machine and Deep Learning (MDL), and data science (Esteva *et al.*, 2019), it is necessary to tune into the winds of change and actively engaged in the major upheavals affecting the digital technology developments (Parviainen et al., 2017). Morrar et al. (2017) and Jussila et al. (2020) proposed meeting the intensive knowledge and resources of rapid growth of the technologies of the future such as robotics through improvements in the approach to the management of collaboration in areas such as prototyping new products. However, changes to collaboration management approach applied in the UK lacks impact intensity, despite near universal use of various performance measurement techniques for funding university research (Webber, 2003). Commentators propose that this is due to a lack of utility of the collaboration management theories espoused in academic research literature.

This chapter, therefore, presents a snapshot of the constructs in literature from the research domain. Section 2.2 explains the use of the Systematic Literature Review (SLR) approach as the framework to examine the literature on collaboration management and its drivers. Section 2.3 examines the management of collaboration, especially with technology firms. Section 2.4 reviews the features of the diverse cultural development of collaborations by UK universities and describes research collaborations adopted to suit organisational developments. 2.5 examines the application of a maturity model to research collaboration. Section 2.6 identifies the barriers towards successful research collaboration in the UK. Section 2.7 analyses the proposed framework without the creation of the themed elements from the responses from the research sample, and Section 2.8 outlines the research gap identified from literature on prior sclerotic research collaboration with universities. Section 2.9 defines the research questions as they are the drivers for the systematic literature review. The chapter is summarised in Section 2.10.

2.2. Systematic Literature Review

A systematic review of the literature (SLR) approach was used within Chapter 2 to define the research problem and throughout this thesis, in context of the research question to expound the current thinking within a specific domain. Literature reviews aim to provide depth and rigour in context of the domain; however, this is not always the case if the method of data analysis and synthesis used ignores careful selection and evaluation of existing studies (Denyer and Tranfield, 2009). Colicchia and Strozzi (2012) emphasised the importance of a systematic literature review (SLR), stating that SLR "... offers a solid and reliable technique that can be easily applied to large fields of research to select the most relevant contributions" (p.404-405). A tailored SLR approach for this thesis was based on the five steps proposed by Denyer and Tranfield (2009) (Figure 2.1).

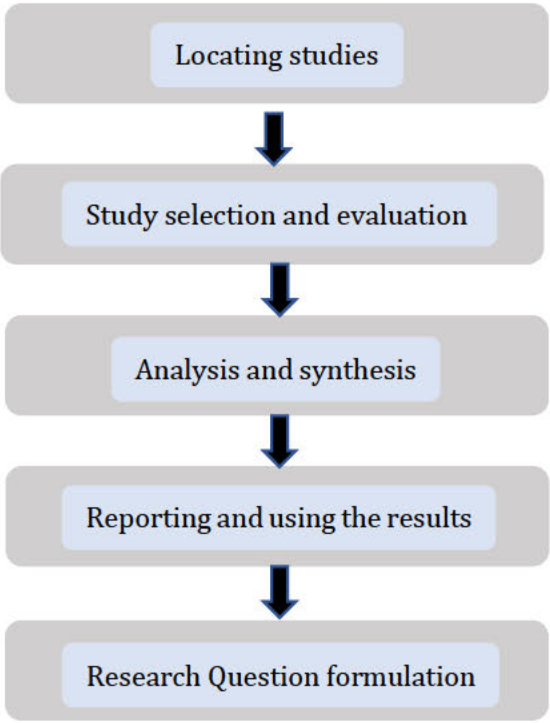


Figure 2.1: Steps of the Systemic Review of Literature (Denyer and Tranfield, 2009).

The first stage is related to the location of studies, identification of keywords and choice of databases (Colicchia and Strozzi, 2012). The searches were conducted between December 2018 and November 2019 and updated in March 2020 and involved the name or abbreviation of the initiative in the title, abstract or keywords, with the terms "collaboration", "research collaboration", and "*collabo*" anywhere in the article in the databases: Scopus, Web of Science, Google Scholar, and Emerald. In all databases the same criteria were used, respecting their particularities.

The choice of the Scopus and Web of Science databases was based on the works of Meho and Rogers (2008) who list them as important search engines because they have copious resources. The Google Scholar host database was selected for having the largest coverage in the supply chain area Harzing and Alakangas (2016). The Emerald database was used for presenting very important works, which were not selected in the searches of the other databases. Since the focus of this review of the literature is rather broad, no time limit has been imposed on research. Despite this, there were few articles on the collaboration of universities with technology companies prior to 1997. Both qualitative and quantitative articles were considered, and the methodology used (survey, case study, simulation, etc.) were considered a criterion for inclusion.

The second step in Figure 2.1, is the selection and evaluation of the studies. In this step, the definition of the inclusion and exclusion criteria is important to select the documents relevant to the research (Denyer and Tranfield, 2009). This is a significant functionality as it expands on the range of choices available. Documents that were not articles, book chapters or reviews were deleted to increase the quality of the search. Only articles in English were selected, which guarantees a good representation on the subject. Duplicate works have been removed and only those available for download have been retained. Finally, the texts were read in full and those that did not present contributions on characteristics, motivators, barriers, and goals to research collaboration were excluded, a total of 124 documents.

The third step refers to the analysis and synthesis of the documents; extracting the relevant data from the literature. For each initiative, the three categories (motivators, barriers, and goals) were extracted. They were later grouped by means of an iterative (deductive-iterative) process, so that the constructs created (categories) were representative, containing elements with similar meanings according to the work of Marqui et al. (2013).

The fourth step is the development of the report with the adopted procedures, results and conclusions found, enabling the replicability of the study (Okoli and Schabram, 2010). Finally, further description of the formulation of the research questions are presented in the following sub-section.

2.3. Collaboration Management

The relation of research collaboration to meet the rapid changes in the development of digital technology is a topic considered by some researchers and technology firms (Laudel, 2001; Glaser, 2001) however, it is not a common theme in literature. The literature on research collaboration and information system indicates that collaboration choices are governed by a wide variety of factors including inter-institutional structures

(Landry and Amara, 1998), formal (Wen and Kobayashi, 2001), informal research networks Ma et al., 2020), research alliances and covenants (Pisano, 1991), as well as the arrangement for funding, expert resources, transfer of knowledge, sharing of expensive or scarce scientific resources and equipment (Debackere and Veugelers, 2005).

While the focus on the concept of collaboration presents its own problems such as those largely based on a lack of process thoroughness, prior studies concerning university's collaboration have focused mainly on self-reported strategy-based problems which avoids consideration of problems relating to performance-based measures. For instance, in an early case study on the investigation of collaborations with external parties (Ioannidis, 2015), conclusions stated that university collaborators/authors were most interested in publishing in high rated academic journals. Ioannidis (2015) showed that often, on one extreme, an academic researcher may be listed as a co-author, simply by virtue of providing material and/or performing a routine test. And at the other extreme, an individual from industry may provide some key ideas for the development of the research, yet for any of a variety of reasons, not be included as a co-author in the developed academic journal publications. Adams (2013) suggested that the practice of making industry contacts an "honorary co-author" in academic journal publications has become quite common. This study is focused on a particular research collaboration that the outcome of the value acquired and deployed from the process is shown in the continuous stage through further collaborative efforts.

This study focuses on the "individual reasons" such as the process that researchers pursue in their collaboration choices. Ioannidis (2015) notes that the move from macro to micro that intertwine with structural circumstances, there are other individual reasons for collaboration. There are often uneasy complications in the relationships with co-existing external partners in the university ecosystems. These complications should not become a constraint and certainly not be disregarded, however, the several ethical aspects governing the management of scientists' collaboration remain very much within the control of the individual and organisations, especially when the researcher works or has a background in an academic institution.

Managing collaboration involves the use of a collection of management techniques to ensure that the partnership between two parties works well to produce the desired end goal. It can be broadly considered as an undertaking of tasks with others to accomplish a common goal within a timeframe. Management of a collaboration focuses on the value which is the starting point outcome of the partnership (Oakland, 2003).

The concepts behind collaboration management approach objectives are:

- use the combination of the varying strengths of the partners to achieve desired goal,
- make it possible to collectively overcome any weaknesses found in individual partners,
- enhance the efficiency and productivity of the partnerships.

These objectives are relevant to the phronesis on variations of academic collaborations, understanding of its limitations, and lack of dynamic research collaboration between UK universities and digital technology firms (Drucker, 2007).

2.3.1. Variations in Academic Collaborations

There are several variations of academic collaboration that UK universities undertake which are as follows:

- Members of research groups in different departments of the same university work together on an academic project. No external funding is involved, and the work is divided reasonably equally between the two groups. All those involved meet regularly to review their progress and plan for the outcome of the project which is publication of their results.

- A researcher from a private company works on a project with an academic faculty member research group of for several months. During this time the non-academic researcher pursues his own project while learning about current techniques and research questions from the graduate students in the group.

- To complete a large data collection for which a senior researcher has received external / government funding, the researcher has organised collaboration with junior faculty members in other HE academic institutions or alumni graduate students.

- To learn a new technique, a graduate student travels to another institution several times over the course of a year. On each occasion the researcher stays for 2-3 weeks and participates in the research of the other research group.
- Needing an analysis of the effect of a new compound on living plants, a researcher who is only familiar with laboratory analyses contact an agricultural researcher that they met at a conference. They agree to each carry out their own analysis of the new compound and combine their results for publication in an academic journal.
- To gain a more global perspective on a public health question, a collaboration is organised among ten research groups in six countries. All research groups independently apply for their own funding. The collaborators agree that all data collected regarding the question they are studying will be made available to the entire collaborative as soon as the graduate student most directly involved in gathering the data set has completed his/her dissertation.

The description of collaboration from these examples shows that it is working with others or together especially in an intellectual endeavour (Gosselin et al., 2016; Nind, 2017). This description opens a broad umbrella under which we can place many forms of collaboration. There is therefore the need for the management of research collaboration to assist the organisation to make the decision on improving its research collaboration maturity.

2.3.2. Need for Collaboration Management

Chrislip and Larson (1994) pointed out that collaborative management needs a different kind of leadership. Dahlstrand (2017) suggested that the leadership of organisations should recognise the close links between the survival of a technology firm and its relationship to the universities that can provide the transfer of knowledge. In an environment such as business clusters (Lundequist and Power, 2002; Simmie, 2004), the transfer of knowledge may still be static as the direction of the maturity of research collaboration of an organisation cannot be controlled only by formal systems but require a dense web of interpersonal connections (Lovegrove and Thomas, 2013). Chrislip and Larson (1994) posit that it needs leaders that can safeguard the collaborative process, facilitate interaction, and patiently deal with high levels of frustration.

On the complex relationship between the business, the government, and various social sectors, Lovegrove and Thomas (2013), suggested that for the survival of businesses in the rapidly changing economic environment, the management of future collaborative relationships depend on the ability of an organisation's leadership to understand, engage and collaborate to ensure efficient knowledge transfer, creative thinking, innovative policy development, and practical action for its survival. Lovegrove and Thomas (2013) suggested that such modern leaders for cross-sector collaboration can be distinguished more by their mind-set, just as by experience, in balancing competitive motives for wealth creation. Similarly, acquiring transferable skills that assist in the leveraging of attractive market opportunities (Mueller and Shepherd, 2016); develop contextual intelligence to accurately assess differences in context of external parties; forging intellectual thread that help to build subject-matter expertise on a particular issue or theme over time. Also, the building integrated networks that help pull organisation to a positive position; and maintaining a prepared mind in the context of possible solutions to facing problems, as often, chance only favours the prepared mind (Ma et al., 2020).

To give a positive essence to theoretical presentations such as Deming Management Method (Deming, 1994) encourages organisations to eliminate objectives in favour of leadership. Deming (1986) felt that an organisation's leadership with an understanding of the systems ecosystem and the management of an alliance was more likely to guide the organisation to an appropriate solution than the incentive of an objective. This thesis focus is on the creation of an organisational system that fosters partnership and learning that can facilitate the implementation of a research collaboration management process practice through a prudent self-assessment. This focus supports Deming (1994) view that continuous improvement of processes is an important part of organisational survival and fulfilment of their strategic goals. Implicit in this theoretical statement is the crucial role that organisational awareness plays to ensure the success of collaboration with external partners. For example, a well-developed collaboration process will assist to ensure awareness assists in the creation of communication vision, ensure trust, and collaborative culture to move the firm toward continuous improvement (Ankrah and Omar, 2015; Giones and Brem, 2017).

2.3.3. Features of Collaborative Management

Some of the significant features of Collaborative Management are as follows:

- principle based on the active participation of all key members in the partnership by using information, communication, and collaboration modules to plan and control the collaboration process during the informal and formal networking as well as during the collaborative effort.
- top management of an organisation actively involved and regarded as an integral part of the teamwork of all members in the partnership.
- high level of transparency and shared awareness of collaborative efforts among team members.

2.3.4. Collaborative Processes

Calvert and Patel (2003) suggest that the collaborative process needs be measurable to ensure improvement of the collaboration process in several ways as shown:

- objectives of collaboration are understood by participants as a perspective and a way of relating with each other as well as the organisation; not merely a tactic, or a set of skills or tools.
- clear and elaborative structure is given to achieve the goal through the partnership.
- trust among the members in the partnership increases after the initial hesitance or suspicions.
- team members work to satisfy, not just their own but, the interests of all members and the collaborating organisations.
- wide inclusion of and openness to all in and outside the project group.
- visibility of the tangible, substantial, and sustainable results from the collaboration by moving from formational stages to joint participation and action.

2.3.5. Collaborative Decision Making

Collaborative Decision Making (CDM) is a joint initiative aimed at improving the flow collaboration through the exchange of significant management components, such as, information in a partnership (Owen, 2015; Filip et al., 2017). CDM is an operating paradigm where decisions are based on a commonly shared vision of the partnership that encourages awareness and trust for beneficial outcomes from the mutual decisions made (Camarinha-Matos, 2009).

Decisions are made during the planning of the collaborative effort (Camarinha-Matos et al., 2009) (see Figure 2.1). Making decisions on the work packages in the aspects of the collaboration such as the objectives, work plan, communication plan, information distribution plan, tracking, explicit knowledge sharing, as well as integration of process, framework, and business models which are all significant for the success of a partnership. Forward planning will give clarity to the deliverables from the effort and encourage trust between the team members assigned to the effort.

Some of the aspects in the planning stage could be done separately by the partners in the collaboration before they are scoped to accommodate and fit the various compromises of the partners to suit the objectives set out for the outcomes and benefits of the research effort. For example, university researchers will design the instruments that will capture the needed data and the processes that will enable good analysis as well as the interpretations of the data gathered. On the side of the tech firm, an example of the decision making in the planning stage will be made on the information to be provided for the research effort, and how the information - if sensitive - will be safeguarded under the data protection policy.

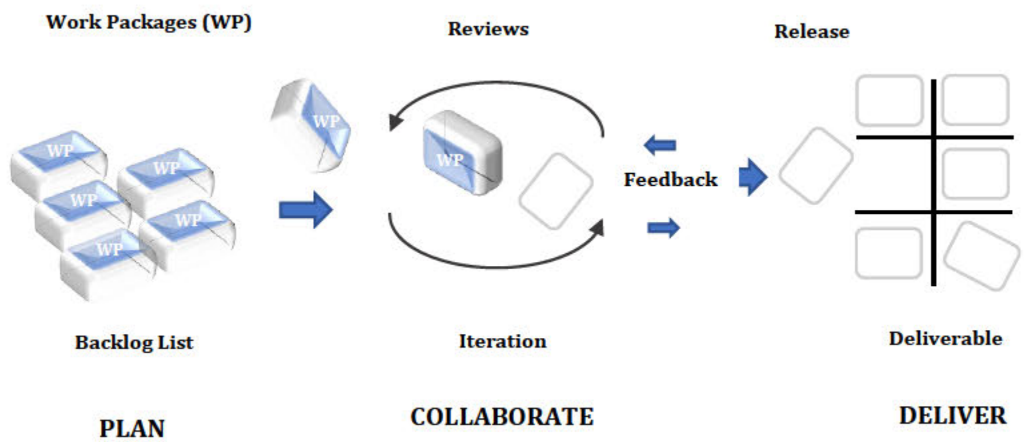


Figure 2.2. Collaborative decision-making process.

The effort of the collaboration is iterative which will be subjected to regular reviews to curb deviations and attend to the mitigation of risks and issues. There must be feedbacks, however, to ensure the releases of the agreed deliverables are of the desired quality and meet the acceptance criteria that had been set in the planning stages of the research or the building of the deliverables.

There are two assumptions made on the outcome of the collaboration decision making process. These are:

- Provision of better information to all parties and throughout the collaborative effort will lead to better decision-making. Tools and procedures, such as agile approach which need to be in place to respond easily to changing conditions, needs to be in place.
- By sharing information, values, and preferences, team members learn from each other and build a common pool of knowledge that can be transferred, resulting in decisions and actions that are most valuable to the collaboration system.

A collaboration system has in it a set of tools that create a workflow of information to specific teams and their respective team members. This allows individuals to share their ideas and talents with other members in the collaborative effort so that the task can be accomplished both efficiently and effectively.

There are several factors that have an influence on a collaboration system, but there are two essential features that not only need to be tailored according to the goals, but also need to be taken into consideration when it comes to corporate culture (Swink, 2006). They are:

- Unstructured Collaboration: Matching answers to unknown questions and using tools to share information about the problems at stake while increasing personal productivity.
- Structured Collaboration: Sharing collective knowledge and written rules in a structured manner and the setting of workflow in a way that does not change.

This thesis will focus basically on both unstructured and structured collaboration, as it is widely used in all cross-sector collaboration efforts harnessing the benefits of the two approaches.

2.3.6. Structured and Unstructured Collaboration Benefits

Structured collaboration approaches encourage the maturing of introspection behaviour and communication (Grover, 2012; Nsanzumuhire and Groot, 2020). These methods aim mainly to increase the chances of success of the organisation as the team gets engaged in collaborative problem solving (van Poorten and Beck, 2021). Some of the positive aspects of structured collaboration are that it makes organising of the partnership easier; provides an excellent hierarchal structure of the organisations involved; facilities increased competences; reduces contradictions in the information exchanged; ensures that members on the team more likely to understand and/or acknowledge their role and act accordingly in the organisation. An unstructured collaboration will foster innovation and quality variance set through the same workflow in the structured collaboration (Diamantini et al., 2016). If an agile approach exists, it will assist the partners to respond to any rapid changes in the research effort and will encourage groupthink as well as reduce conflicts in the collaborative environment (Chitta et al., 2012).

In order to create a collaborative working culture that responds to the demand of a fast-paced environment, the structure of the firm needs to be examined and evaluated first to get a better understanding on developing a collaboration culture model best fits the specific organisation.

2.4. A Culture of Collaboration

The issue with the question underlying the concept of culture, on the one hand, is it is so actively discussed in both academic circles and beyond (Valsiner 2009) and on the other hand, there is a confusion in academic community with the various definitions of culture itself (Jahoda, 2012). Culture is a complex concept and there is no single definition of it that has achieved consensus in literature. From the various assessed definitions, the following definition guides consideration of culture in this study, i.e., culture is a set of shared and enduring values, meaning, and beliefs that characterise groups and set their behaviour (Mironenko and Sorokin, 2018).

The question addressed in this study is “what”? That is, “what” is the central (at least, in terms of popularity) that refers to both internal and external properties of research collaboration between UK universities and technology firms? Therefore, in response to the unusual ontological congruence between internal and external, the fundamental “ontological shift”, “reversing the poles” of the human-related reality. The human individual becomes its core element and pivot. Other “objects”, “external” in relation to the individual (for example social structures and institutions), undergo such massive and rapid changes that grow progressively ambiguous and sometimes less “real”, comparing to the individual. The “inner” nature of the individual also transforms from being “subjected” to think, act and feel according to certain external conditions, an individual becomes an Actor, who is empowered to change the environment following his purposive plans, desires, and visions.

There is a proliferation of various contradicting definitions of culture e.g., references to both internal and external properties (Johada, 2012). Most studies have, however, categorised various macro culture such as occupations, nations, or big organisations. Researchers have therefore, used these categorisations to develop several definitions with a considerable degree of overlap on the various levels of “observability” (*see* Table 2.1).

All the phenomena and concepts identified in Table 2.1 relates to the culture that deal with elements that group members share or hold in common. None of the factors in Table 2.1, however, are implied as unique to the culture of a country, organisation, occupation, or group. Several studies argued against the need for the word culture when many other concepts exist, such as norms, values, behaviour patterns, rituals, traditions (e.g., Eriksen, 2001; Geertz, 2008), however, the word culture adds several other critical elements to the concept of collaboration between entities.

Before explaining the suggested perceptions of culture as shown in Table 2.1, it is appropriate to give a usable and dynamic definition that highlights how culture is formed, encouraged, and evolves in a dynamic research collaboration between UK universities and digital technology firms.

The significance of the concepts and phenomena of culture imply that it covers several elements that a group or team has learned as it evolves. However, in moving forward in the advocacy for a beneficial and dynamic integrative research partnership between UK universities and tech firms, the forgoing culture classification in Table 2.1 will assist in formal definition of culture, with a view for it as a dynamic holistic process.

Table 2.1: The Problem of Defining Culture
(Adapted from *Organisational Culture and Leadership*: Schein, 2017, pp.3-4)

Concepts	Authors	Observation Cultural Elements
Observed behaviour (People Interaction)	e.g., Goffman, 1959, 1967; Jones *et al.*, 1988; Trice and Beyer, 1993; van Maanen, 1979; Schein, 2017.	Observed interaction patterns, customs, and traditions become evident in all the groups in a variety of situations. The language used with regularities in the interaction such as "Thank you" followed by "Don't mention it," or "How is your day going so far," "Just fine."
Climate	e.g., Ashkanasy *et al.*, 2000; Schneider, 1990; Tagiuri and Litwin, 1968; Ehrhart *et al.*, 2013.	The feeling that is conveyed in a group by the physical layout and the way in which members of the organisation interact with each other, with customers, or with other outsiders. Climate is sometimes included as an artefact of culture and is sometimes kept as a separate phenomenon.
Formal Rituals and Celebrations	e.g., Trice and Beyer, 1993; Deal and Kennedy, 1982, 1999.	The ways in which a group celebrates key events that reflect important values or important values or important "passages" by members such as promotion, completion of important projects, and milestones.
Espoused Values	e.g., Deal and Kennedy, 1982, 1999; Schmidt and Rosenberg, 2014.	The articulated, publicly announced principles and values that the group claims to be trying to achieve, such as "product quality," "price leadership," or "safety". Many companies in Silicon Valley such as Google and Netflix announce their culture in terms of such values in all of their recruiting materials and in books about themselves.
Formal Philosophy	e.g., Ouchi, 1981; Pascale and Athos, 1981; Packard, 1995; Schmidt and Rosenberg, 2014.	The broad policies and ideological principles that guide a group's actions toward stockholders, employees, customers, and other stakeholders such as the highly publicised "HP way" of Hewlett-Packard or, more recently, the explicit statements about culture in Netflix and Google.
Group Norms	e.g., Homans, 1950; Kilmann and Saxton, 1983, Klevorick et al. (1995).	The implicit standards and values that evolve in working groups, such as the norm of "a fair day's work for a fair day's pay" that evolved among workers in the Bank Wiring Room in the classic Hawthorne.
Rules of the Game	e.g., Schein, 1968, 1978; van Maanen, 1976, 1979b; Ritti and Funkhouser, 1987; Deal and Kennedy, 1999.	These are the implicit, unwritten rules for getting along in the organisation, "the ropes" that the newcomer must learn to become accepted member, "the way we do things around here".
Identity and Image of Self	e.g., Schultz, 1995; Hatch, 1990; Hatch and Schultz, 2004.	How the organisation view itself in terms of "who we are," "what is our purpose," and "how we do things".
Embedded Skills	e.g., Argyris and Schon, 1978; Cook and Yanow, 1993; Peters and Waterman, 1982; Ang and van Dyne, 2008.	The special competencies displayed by the group members in accomplishing certain tasks, the ability to make certain things that get passed on from generation to generation without necessarily being articulated in writing.
Habits of thinking, mental models, or linguistic paradigms	e.g., Douglas, 1986; Hofstede, 1991, 2001; Hofstede et al., 2010; Hatch and Schultz, 2004.	The shared cognitive frames that guide the perceptions, thoughts, and language used by the members of a group and are taught to new members in the socialisation or "onboarding" process as it is now often called.
Shared meanings	e.g., Geertz, 1973; Smiecich, 1983; Weick, 1995; Weick and Sutcliffe, 2001; Geertz, 2001; Hatch and Schultz, 2004.	The emergent understandings that are created by group members as they interact with each other where the same words used in different cultures can have very different meanings.
Root Metaphors or Integrating Symbols	e.g., Gagliardi, 1990; Hatch, 1990; Pondy *et al.*, 1983; Schultz, 1995.	The ways that group evolve to characterise themselves, which may or may not be appreciated consciously but become embodied in buildings, office lay-outs, and other material artefacts of the group. This level of the culture reflects the emotional and aesthetic response of members as contrasted with the cognitive or evaluative response.

The reason for a formal definition is that on one hand, there are different distinctive clusters of factors that can be used to classify the 130 UK universities, such as, student population, sizes, research funding as well as pre-and post 1992 classifications (Shattock, 2013; Boliver, 2015). On the other hand, for tech firms, there are different categorisations that highlights their diversities, such as, gradient in level of intellectual works, knowledge sharing, product market performance, and stock shares (Keeble and Wilkinson, 2017). Although, all these clusters of classifications and categorisations may have differing shared configurations in their own terms, the definition of the collaboration culture in this study deliberately focuses more on the general process of how culture is learned and evolve in a theoretical context. However, in the practice context, according to Schein (2017), the focus may incorporate diverse additional elements to make sense in accordance with the working relationship that has been developed between a specific university and a particular digital technology firm.

The development of a culture for collaboration is crucial in the success of an effective collaboration management that enables a beneficial partnering between UK universities and tech firms, where the fundamental components are the people of the organisations.

Therefore, in this study, the collaboration culture in a dynamic research collaboration between UK universities and digital technology firms shares the views of Graesser et al. (2018) that behavioural and attitudinal norms are developed and sustained by either conscious or subconscious learning. These two factors are considered as acceptable path to *accumulated shared learning* that can be transferred with a *collaborative approach to problem solution* and those that require external adaptation and internal integration in a *collaborative approach to solve 'wicked' problem* (Gruber and Schlegelmilch, 2014).

It is important to expand on the importance of each component of the above views in preparation for the more detail analysis of these elements that will feature in this thesis.

2.4.1. Behavioural and Attitudinal Norms

Earliest behaviour is established as norms and become reinforced as shared learning. These provides meaning and stability as they become, in a sense, the cultural instructions for future members such as beliefs, values, and desired behaviours that launched the group and made it successful. This early level of beliefs, values, and desired behaviour becomes the *de facto* reality become taken-for-granted fundamental assumptions of the group subsequently, becoming their awareness. Over time, these assumptions become accepted stable, therefore, serving as the basis of latter ways of doing things and with this it becomes a culture that will continue to evolve. Noteworthy, is that these elements, learned early and composing the cultural instruction, are the source of the group's stability and cannot be changed without changing the group altogether. This point is understood at the outset because culture-change programs can work only if they are consistent with the group's cultural DNA.

2.4.2. Accumulated Shared Learning

Shared result of shared learning (*e.g.,* Edmondson, 2012) is the most important element in the definition of culture. To fully understand a given group's culture, we will need to know the culture complexities and the significance of the history of the shared learning over a time span and what kinds of top management exist. Deciphering such history is impossible with pre-literate culture of nations and some occupations; however, with contemporary organisations' collaboration work groups, it is possible and fruitful to begin culture analysis with historical analysis.

If learning is shared and the group identifies with it, it forces the identity formation and cohesion that come into play to stabilise that learning because and as it evolves, it begins to define the group and what is their purpose or "reason to be". The various components of what is learned then become a pattern or the template of beliefs and values that give meaning to the daily effort and work of the group. If the group record successes in achieving its objectives and is internally well organised, it will come to take these beliefs and values, along with the accompanying behavioural norms, for granted, and will naturally teach them to newcomers to the group as the way that members think, feeling, and behave. In many ways this can be thought of as the group's mindset and sense of identity, which has both an external component of how the organisation collaboration with others while, which is presented itself to the outside and internal stakeholders as what defines its inner sense of itself is.

To change this culture will requires a change in the mindset of all members of that group (Jeffries et al., 1996). However, the identity created in social and organisational situations by culture are very powerful and cannot be changed by simply saying "here are the new rules" (Clutterbuck and Crainer, 1990, p.195). Schein (2010) pointed out that these forces are powerful because they operate outside awareness. Culture, according to Schein (2017) is made of three levels, illustrated in Figure 2.2.

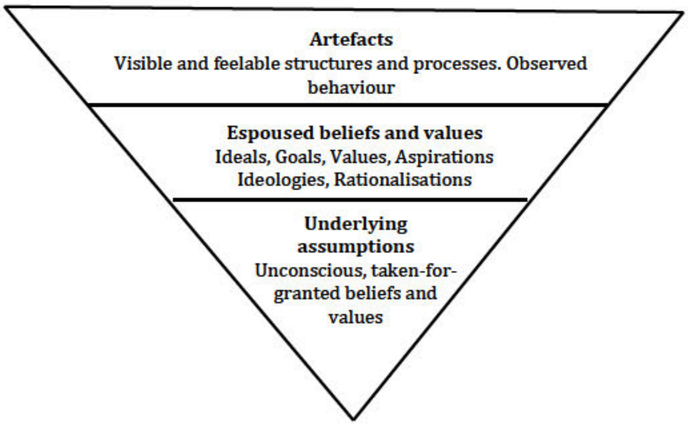


Figure 2.3: Three Levels of Culture (Schein, 2010)

The tangible, overt behaviours are the visible manifestations of a culture. These artefacts are underpinned by the conscious beliefs, values, ideals, goals, ideologies, and aspirations of the culture. In turn, the foundations of the culture are the unconscious, assumed beliefs and values, which drive behaviour, perception, thought and feeling. These underlying basic assumptions must change for an organisational culture to change.

Underlying basic learning are non-confrontable and non-debatable (Schein, 2010). Those who do not share 'the learning' are seen as dissident and are often unconsciously kept outside the 'cultural web' within the group or organisation (Johnson and Scholes, 2002, p.230). However, such unconscious beliefs and values often mature from procedures and measurement systems, which are seen as a communication of what senior management consider to be important (Beckford, 2010). Therefore, a way to change organisational culture is to design maturity measurement systems and procedures that are congruent with the desired culture. Eventually, these will become culturally embedded as part of the underlying value and belief system of the organisation, and so behaviour will change to reflect this.

2.4.3. Collaborative Approach to Problem Solution

A collaborative approach that provides a solution to problems, is made not only in the corporate sector but in every profession that has assisted organisations to making effective and efficient decisions. The Collaborative Problem Solving (CPS) approach demonstrates effectiveness by organisational employees with a wide range of other professional, social, emotional, and behavioural challenges across a variety of different settings from various consumers, clients, team leaders, and team members (Phan and Siegel, 2006).

Applying the CPS to the collaboration between organisations, the model sets out two key principles:

- First, the problems are well understood in terms of the necessity, the issue as well as provision of solutions that are used to translate the vision and strategy into objectives and measures (rather than pointing out mistakes of group members)
- Second, these problems are best addressed through mutual discussions, i.e., allowing all views to be considered; letting all collaborative stakeholder speak, and ensuring that all relevant issues raised are considered (rather enforcing superiority and domination by controlling group members).

Whilst solving a problem with a collaborative approach, it is significant to know that there are alternatives to some unique single problems that may be addressed differently by team members that share a common idea that give the best solution to the problem. Resolving problems collaboratively does not necessarily have to be complicated, but it requires leadership experience and patience, so it can take a while for all stakeholders involved to feel comfortable and keep their views open.

2.4.4. Collaborative Problem Solution (CPS) Planning

There is the need for the development of a planning approach for solving the problems of process activities for a dynamic collaboration (Nelson, 1999). The approach may affect the completion of collaborative tasks to meet the objective of the collaboration. CPS culture makes it explicit that there are three options available to members in the partnership of how to respond to existence of a ‘wicked problem’. These three options are referred to in this study as: Plan 1 (the original ambitious plan), Plan 2 (a collaborated/compromised solution), and Plan 3 (put points on hold or give up on collaboration).

Plan 1 relates to delivery of ideal ambitious plan/solution. Plan 1 requires considerable mutual agreement, how the potential outcome is high. Unfortunately, high expectations in Plan 1 also greatly increases the possibility of the ideas being a challenge to members in the partnership. For example, partners in the collaboration may feel that some of these ideas have been imposed on them by a partner that wanted to take leadership of the collaborative effort. Therefore, Plan 1 that can possibly lead to challenging behaviour, does not teach the skills that a partnering member lacked.

Plan 3 can be used strategically, as it is possible that resolution of all the collaboration problems and completion of all objectives may not be achievable at the same time. Plan 3 is to prioritise and decide the tasks that needed to be accomplished first. Plan 3 facilitates stakeholders to put some problems or unmet expectations on the "back burner" while, addressing higher priority problems - allowing some challenging behaviours to be consequently reduced (or managed).

Plan 2, which relates to development of a collaborated or compromised solution, involves four basic steps.

- Identify and understand all member of the teams' concerns and opinion regarding the problem,
- Identify and share the leader of the collaborative effort concerns about the same issue,
- Brainstorm solutions and share views together with the leaders and junior partners,
- The junior partners and leader working together to assess the potential solutions and choose the one that is both realistic, mutually satisfactory, effective, and efficient.

Plan 2 can feel slow - "like slogging through mud" - in the beginning, but the continuous use of Plan 2 helps solve problems that are precipitating challenging behaviour in a durable way while, thus building healthy professional relationships, thinking skills, intrinsic motivation, and confidence to achieve the objectives within a given period. Illustrated in Figure 2.4. below is the collaborative problem-solving planning

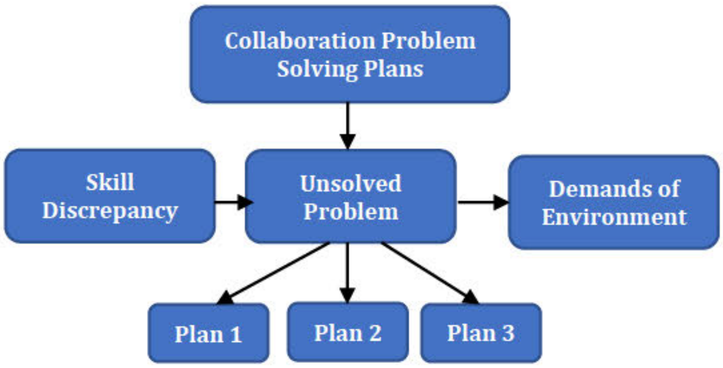


Figure 2.4: Collaborative Problem Solving

2.4.5. Collaborative Approach for 'Wicked' Problem Solving

Several research collaborative efforts present complex problems that are difficult to resolve as result of several factors e.g., organisational cultural differences. However, some problems are truly 'wicked'. A wicked problem is a social or cultural problem that is difficult (or impossible) to solve due to: incomplete or contradictory knowledge, the number of people and opinions involved, the large economic burden on those involved, and the interconnected nature of these problems with other problems. These 'wicked problems' are often difficult to define and constitute a collection of conflicting views by partners and typically cross organisational boundaries.

Key managers responsible for the collaborative effort can address such wicked problems by adopting a collaborative approach (van Der Vleuten and Schuwirth, 2005; Weber and Khademian, 2008; Sørensen and Torfing, 2011). Such an approach which focuses on the underlying causes of the problem to resolve wicked problems, includes three key features:

- A commitment to engage all members in the team,
- Decisions based on both qualitative and quantitative techniques,
- Focus on collaborative effort outcomes and benefits.

Members in the partnership that are engaged in a collaborative journey of consultation and engagement may have varied opinions and ideas on the nature of the problem and the 'right' solution. However, bringing all the affected parties together can assist to build a sense of shared ownership so that commitment to solutions and their delivery are increased.

2.5. External Adaptation and Internal Integration

One of the inherent dangers in collaborating with external organisations is the cultural changes that precipitates on the assumption that internal integration strategy and external adaption issues are somehow separate from culture. This is where a group aims to focus solely on the development of the internal cultural change mechanism, i.e., where a group aims to make life pleasant for itself without addressing the issues of the external cultural mechanism. Emphasis on analysing and/or improving only on an organisation's internal collaboration therefore, without identifying and developing its strength on working with external parties, i.e., to achieve needed strategic objectives reveals i) an organisation with immature collaborative management practices; and ii) an organisation that lacks collaboration processes, facilitation resources, and strategic plans. If an organisation's senior management lacked an awareness of the advantages of knowledge transfers and incentives for participating in collaboration with strategic partners, such as universities, then they would struggle with the insights into solutions to problems of the evolving digital economy (Rajaeian et al., 2018). An organisation that fails to be dynamic to evolve a collaboration strategy according to the changing economic needs for a solution facing the organisations, will have a culture that encourages succumbing to increasing mediocrity (Friedman, 2014).

As series of studies covering the reduction of organisational value slippage and efficiency (Nightingale, 2000; Avison et al., 2001; Mowles, 2008) suggests that an effective matured culture of learning and collaboration management are some of the incentives to effective performance and the increase of an organisation's value exchange. Focusing only on the internal management of collaborative efforts within the local organisation's ecosystem or economic cluster, for example, the "socio-technical systems" that Baxter and Sommerville (2011) described as interaction between complex infrastructures and human behaviour, will not ensure the development of aligned (if not integrated) external and internal cultural maturity dimensions. In business organisations, the efforts to ensure the reduction of value slippage has led to various performance measurement methods such as a "scorecard" or a "double bottom line", which emphasises the internal organisational health and allows it to function and maintain itself (Bagnoli and Megali, 2011; Maas and Liket, 2011; Mair and Sharma, 2012). However, based on increasing disruptive digital technology innovations, a process by which a product or service is powered by a digital technology enabler will affect how it takes root in simple applications at the low end of a market (Simmons et al., 2013; Snow et al., 2017; Skog et al., 2018). This occurs typically when technology becomes less expensive and more accessible, it will often replace existing upmarket products, eventually globally displacing established competitors (Christensen et al., 2015; Sousa and Rocha, 2019). As such, there is the need for a maturity framework that is lightweight and easy for organisations to use in the evaluation of the stages of the development of their external collaboration (Guo et al., 2019).

2.6. Application of Maturity Framework in Research Collaboration

There is a place/need for a lightweight evaluation framework for assessing research collaboration as part of research collaboration management (Pries-Heje and Pries-Heje, 2012; Guo et al., 2019). This should not be seen as a means of criticising the original stakeholders or organisational requirements, but rather as a constructive activity that leads to effective management of collaboration with external partners. Essentially, the evaluation should be concerned with collaboration health check and 'fill the gaps' in the analysis of the development of the organisation's culture in responding to aligning its objectives to the provision of a solution which may arise because of incompleteness or incorrectness, or subsequent organisational maturity level of awareness (Venable et al., 2012): for example, a digital technology firm having increased new requirements or the need for changes in existing requirements because of new innovations or various forms of disruptions affecting the side of survival will need to revaluate possible collaborations to support the development of more efficient solution (Enkel and Gassman, 2010). The collaboration culture of the organisation to collaborate needs to be re-assessed in terms of the wider development project to solve the problem. This reassessment is due to be evolutionary changes to the shape of the organisational agility culture to the delivery of the solution through collaboration, hence, the nature of the evaluation of whether the system meets its goals. An inexpensive self-assessing framework will be useful because of the regularity of the evaluation.

One of the primary roles of self-assessment framework is contribution to the process of 'domestication' (Guo et al., 2019), that is, if there is a collaboration culture is embedded in the organisation. When collaboration culture is embedded, it will assist teams or groups in a new collaboration effort to self-assess and measure their maturity for an external partnership for solution to a problem. It will also be easier for changes to both the collaboration management and business processes as the collaboration culture has become an integral part of the group everyday activities. This may, of course, lead to changes in the management of the partnership and further analysis and reconstruction of new stages for the activities to meet with new challenges. However, the changes required may be process changes that people carry out to fit the behaviour for a normal work practice.

There is considerable variation in the understanding of the term culture by organisation's top management. This variation is inevitably confusing to potential adopters of these approaches. Culture has its original roots in the research of anthropologists and sociologists yet has resulted in many models and perspectives (Schein, 2017). However, culture is also often linked with the field of organisational management science. Many different fields of studies have ultimately adopted the term, 'organisational culture', yet often apply their own interpretation of scope; sometimes focusing on the social dimension, sometimes focusing on the technical dimension, but rarely on both together. This may help to explain the somewhat disparate nature of the literature (e.g., Griffiths and Dougherty, 2001).

Studies that focus on organisational culture came to prominence in the 1980s. These studies expounded company traditions, employees' beliefs, organisational roles, set of patterns for company's activities, and management attitudes. Moreover, various research described i) how their culture can support or impedes the CEO's strategy for the expansion of that company; often because of diverse subcultures within the larger organisation (Schein, 2017), and ii) that the corporate culture can create difficulties when moving from one level of corporate culture to another "It's like putting your hand in a cloud" (Schein, 2017, p.149).

To develop organisational collaboration, it is important that the people involved in a specific collaborative development project have an agreed understanding that increasing the level of collaboration maturity within the organisation to that will yield value to the company. This particularly applies to the management and the workforce, to ensure that the development team collaborating with the university focus on the appropriate social and technical aspects of the collaborative effort and how these are interdependent and interact. The critical point is that there needs to be agreement about the social and technical elements of the maturity level that need to be jointly optimised to facilitate collaboration.

2.6.1. Levels of Collaboration Maturity Abstraction

Terminology is a problem in determining the appropriate levels of collaboration maturity abstraction, i.e., when analysing and describing the research collaboration between UK universities and digital technology firms. Rather than using different terms to describe the same thing, here we are talking about people describing the same maturity level but using different descriptions of abstraction for the labels in each level. This is often because they draw the categorisation boundaries in different places according to the understanding and experience of the people within the organisation. There is a tendency by some to decompose the collaboration culture of the organisation by considering separate social and technical dimensions. The depth of analysis for each of the sub-systems is then given different emphasis, with the focus often falling mostly on the technical aspects of the system (Eason, 2001).

Finding the appropriate level of research collaboration abstraction - for each stage of maturity - is critical, but often not easy. For example, Hollnagel (1998) criticises the work of how maturity levels for over-emphasises the context, of operation: including the organisational aspects, yet neglecting consideration of individual behaviour. Hollnagel (1998) argues that current approaches cannot satisfactorily explain why humans perform erroneous actions and, hence, cannot be used in human reliability analysis. On balance, when this view is taken to the extreme, undesirable labels are simplistically seen as the result of organisational failings, which stack the odds against the human operators in the collaboration, who are then portrayed as the innocent victims of these failings. In other words, it overlooks the fact that the context includes individuals, often working as part of the collaboration, who through their own volition could still theoretically perform the correct action.

2.6.2. Conflicting Value of Collaboration Maturity

When attempting to make sense of the literature, Kanter (1994) suggested that research collaboration can be divided into three basic extreme categories with varying set of values i.e., *mutual service consortia*, *joint ventures*, and *value-chain partnerships*. Each category is based on a set of values that underpins much of the thinking around the cultural collaborative maturity.

The first set of values that was expanded by Contractor and Lorange (2002) i.e., *mutual service consortia*, describes companies in a similar industry that pool their resources. Both companies gain the benefit from an output that would have been too expensive to achieve alone, such as the development / purchase of an advanced technology. The second set of values, often described as managerial values is view, *joint ventures*, which describes a relationship developed as a means of achieving a strategic company's objectives, particularly economic ones (Caloghirou et al., 2003). This is when companies pursue an opportunity that needs a capability from the other stakeholders. In this mode of operation partnering companies might operate independently, however, may link operations. The strongest of the categories is the *value-chain partnerships* (Ilyas et al., 2007). In the context of this research, concerning collaboration between UK universities and digital technology firms, a *value-chain partnership* could be represented by multiple stakeholders that creates a centre of excellence that can be used by multiple contributing organisations to provide cutting edge solutions against challenges to organisational survival (Peus and Fray, 2009).

An organisation aiming to improve the quality of its product, service or maximise value, and increase market shares, may require specialist input, could interact with universities to achieve the objective or solution (Peus and Fray, 2009; Calvard and Hine, 2014; Mesa and Usrey, 2014). In principle, for development, invention and creativity focused on efficiency and cost-cutting, and without consideration of inherent value, there could be i) various types of collaborations that leads to better organisational performance; ii) skill development for employees, and iii) several company's benefits from such partnerships (Mesa and Usrey, 2014). Companies, such as digital technology firms need to have improved relationships with universities to complement their skills and capabilities that assists to create value. Commitment in these relationships is significant, as partners will tend to require changes in several functional areas, that may often become complex in relating operations integration. Therefore, these conversions often create substantial unexpected changes to partner's organisation culture. These changes are essential for increase in productivity that will automatically follow and generate added value for the organisation (Kanter, 1994).

Approaches to contextual humanistic collaboration efforts for the provision of value are primarily geared to the use culture development at different maturity levels to build systems that provides more effective organisational support for collaboration with observational category. This is because collaboration actors make choices according to perceived options (Corbin and Strauss, 1990). According to Glaser and Strauss (2017), pragmatism and symbolic interactionism share this position. Therefore, since the research collaboration phenomenon and the other concepts associated with it, such as the development of the culture and maturity stages, are not conceived from literature as static but continually formed in response to the prevailing context / conditions, the grounded theory analysis appears encouraging to be applied as a qualitative approach and as a possibility that can be considered as an intermediate category. There are other qualitative approaches, such as ethnography, which is based on multiple detailed observations of what people do in a social setting, for example, an illuminative account of social life and culture in a particular social system.

Some academic work in this area (Heath and Cowley, 2004; Walker and Myrick, 2006) adopted an ethnomethodological approach where, it is claimed, the analysis of the findings was not influenced by any theoretical framework or an intended outcome. Although the extent to which such analysis is value-free is, of course, debatable.

Grounded theory, as a procedure in this context, seeks to uncover the relevant conditions that support collaboration between universities and digital technology firms to determine how the actors in the context actively respond to those conditions and the consequences of their actions (Corbin and Strauss, 1990; O'Shea et al., 2008). It is the responsibility of the researcher to capture the interplay between the actors within the context. To do this, the technique needs to be consistent independent on whether the focus of a study.

The data collection procedures used in literature, to evaluate the maturity level of research collaboration, can be divided into two significant categories (Corbin and Strauss, 1990): i) interviews of actors to develop a collaboration artefact with differing values, and ii) key actors involved in funded and non-funded research collaborations are interrogated in order assess / observe the impact of collaboration on their organisation's culture. Other sources of data collection, such as government and university's knowledge transfer centre documents, newspapers, letters, as well as books, can be used to provide needed insights on the questions under study. Each of these sources will be coded in the same way as interviews or observations (Glaser and Strauss, 2017). The researcher used the methods suggested in the literature by Guba (1981); Hammersley and Atkinson (1983); Kirk and Miller (1986) in the interview and evaluation work to ensure credibility of respondents' responses and avoid the researcher's bias in the designing of the questions and observations. The researcher follows similar protective procedures for collecting and analysing the data on the values held by actors in research collaboration.

Problems may arise when there are different and conflicting value expectations from the collaboration by the actors (Avison et al*.,* 2001; Schein, 2017) which may lead to a conflict of interests. The dichotomy between the two data collection categories helps to identify and explain "what", key barriers exist to collaborations between universities and organisations applying humanistic values. Answering "how" questions, allow the research to consider 'how' organisations are applying the managerial values and / or 'how' a dynamic research collaboration yields productive success to stakeholders in the partnerships.

2.7. Economic Benefits of Collaboration

There has been substantial theorising around how universities collaborate with external economic partners for various economic benefits (Calvert and Patel, 2003; Altbach, 2009; Keeble and Wilkinson, 2017). This collaboration usually differs based on the perception of benefits. Recent published examples, considering works the role of collaboration between local universities and UK as well as European regional digital technology-based SMEs are comparatively scarce (Keeble and Wilkinson, 2017). Consequently, there has limited evaluation of the efficacy of using a research collaboration approaches. Keeble and Wilkinson (2017) conducted a thematic overview based on high levels of inter-firm collaboration, cooperation, and strong links with local knowledge centres, such as those in universities, however stressed that existing socio-technical collaboration approaches were not specific enough to allow for empirical testing. A reason also linked for the lack for the lack of effective evaluation may be the predominant emphasis on collaboration research design driven in the UK by poor research funding which negatively impacts the long-term longitudinal culture of research developments (Dahlstrand, 2017).

Local universities and public research institutes have over the years used collaborations to shape the growth of European regional digital technology-based SMEs clusters; usually characterised by substantial number of innovative small and energetic entrepreneurs that collaborate at low levels in fragmented digital manufacturing and service activities (Camagni and Capello, 2017). However, it is the USA digital technology advanced firms that drive the agenda of regional high-technology clusters (Keeble and Wilkinson, 2017; Tamasy and Sternberg, 2017). Despite, the 1990s, European-wide recession, most high digital high-technology clusters appear to have been growing rapidly i.e., through processes such as new firm collaboration spin-offs and endogenous expansions: characterised by new forms of production organisation (Camagni and Capello, 2017; Dahlsrand, 2017; Smith and de Bernardy, 2017). There are problems and a lack of literature concerning the assessment of research collaboration between universities and the digital technology firms and in understanding the evolutionary trajectories and forces driving these trajectories, the evolutionary of success criteria, and the process of value creation.

The problem of assessing research collaboration successes also includes not establishing the evaluation criteria for the research collaboration elements. Whilst benchmark tests can be used to define or explain the technical part of research collaboration, measuring the appropriate criteria (e.g., awareness of the improvement of the culture, throughput of the maturity process, cost/benefit analysis), realisation is difficult to determine. These characterisations require an instrument or tool to examine derived effects. For example, if a digital technology firm is able to increase its competitive market / advantage through the introduction of a capable or solution disruptive technology (as a first order effect of value creativity), with improvement measured through the changes in the level of sustainability improvement, technology solutions that gather data from internal and external sources, storages that provide access via a network, improvements in management planning, and increases in productivity (Gilbert and Bower, 2002; Land, 2000). This evaluation is made harder by the fact that there are other, quite separate, influences on these factors and in many cases, it may be impossible to link them directly to a new digital technology firm. Three significant influencers from literature are cultural (Schein, 2017), behavioural (Lovegrove and Thomas, 2013), and physical (De Geus, 2011).

Furthermore, the success (or otherwise) of collaboration value creativity, research value, and implementation is defined and scoped differently by different stakeholders, e.g., university operators, researchers, middle management, and top-level management (Land, 2000) with categories of stakeholders having potentially a different (or multiple) criteria concerning the success of the research collaboration and the values. New methods may be perceived by managers and researchers differently; with many seeing collaboration as an additional effort, drain on time, and resources. Accordingly, it is critical to be able to demonstrate the cost-benefits of research collaboration maturity.

Related to the lack of criteria for success is the absence of work that demonstrates the cost-benefits of research collaboration maturity approach and tools. Similar problems have also affected collaborations in other (related) Fields of Science and Technology, and more generally, human factors/ergonomics (Mowery and Sampat, 2004; van Raan, 2004). New methods may be perceived by managers and researchers as simply adding extra time, effort, and cost to what are already long and expensive development projects. Demonstrating the cost effectiveness of an approach for dynamic research collaboration should be an important goal, as is needed for them to integrate with existing collaboration design development processes (Phan and Siegel, 2006).

2.8. Impact of Academic Research Collaboration with Digital Technology Firms

Impact has been part of the thinking of funding research for quite some time and has always been part of research evaluation. This focus has been framed in several ways that includes knowledge transfer, third stream activities, social benefits, public values, and knowledge exchange (Bornmann, 2013).

The HEFCE (Higher Education Funding Council for England), the body that determines funding for universities in the UK, defines research impact as ‘any identifiable benefit or positive influence on the economy, society, public policy or services, culture, and the environment or quality of life' (HEFCE, 2019). Stepping away from literature, an everyday definition of impact could be 'the degree that research has changed the world outside academia for the better' (Cruickshank, 2016). Framed in this way many academics warm to the idea of impact and actively aspire to this beyond a tactical engagement with politics or funding priorities. Many academics are keen to see their work having a wider resonance beyond academia.

The economic benefits link between research excellence and high impact research have been given prominence as significant in assisting higher education in the UK to contribute more effectively to the improvement of the performance of the economy (Johnes, 1996). Following this trajectory therefore, there is the need to challenge the assumptions that are still sometimes prevalent in academia, that 'outward facing' or Mode 2 research is separate, and of lower quality than pure or Mode 1 research (Martin, 2011). The targeted outcome of this thesis is to emphases that Mode 2 is different but no less valid and further that moving between these Modes gives an academic robust base to build both new theory and impactful research.

The new thinking from the prevalent assumptions about and in describing research emerging from the sociology of science and management fields are in the two fields of building a theoretical position that distinguishes between traditional and new 'outward facing' research. For the 'traditional' or Mode 1 research, focus is on new knowledge as defined by a set of peers within a particular discipline while, the 'outward facing' or Mode 2 research focus on academic activities that are cross disciplinary, external collaboration, and problem solving without a well-defined body or peers (Gibbons, 2000). Ernø-Kjølhede and Hansson (2011) described Mode 2 research as those that seeks knowledge for application by the society whereas, Mode 1 research is aimed at accumulation of 'centrified, true knowledge as an end in itself' (Gibbons et al., 1994).

The explanations of the two Modes research have expressed the motivations for an increase in the emergence of Mode 2 research (also described as non-linear or post-normal science). The concept of the Mode 2 research is becoming more widespread within UK universities largely due to growing political pressure to make research more readily applicable and to improve cooperation between public and private players (Ernø-

Kjølhede and Hansson, 2011). This emphasis was reflected in the University Grants Committee (UGC) process where impact was included within the research effectiveness key performance indicator (Auranen and Nieminen, 2010). There is an element of recognition of the effect of research outside of academia as part of the research evaluation in the Research Excellence Framework (REF). The current REF needs to spotlight on the effectiveness of Mode 2 research impact more directly to include collaboration between UK universities and digital technology firms.

2.9. The Research Gap

There are various motivations for university-industry collaborations (UIC): in a win-win situation, companies or firms profit from highly skilled and qualified human resources such as researchers and experts (Myoken, 2013); they gain access to technology and knowledge (Barnes et al., 2002); firms can use expensive research infrastructure (Ankrah and AL-Tabbaa, 2015). In return, universities benefit from additional funding provided, from access to industry equipment or from licensing or patenting income (Barnes et al., 2002). According to Freitas et al. (2013), over 10 per cent of global new processes or products are based on the contribution of academic research. Collaboration with industry has increasingly become part of university income and the funds from business enterprises and international organisations for R&D in the higher education currently represent a 'significant source' in many countries (OECD, 2015). Considering these effects and

The financial relevance impacts make it is significant for a successful management of UICs to ensure the realisation of the benefits on both sides. Research articles on university collaboration and partnerships have increased in recent years, however, there is not yet research on the management of research collaboration barriers between universities and digital technology firms in the UK. There is the need to be able to manage knowledge transfer between UK universities with research partners within the proximity of collaborating actors that is generally considered beneficial (Dahlstrand, 2017). From studies such as Markman et al. (2008) for example generally refers to only individual lessons learned. Recent reviews summarizing the literature have mostly focused on other issues: for example, Perkmann et al. (2013) investigate how academic engagement differs from commercialisation (in the sense of the exploitation of patented inventions), Schofield's (2013) focused on the success factors in the emerging market context while, Ankrah and AL-Tabbaa (2015) also investigated the success factors, focusing primarily on organisational forms of UICs, motivations for UICs as well as their formation and operationalisation. Asheim (2000) focused on the impact of proximity on collaboration in contemporary academic hubs or clusters (Lundequist and Power, 2002), coining the term 'business cluster'.

Therefore, this thesis aims to fill the gap in the reduction of barriers in the management of collaboration between UK universities and digital technology firms in business clusters by identifying relevant management success factors, establishing a model for organising them, providing practical recommended actions, and suggestions for future research. The strong focus on the main question 'What are the key indicators to reducing barriers to dynamic research collaboration between UK universities and digital technology firms?' distinguishes this research from others that mostly examine this question merely as a subtopic. The adoption of a comprehensive research approach well-established in Information System research allows a more thorough analysis of barrier factors that inhibits the UICs' success in business clusters, which goes beyond existing research such as those mentioned above. This research intends to add to a better understanding of UIC research collaboration and managing the barriers while connecting the fragmented collaboration process for the purposes of addressing multifaceted concerns and enable digital technology firms and UK universities to thrive and survive leading to both competitive advantage as well as encouraging economic revival (Sørensen et al., 2016). This will be achieved not only by summarising the evidence and findings but also by developing a conceptual model and organisational empowering artefact based on a rigorous and transparent methodological approach, including the most recent research.

2.10. Research Questions Formulation

The last step of the Systematic Literature Review (SLR) described in Figure 2.1, relates to formulating of the two research questions. These research questions are: RQ1 - What are the key indicators to reducing barriers to dynamic research collaboration between UK universities and digital technology firms? and RQ2 - How can UK universities and digital technology firms have value from dynamic research collaboration?

The research questions are defined by identifying gaps in literature on the internal and external environment and the ecosystems of UK universities and digital technology firms.

Similarly related, is the lack of assessment instruments to assist in recurring successful collaborations by digital technology firms, and the barriers that are contributing to the slow adoption of research collaboration with UK universities in development of value in technology solutions. These indicators are also presented as motivators. The barriers are the components that obstruct the process of implementing an initiative. Finally, the results are the goals obtained with the adoption of the initiative.

2.10.1. Research Questions

The first question, RQ1, was formulated with consideration to prior scholarships on collaborations between several universities and external parties that relates to societal improvement, providing current or future solutions, skills, and knowledge transfer, such as, awareness, new information, knowledge transfer, and improved organisational productivity in an increasingly changing world. The provisions of methodological skills have had a significant impact on the growing number of technological advancements and innovations that require sophisticated knowledge and critical thinking to design (Bozeman and Corley, 2004). This is particularly significant at present, i.e., when universities are endeavouring to creatively fulfil their societal roles and missions other than the central responsibility of only a teaching mission (Ordorika and Pusser, 2007).

In this thesis, research is characterised as funded research, which is still the central value of top-tier universities; as academic rewards and institutional prestige for individual faculty members is commonly bestowed largely due to research productivity and impact (Altbach, 2009). In several countries, including the UK, research can take several forms. There is pure research, applied research, and in humanities, interpretation of texts, or gaining insights on literature as well as historical (Altbach, 2009). All are centrally focused on the discovery of new knowledge in areas such as pure research and applied research which are current the main interest of most universities. The research for this thesis reflects on dynamic collaboration with external parties to generate income from research output such as application of technological solutions to complex problems and scientific discoveries, and commercial products or related practical goals. It will be significant for an effective assessment tool and / or design a framework to make applied research function to be dynamic and useful for the collaboration of both universities and digital technology firms.

The second question, RQ2, is structured to identify the impact of the value attached either as an outcome and / or output of research collaboration when it is birthed to meet digital technology complex initiative objectives. In this case, the important criteria are evaluated and made applicable in the context.

2.10.2. Concepts Influencing the Research Questions

There are certain criteria that conditioned the formulation of both RQ1 and RQ2. The criteria are grouped into three significant elements to assist in the designing of a self-assessment evaluator framework for a dynamic research collaboration between UK universities and digital technology external partners. From the SLR in Chapter 2, the three relevant themes: *Cultural*, *Behavioural*, and *Physical*.

In the context of research collaboration in university academic community, *cultural* is viewed a barrier in effective collaboration (Schein, 2017). The incompatibility in culture within the universities include narrow focus on knowledge transfer, lack of research skills, and imposition of non-research disciplines which do not support collaborative relationships with external parties and business stakeholders. There is, similarly, lack of training and development of new mindsets, i.e., that will support collaborative research initiatives. For digital technology firms, incompatible culture includes dogged desire to undertake problem solving and decision-making based on a silo mentality that ignores the greater operation that affect efficiency as opposed to through a research collaborative processes that encourages growth (Flowers and Edeki, 2013).

For the *behavioural*, Lovegrove and Thomas (2013) and Schein (2017) identified this concept as ethical business approach that focused on the emergence of widespread unethical decision-making and challenges management challenges such as unwillingness to share / hide information between partners and inimical behaviour to obtain or steal research information. Development of trust between stakeholders in a collaboration is an identified issue in literature (De Cremer et al., 2011). Unwillingness of organisations to share information impedes the implementation of research initiatives, since exchange of information is the basis of much collaboration. In most collaborative partnerships while, a lack of trust also impedes the development of the collaborative relationships. This makes trust to be regarded as a key success factor. Similarly, deficiency in the information and communication flow will result in data and information inaccuracy that may detract from the performance of the entire chain.

The *physical* concept in collaborative activities or ventures between UK universities and external organisations, specifically small and medium enterprises, often centres on management insufficiencies, as the proprietor or the instigator of the company may wear many management hats that does not give adequate opportunity for broadminded thinking. This may give rise to a tendentious relationship in the collaboration as a single individual is juggling several business activities usually will not meet UK universities requirement (De Geus, 2011). Lack of financial resources and increasing cost required for the implementation research project initiatives is seen as a barrier to development of industrial innovation research (Mansfield, 1991; Frenkel, 2003).

2.11. Summary

Ultimately, as stated by Austin (2000), “alliances are successful when key individuals connect personally and emotionally with the alliance’s social purpose and with one another” (p.173). Intra- and inter-personal needs of individuals must be addressed along with that of organisations in collaboration if alliances are going to be successful. The development of a self-assessment framework for academic and practice will need to be easy to use and inexpensive. The framework can be used as a tool to both assess the level of the organisation level of collaboration attainment and to improve the culture of collaboration that may improve the success of a strategic partnership.

Several theorists have demonstrated in literature that there are positive impacts in practice when industries or external entities have collaborative efforts with universities (Moodysson and Jonsson, 2007; Magdalene et al., 2009). The lack of innovation and creativity have often been attributed to the silo mentality of several sectors of in most economies (Enkel and Gassman, 2010). The UK is not an exception in this criticism. However, collaboration is agreed to be a complex concept that requires understanding and tools to make self-assessments of the capabilities to be matched or improved to meet the universities high standard requirements for a partnership, joint venture, or collaboration. The collaboration process is therefore, described to fall within a continuum of low to high integration levels and are in different performing stages.

Terminology and confusion on how to improve at each of the different performing levels of the collaboration is a problem in literature and practice. Determining the appropriate levels of collaboration maturity abstraction, i.e., when analysing and describing the research collaboration between UK universities and digital technology firms is still an issue in the literature on UK universities collaboration with industries. Rather the use of different terms to describe the same thing, this research with a self-assessment evaluator will be able to describe the same maturity levels and use similar descriptors of the abstraction for the labels in each level.

The problem of assessment in current literature on collaboration successes includes the absence of established evaluation criteria for the research collaboration elements for universities. Whilst there are several benchmark tests setup and used by universities, they cannot be use by potential stakeholders or entrepreneurs to define or explain the technical part of research collaboration such as measuring the appropriate criteria (e.g., awareness of the improvement of the culture, throughput of the maturity process, cost/benefit analysis). The realisation of such is difficult or confusing to determine. These characterisations require an instrument or tool to examine derived effects. For example, if a digital technology firm is able to increase its competitive market / advantage through the introduction of a capable or solution disruptive technology (as a first order effect of value creativity), with improvement measured through the changes in the level of sustainability improvement, technology solutions that gather data from internal and external sources, storages that provide access via a network, improvements in management planning, and increases in productivity (Gilbert and Bower, 2002; Land, 2000). Evaluator maturity criteria for an inexpensive self-assessment will make it easier for a company to understand the factors, and in many cases, the link the significant influencers on their collaboration culture.

CHAPTER THREE

METHODOLOGY AND OBJECTIVES FOR A SOLUTION

3.1. Introduction

In this chapter, a reliable research method that is adequate for the development of a self-assessment artefact with evaluators that can be used by stakeholders in a collaboration is introduced as the epistemological framework used to underpin the collection of data, and evaluation of artefacts developed within this research. The Design Science Research (DSR) in Information Systems (IS) and its paradigm applicability are considered while it was explored as suitable for this research. To ensure its fit for purpose, the DSR features, and applicability were explained and demonstrated with variety of approaches to ensure it is a research method that could be advocated for a maturing discipline of research collaboration between UK universities and digital technology firms.

DSR is considered a "lens" or set of synthetic and analytical techniques distinguished from routine design by the *production of outstanding (to a community) new and true knowledge* i.e., generally produce a new artefact using state-of- practice application with state-of-practice techniques and readily available components to a desirable level. Its perspectives are complementary to interpretive, positivist, and critical views, used for performing research in IS (Vaishnavi and Kuechler, 2015). DSR has two primary activities to improve and understand the behaviour of aspects of IS: i) the creation of new knowledge through design of novel or innovative artifacts (things or processes) and ii) the analysis of the artifact's use and/or performance with reflection and abstraction. The artifacts created in the DSR process are and not limited to, algorithms, human/computer interfaces, and system design methodologies or languages.

DSR is a rapidly evolving field (Vaishnavi and Kuechler, 2015). There are several excellent DSR process models (cf. Peffers et al., 2008; Hevner et al., 2004; March and Storey, 2008) that have been developed and regularly used by researchers to create or contribute to new as well as interesting design science knowledge that fits into the area of "a body of intellectually tough, analytic, partly formalizable, partly empirical teachable doctrine about the design process" (Simon, 1996). A DSR model used in this research from these models emphasised core components such as i) awareness of problem, ii) suggestion as new insights into the problem continued to emerge even as, precisely, potential solutions to the problem were considered during the alternating iterative cycles of discussion, iii) awareness of problem is revisited from any of the phases considered as a form of "drilling down" into the problem or re-scoping the research at a more basic level iv) development of artefacts iv) continuous evaluation of the artefacts v) conclusion with the codification of the problem development, design basis in prior work, the design itself, and the results of the evaluation effort.

The DSR preferred model from the above with the detailed process for generating design science knowledge is the Peffers et al. (2008) version of DSR Methodology. In this chapter, Peffers *et al.* (2008) phases are considered in more detail. This includes the explanation of the relevance of Peffers et al. (2008) to research collaboration evaluative framework described in Chapter 2. This was triangulated to represent the effort to development of the dynamic research collaboration between UK universities and digital technology firms. A reference model used in the triangulation of the solution to the problem was identified and used in a discussion of the initial search for a solution for assessment of levels of the maturity of collaborative efforts as an enabler for it to be dynamic and the advancement of the designed artefact to be simpler to understand.

Section 3.2 presented the details of the intellectual discuss the DSR method in the context of research collaboration between UK universities and digital technology firms. Section 3.3 discussed the cognitive processes of the DSR to bring the use of the method for the design of artefacts while, Section 3.4 described the DSR model perspective of Peffers et al. (2008) for the study of the research context. Section 3.5 summarised the features of the iterations in the Peffers' DSR paradigm. Section 3.6 described the maturity reference model and its significance in the simplification of suggested solutions and Section 3.7 discussed the importance of a maturity model to underpin the designing of a solution to the identified problem. Section 3.8 presented the importance of DSR to the research questions and in Section 3.9 the DSR significance to a self-assessment framework. Section 3.10. showed how DSR method is applied for innovation and finally, the chapter is summarised in Section 3.11.

3.2. Design Science Research Method

Research collaborations between Higher Education Institutions such as, universities, and external partners demonstrates similar occurrences in information systems discipline that is concerned with the interaction of information and people. Several researchers in information systems have presented, demonstrated, and evaluated frameworks for use of DSR in the information systems discipline in interdisciplinary fields. They applied research theory from other disciplines such as computer science, the social sciences, and management science to solve problems in their fields. This follows Orlikowski and Baroudi (1991) view that, "the research approaches adopted by researchers [...] are influenced to a greater or lesser extent by the various institutional contexts within which they are trained and work." (p.24). Therefore, this study is influenced by the Information Systems and Computing discipline context, thereby, motivating the author to follow the DSR methodological framework that applies to the business informatics context.

One of the most influential models for DSR was by Hevner et al. (2004); shown in Table 3.1. Hevner's model became an influencer of design science as it attempts to cover what constitutes a good DSR through a set of seven guidelines below.

Table 3.1: DSR Guidelines (Hevner *et al.*, 2004)

DSR Guidelines	Explanation of Guidelines
Design as an artefact	the research must produce viable artefact(s), as defined by March and Storey (2008).
Problem relevance	the research must address an important and relevant business problem (p.83).
Design evaluation	the utility, quality, and efficacy must be "rigorously demonstrated via well-executed evaluation methods" (p.83).
Research contribution	the research must provide "clear and verifiable contributions" (p.83).
Research rigour	the research must apply "rigorous methods in both the construction and evaluation of the ... artefact" (p.83).
Design as a search process	the research process is a cyclical problem-solving process, where solutions are tested against each other and against their efficacy for solving the problem.
Communication of the research	the research must be appropriately presented to both an academic and professional audience.

Despite such influence, Venable et al. (2012) found that very few researchers that have used the DSR paradigm, adhered to all seven of the mandatory guidelines. There is often a form of generalisation to the application guidelines that makes it too dogmatic, and not specifically useful in context of the problem. The is the need to use the DSR paradigm that suitable for the problem identified in the business informatic context and equally adhere to the significant relevant elements of the Hevner's guidelines.

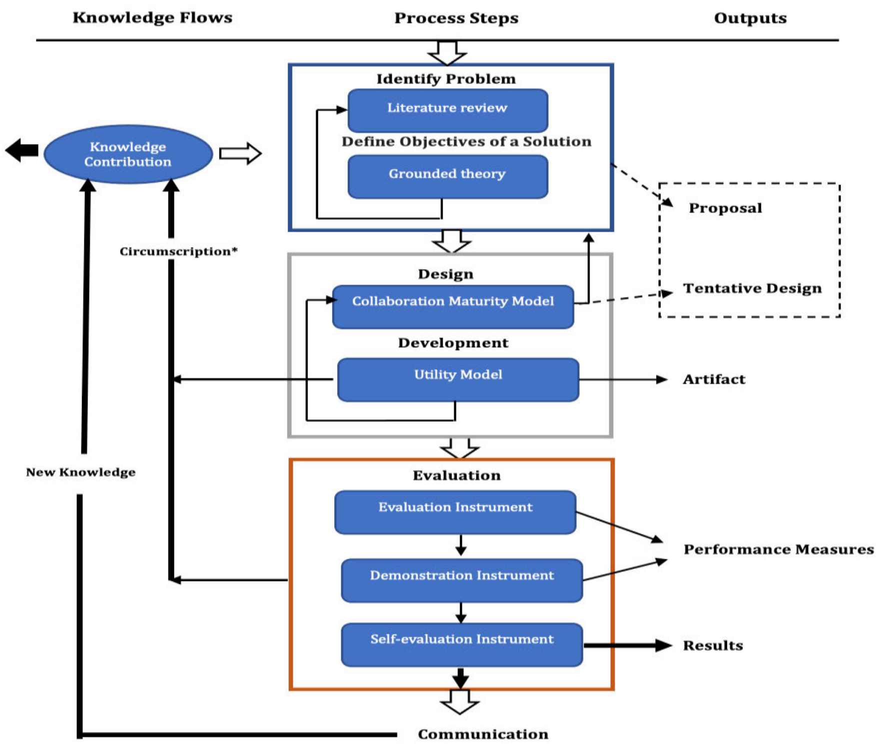
3.3. The Cognitive Processes in the Design Science Research

To bring the artifact design activities into an intellectual level focus, the design of phases in this research are carried out iteratively (see Figure 3.1) to meet the desired goals. The phases are a mixture of the varying cognition that emerges during the research cycle and referenced to the conceptual map of an *inner environment*, an *outer environment*, and the *interface* between the two (Simon, 1996). The inner environment is the set of components that make up the artifact and their relationships, the organisations, of the artifact while, the outer environment is the total set of external forces and effects that act on the artifact (Vaishnavi and Kuechler, 2015; Vaishnavi et al., 2017).

The behaviour of each of the artifacts in each of the iterative phases is constrained by both its organisation and its outer environment. The design activity is the bringing-to-be of an artifact, components, and their organisation, which interfaces in a desired manner with its outer environment. The phases for the design of the artifact are "structurally coupled" in this research to assist in the understanding of the influence of the environments and many of the concepts of structural coupling that Varela (1988) and Maturana and Varela (1987) developed for biological entities made applicable to designing artifacts with design science research (Vaishnavi et al., 2017).

Consistent with the design science research model previously described, this research begins with *Identify Problem* and *Define Objectives of a solution* phase as shown in Figure 3.1 below. The focus on problem-solving / performance-improving nature of the design science research activity sometimes makes it to be identified as "Improvement Research". *Design and Development* for a problem solution phase are inductively drawn from the existing knowledge / theory base for the problem area (Lee et al., 2011). However, the suggested designs for this phase may be inadequate for the problem or have significant knowledge gaps (this escalates the problem into a research problem). Using existing knowledge, an attempt is made at creatively solving the problem. The solution in this phase is a tentative design that can be used to implement further artifact in several phases. Partially or fully successful implementations are then *evaluated* according to a functional specification (sometimes implicit) during the *Evaluation* phase. Iteratively, the *Development*, *Evaluation,* and further *Design* phases are frequently performed during the research effort. The basis of the iteration, indicated by the *Circumscription* arrow flow from partial completion of the cycle, goes back to *Identify Problem* and *Define Objectives of a Solution*. *Communication* indicates the conclusion of a research cycle or the termination of a specific design science research project.

From the adaptation in Figure 3.1 below, though the computable design process is similar, the phases are different while, the activities carried out within the phases are considerably different. Also, the focus introduced in this adaption is the contribution of new (and true) knowledge. The adaptation shown in Figure 3.1 can therefore, be interpreted as an elaboration combination of both the Knowledge Using Process and the Knowledge Building Process.



*Circumscription is discovery of constraint knowledge about theories gained through detection and analysis of contradictions when things do not work according to theory (McCarthy, 1986)

Figure 3.1: Conceptual framework adaptation of research design frame, and Borges, 2009)

3.3.1. Knowledge Contribution / New Knowledge

Knowledge contribution resulting from new knowledge production is indicated in Figure 3.5 by the arrows labelled as *Circumscription* and *New Knowledge*. The *Circumscription* process is significant to the process of understanding the designing of the artifacts in design science research process because it generates *understanding that could only be gained from the specific act of construction*. Circumscription is a formal logical process (McCarthy, 1986) that assumes that every fragment of knowledge is valid only in certain situations. Further, the applicability of knowledge is truly determined through detection and analysis of contradictions that implies that a design science researcher '*learns or discovers'* when things '*don't'* work according to theory (Peffers et al., 2008). This happens many times not due to a misunderstanding of the theory, but due to the necessarily incomplete nature of *any* knowledge base. The design science research process, when interrupted and forced back to *Identify Problem* and *Define Objectives of a Solution* in this way, contributes valuable *constraint knowledge* to the understanding of the always-incomplete-theories that abductively motivated the original research.

3.3.2. Identify Problem and Define Objectives of a Solution Phase

For this research, phase of awareness of a research problem may come from multiple sources, such as new developments in industry or identification of problems within a reference discipline. Findings in an allied discipline may also provide the opportunity for application of new output to the researcher's field. The output of this phase is a Proposal, formal or informal, for a new research effort.

3.3.3. Design Phase

This *Design* phase follows immediately the proposal and is intimately connected with the proposal developed based on the *Identification* and *Definition of a Solution* of a Problem. Indeed, in any formal proposal for design science research, such as one to be made to the publicly funded research or government research grant agency or an industry sponsor, a Tentative Design and the performance of a prototype based on that design would be an integral part of the Proposal. Moreover, if after investing considerable effort on an interesting problem a Tentative Design or at least the rudiment of an idea for problem solution does not present itself to the researcher, the idea (Proposal) will be set aside. It is this intimate connection between the Proposal and Tentative Design that serves as the reason for the dotted line surrounding the arrows and the outputs of the *Identification* and *Definition of a Solution* and *Design* phase in Figure 3.5. *Design* is essentially a creative step wherein new functionality is envisioned based on a novel configuration of either existing or existing elements.

The step to be used would be to organise the empirical secondary observations in literature into coherent and meaningful frameworks. This framework which will form the first iteration allows scholars to "to make sense of the field and understand its boundaries, major findings, and challenges" (Shapira, 2011, p.1314). They provide the foundation for theory development and assist in the framework of the artefact that would be developed in this thesis which is part of the contribution to research done in this research. In this thesis, the first artefact to be developed is described as introducing non-repeatability into the design science research method since human creativity is still a poorly understood cognitive process (Nooteboom et al., 2007). However, this creative step has necessary analogues in all research methods; in positivist research, for example, creativity is inherent in the leap from curiosity about a phenomenon to the development of appropriate constructs that operationalize the phenomena that yield an appropriate research model.

3.3.4. Development Phase

The Tentative Design is further developed and implemented in this phase. The techniques for implementation will, of course, vary depending on the artifact to be created from the organised empirical observations of the findings made in literature on collaborations and partnerships by universities with the industrial sectors. The algorithm developed from the first artefact may require construction of a formal proof to show its correctness. This will be done with organising interviews with experts and those with knowledge that can assist on the established perspectives and broaden the boundary on the generally accepted outlook of the interface between universities and technology firms with the surges in the development of innovative digital technologies. For example, the increase in digital technologies that influences in the financial sector of the economy. An expert system embodying novel assumptions about human cognition in an area of interest will require the use of qualitative approach, probably using a high-level interview question.

The implementation of such interview questions will need to involve several actors from the universities and digital technology firms. This approach will assist in the development of a state-of-practice for the given artifact; the novelty is primarily in the design, not the construction of the artifact.

3.3.5. Evaluation and Demonstration Phases

Once constructed, the artifact is evaluated according to criteria that are always implicit and frequently made explicit in the Proposal (Identification and Definition of a Solution phase). Deviations from expectations, both quantitative and qualitative are carefully noted and *must be tentatively explained*. That is, the evaluation phase contains an analytic sub-phase in which hypotheses are made about the behaviour of the artifact. This phase exposes an epistemic fluidity that is in stark contrast to a strict interpretation of the positivist stance (more discussion about this appears later in the section on Philosophical Grounding of Design Science Research). At an equivalent point in positivist research, analysis either confirms or contradicts a hypothesis. Essentially, save for some consideration of future work as may be indicated by experimental results, the research effort is over. However, for a design science researcher, the research can be progressed. Rarely, in design science research, are initial hypothesis concerning behaviour completely borne out. Instead, the evaluation phase results, and additional information gained in the construction and running of the artifact are brought together and fed back to another round of *Design and Development* (cf. the circumscription arrow of Figure 3.5). While design science research often focuses on examining the utility of an artifact (e.g., Peffers et al., 2008), others have suggested that the evaluation of the artifact is evaluated for its fitness to adapt and survive within an environment (Hevner et al, 2004). The explanatory hypotheses, which are quite broad, are rarely discarded, but rather are modified to be in accord with the new observations. This suggests a new design, frequently preceded by new library research in directions suggested by deviations from theoretical performance. This conception has been observed by philosophers of science in many communities (Hevner et al, 2004).

3.3.6. Conclusion Phase

This phase could be just the end of a research cycle or is the finale of a specific research effort. The finale of a research effort is typically the result of satisficing, that is, though there are still deviations in the behaviour of the artifact from the (multiple) revised hypothetical predictions; the results are adjudged "good enough" (Peffers et al., 2008). Not only are the results of the effort consolidated and "written up" at this phase, but the knowledge gained in the effort is frequently categorized as either "firm", facts that have been learned and can be repeatedly applied or behaviour that can be repeatedly invoked, or as "loose ends", anomalous behaviour that defies explanation and may well serve as the subject of further research (Gill and Hevner, 2013). Communication is very important in research (Hevner et al., 2004). Therefore, this phase, as a conclusion of a research effort indicated by the small leftward arrow coming out of Knowledge Contribution in Figure 3.5, needs to appropriately position the research being reported and make a strong case for its knowledge contribution (Gregor and Hevner, 2013). Depending on the type of knowledge contribution and the state of knowledge in research, the expectations on the nature and depth of knowledge contribution outputs can vary.

3.4. Application of Peffers' DSR Method to Research Collaboration Context

The DSR method involves the design and development of artefacts as an iterative search process. A design artefact is complete when it satisfies or resolves the requirements and constraints of the problem that have been identified. However, these requirements and barriers are often complex. They could also be unknowable due to key environmental indicators that are not well-defined and/or complex interactions or interfaces between sub-components of the problem and its solution. Therefore, the DSR process is a problem-solving search process to generate, through test iteration, solutions that attempt to solve a clear practical issue / problem. Each attempt at a solution further clarifies the requirements and barriers in the phenomenon. Reliance on creativity, innovation and trial-and-error are characteristic of design science research.

Peffers *et al.* (2008) acknowledged that existing literature has introduced principles that define what DSR is and the practice rules that guide its conduct however, asserted that, "these are only two out of the three characteristics of a methodology ... The missing part is a procedure ... for carrying it out." (p.50). They suggested a "road map" (p.50) for those who wish to use the design science paradigm without the dogma on how it must be done, but a "good way to do it" (p.50). Peffers et al. (2008) synthesised the existing literature from information systems, computer science, and engineering to produce a process model for design science research consisting of six activities as shown in Figure 3.2.

Peffers et al. (2008) framework is graphically described in Figure 3.2 and explained in the subsequent sections.

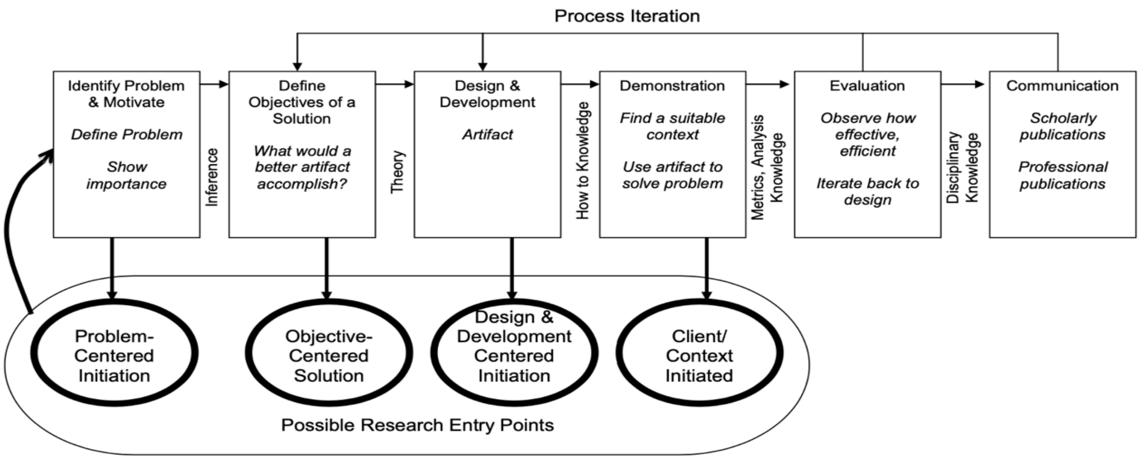


Figure 3.2: The Design Science Research Methodology (Peffers et al., 2008, p.54)

3.4.1. Identify Problem and Motivation

In this stage, the specific research problem should be defined while, the impact of the solution is justified. The problem definition is used to develop an artefact that can effectively provide a solution, it is useful to explore the problem at the highest level of granularity, so that the solution can effectively address the complexities. Justifying the value of a solution helps the audience of the research to understand the reasoning behind the researcher's perception of the problem. It also motivates the audience of the research to accept the results of the research.

Once the problem has been identified, it does not necessarily directly translate into objectives for the artefact because the process of design is necessarily one of provision of partial or incremental solutions. Consequently, after the identification of the problem, the performance objectives for a solution must still be determined.

3.4.2. Define the Objectives for a Solution

The objectives of a solution should be inferred rationally from the problem definition and from knowledge of what is both possible and feasible. The objectives can be quantitative, such as, how a desirable solution would be better than existing solutions, or qualitative, such as, description of how a new artefact is expected to support solutions to a previously not well-addressed problem.

3.4.3. Design and Development

This stage is the core of DSR as it consists of the creation of the artefact. A DSR artefact can be any designed object in which a research contribution is embedded in the design. In published DSR academic journals, artefacts tend to be constructs, models, methods, instantiations, or according to Jarvinen (2007, p.24) "new properties of technical, social, and/or informational resources."

Constructs are the conceptual vocabulary of the problem/solution space. Constructs arise during the conceptualisation of the problem and are refined throughout the design cycle. Models are representations of the design problem, the proposed solution, and the connection between them (March and Storey, 2008).

Although there are similarities between design science models and natural science theories, a framework is presented in terms of what it does (situated utility), whereas a theory is described in terms of the relationship between constructs. Examples of models include mathematical algorithms, narrative descriptions of best practice, data models, and expert systems. Methods are the steps necessary to produce a model, or part of a model that are often used to transform one model into another (March and Storey, 2008). Instantiations operationalise the constructs, models, and methods, demonstrating their effectiveness (ibid). Instantiations may precede constructs, models, and methods, in much the same way that proof of an existence can occur before a full understanding of how, why, and where it came to be.

Creation of the artefact includes determining the artefact's desired functionality and its architecture as well as creating the artefact.

3.4.4. Demonstration

This stage of the DSR framework involves demonstrating the use of the artefact to solve one or some design of the problem. This may be demonstrated by using the artefact in experimentation, simulation, case study, proof, or any other appropriate activity.

3.4.5. Evaluation

The evaluation stage consists of the observation and measurement of the effectiveness of the artefact in supporting a solution to the problem (Sarana and Mason, 2006). This involves comparing the objectives of a solution to the actual observed results from the use of the artefact in the demonstration. Evaluation can include any appropriate empirical evidence or logical proof; its form depends on the nature of the problem demonstration and the artefact.

At the end of the evaluation stage, the researcher must decide whether to iterate back to Design and Development to try to improve the artefact, or whether to continue to the Communication stage.

3.4.6. Communication

This is the last of the stages of the design science research methodology, as defined by Peffers et al, (2008), and involves the communication to both researchers and research collaborators. The communication should include: the problem and its importance; the artefact; its utility and novelty; the rigour of the design; and its effectiveness.

The Peffers et al. (2008) DSR Methodology is structured in a consequential order, but researchers may start at any of the first four steps and move onwards: a problem-centred approach would start at activity one; an objective-centred approach would start with activity two; a design- and development-centred approach would start with activity three; a client/context- initiated solution would start with activity four. The Peffers et al. (2008) DSR methodology is used extensively in information systems research (Google Scholar has 5,013 citations as of December 2019), including being advocated in the influential article by Hevner and Chatterjee (2010). This research takes a problem-centred approach and so starts at ‘Identify Problem and Motivation’.

3.5. Peffers’ Design Science Methodology Iterations

The iterations in Peffers et al. (2008) builds on the artefact produced from a preceding iteration, which can be escalated into a succeeding iteration. This process may result into multiple iterations until it reaches a saturated iteration as demonstrated in Figure 3.3.

The solution from the problem space gives better understanding through the evaluation of the demonstration of that artefact. Finally, the research ends with 'Communication'.

Figure 3.3 represents the frame that encases the elements of the iterations in this research. The basic key elements in each iteration are (a) *objectives of a solution*, (b) *learning about problem* space, and (c) *evaluation*. The initial objectives of a solution will be derived from the survey of literature on university's collaborations with stakeholders within and external to its ecosystem in Chapter 2. It is suggested in the representation of the that to have a good general view of the collaborations between universities and digital technology firms, it should be done from the survey of literature used to understand the Research Gap in Chapter 2. Actuating solution will conform to two constraints. Therefore, the provision of solution to the problem detailed in the gap in literature in Chapter 2 will be highlighted as the individual first-order factors that make up the concept of dynamic research collaboration.

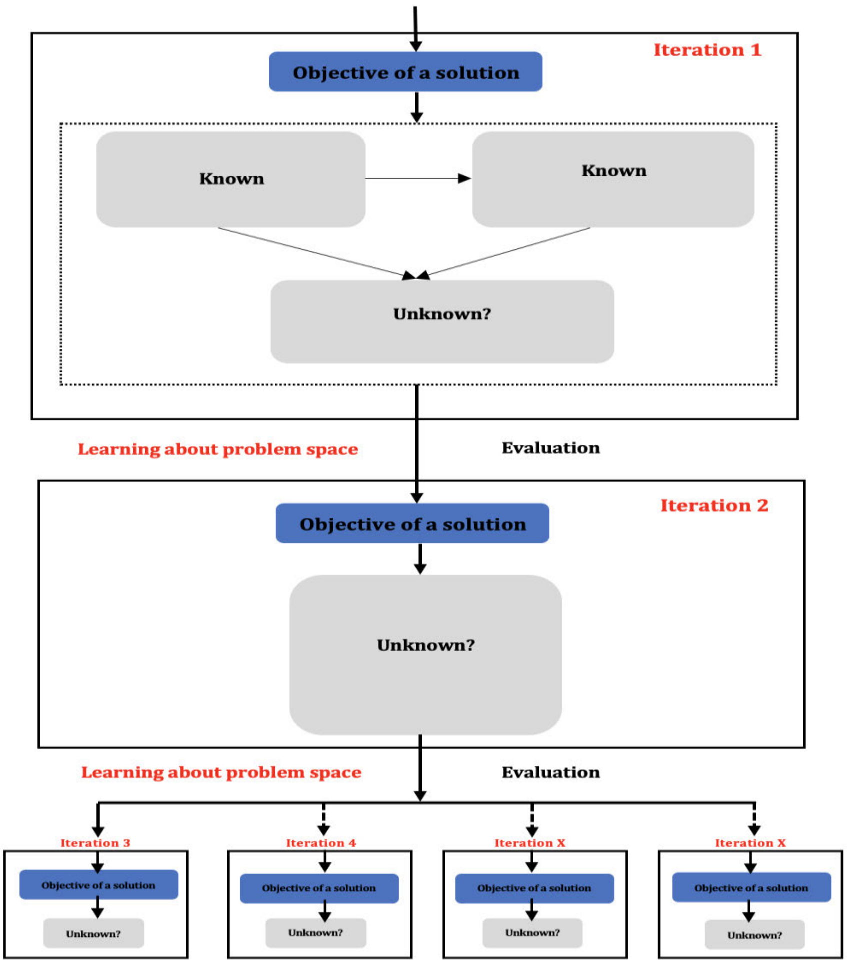


Figure 3.3: Research Iterations

The initial objectives of a solution will serve similar functions as existing DSR techniques that requires that to derive solution there should be allocated key indicators for the measurement of the derivatives to the various research collaborations. This follows Drucker's (2006) recommendation that the variable that gets measured should be easily managed; and for it to be measurable, there is the need for quantifiable assessment parameters that can be easily, effective, and understood.

In addition, if the measurement of collaboration maturity and impact goals are to be used to assess progress, i.e., towards a dynamic collaborative culture / behaviour / funding, then it must i) describe the evolutionary stages related to adoption of the dynamic research collaboration, and ii) consider built-in levels of maturity practice and high impact value. Accordingly, the solution must function as a roadmap to enable practitioners to both assess where they are, but also identify where they should aspire towards.

The solution should, therefore, be useful to all the stakeholders internally and externally in both the universities and digital technology firms that have expressed an interest in knowledge transfer. Knowledge transfer often provides either a meaningful commercial outcome and / or reputational impact value (Comunian et al., 2014). The outcomes of the collaboration are tangible representations and may be used to measure the success of the projects in the collaboration. However, as highlighted in the systematic literature review done in Chapter 2, stakeholders in UK universities and digital technology firms or creative innovators are yet to have a framework that adequately be used as a measurement to assess the collaboration process such as culture and/or organisational competences / capabilities. There are various assessment techniques available, however, they are not designed to assess nor used to measure the collaborative maturity of stakeholders in organisation for a dynamic collaboration. The purpose of this study, therefore, is not to 'reinvent-the-wheel' by developing a new knowledge-based framework for dynamic research collaboration but change/adapt the representation of collaboration that has already been shown to enable university researchers and digital technology innovators to manage their collaborative engagements. Consequently, the solution in the design of an evaluative artefact must be consistent with existing frameworks and/or theory that is identified as useful in designing the instrument for research collaboration engagements by universities and digital technology innovators; as shown in the iterations in Figure 3.3. Similarly, having an understanding from literature on the drivers and challenges to collaboration between universities and companies enhance elicit knowledge on the learning technique for UK universities and technology firms to self-assess their maturity to collaborate on meeting the increasing digital challenges. A dynamic learning organisation is an organisation that has developed the continuous capacity to mature, adapt and change (Hodges and Gill, 2014).

3.6. Reference Model to Clarify Design Solutions

There is the need to identify a suitable resourceful reference model that can be used to guide in the designing of an assessment framework for the collaboration process. There are various models that organisations use in the form of assessment instruments to overcome challenges in meeting customers' demands or ensure competitive advantage such as in customising the quality of products and services (Rugullies, 2003). However, in practice, various models, and instruments for available to organisations and groups for stage processes such as critical strategic positionings and improvement of resources disregards/lacks a stage to improve research collaboration processes (Murphy, 2004).

Currently, there is a lack of framework to self-assess by researchers, research centres, and managements of UK universities as well as digital technology firms to aid the continuous improvement of the maturity of research collaboration in academic literature (Mollas-Gallart et al., 2002; Charles and Conway, 2001; Calvert and Patel, 2002; Godin and Gingras, 2002; Pavitt, 2001). Similarly, there are no provisions in any of the existing frameworks and models to self-assess progressive maturity levels, which could be used for improving significant collaborative culture / process for research collaboration or evaluate the impact value of such collaborative partnerships. Magdaleno et al. (2009) depicting progressive levels, elements, and practice areas for collaboration, but gave no indication when an organisation has reached a goal that signifies a seamless collaborative research readiness.

Previous studies considering university collaboration with the business sectors have emphasised that awareness, process modelling, and use of digital technology devices can be used to generate a research collaboration and even improve the way participants get committed towards ensuring their work within the collaboration produce impact value (Araujo and Borges, 2007). There are several frameworks commonly used in the business domain such as the business partnerships maturity model (BPMMM) in the business management process context, and the Quality Management Maturity Grid. According to Lockett et al. (2002) one of these frameworks are used in the research of collaboration efforts or to assists stakeholders in a partnership or a venture for organisation management assessments in the levels of their processes. With these frameworks, organisation maturity growth is often divided into differing rising stages. Therefore, this research explicitly considers a process model for a systematic dynamic collaboration between UK universities and digital technology firms. Integrating growing maturity levels into a designed framework for a dynamic research collaboration between universities and digital technology firms will allow shareholders in research collaborative efforts to self-assess and plan to progressively reach higher levels. This is possible as they position an organisation relative to its performance of a given task, and so allow possible improvements to be identified (CMU-SEI, 2006). These frameworks, however, cannot stand on their own to assist alignment with identified key indicators recognised in literature on the contribution of university partnerships with stakeholders.

Often digital technology firms do not know how to promote collaboration with universities (Hansen and Nohria, 2004), and many firms adopt initiatives that are fragile and ill-structured (Murphy, 2004). Accordingly, there is the need for a framework that addresses collaboration culture, behavioural, and funding. Existing frameworks fall short and fail to encourage the dynamism for knowledge transfer that will promote knowledge and improve wealth (Calver and Patel, 2003). Similarly, there are no framework that is favoured by academics and policy makers (Khoshafian and Buckiewicz, 1995). Intuitive approaches are mostly used by academics in UK universities, yet firms that are involved with the development of digital technologies do not use scientific and robust practice to enlighten the usefulness of research impact and/or value of collaborating with trained researchers, techniques, improved data capturing instruments, tacit knowledge, and membership of international research networks (Martin et al., 2005).

The business partnerships maturity model (BPMMM) is used by organisations to determine the business maturity of their external partnerships through the identification of the stages of their strengths and weaknesses in each stage until an advanced maturity level is reached (Rosemann and Bruin, 2005). Although, this framework has human factor considerations, it does not, however, have self-assessment mechanism to investigate areas such as the existing research collaboration level in process modelling and implementation maturity process assessment. The framework also cannot be used to consider the knowledge transfer management domains (Ehms and Langen, 2000), which is essential for evaluating organisations and their processes regarding the set of values, culture, and practices needed in the framework.

The Quality Management Maturity Grid presented by Magdaleno et al. (2009) is used to measure quality management within organisations and help in determining the road to implementing an improved quality programme. This framework is firmly rooted in Crosby (1979) definition of quality as 'free from defects', and therefore cannot be used directly as a reference framework to self-assess the progress on the improvement of research collaboration elements, such as culture, behaviour, or process. However, the concepts in Crosby (1979)'s maturity grid is accepted and used by several authors to approach and determine the levels of maturity in organisational management processes. For example, Magdaleno et al. (2009) framework, CollabMM, organised activities in an evolutionary path level with a progressive seamless progression until an advanced maturity level is reached. CollabMM framework design is based on the collaboration assessment supports such as, communication planning, coordination, awareness, goals, and reflective. With the framework, organisations can take advantage of modelling their processes on an explicitly embed collaboration aspects based on the known elements. The key elements of this framework are shown in Figure 3.4, which are relevant to an envisage research collaboration framework for this study.

The CollabMM framework is organised into four maturity levels: Ad-hoc, Planned, Aware and Reflective (see Figure 3.4). Levels are a way of prioritising practices for improving collaboration in a process. A specific level comprises a group of related activities which can be executed together and aimed at improving collaborative capability processes.

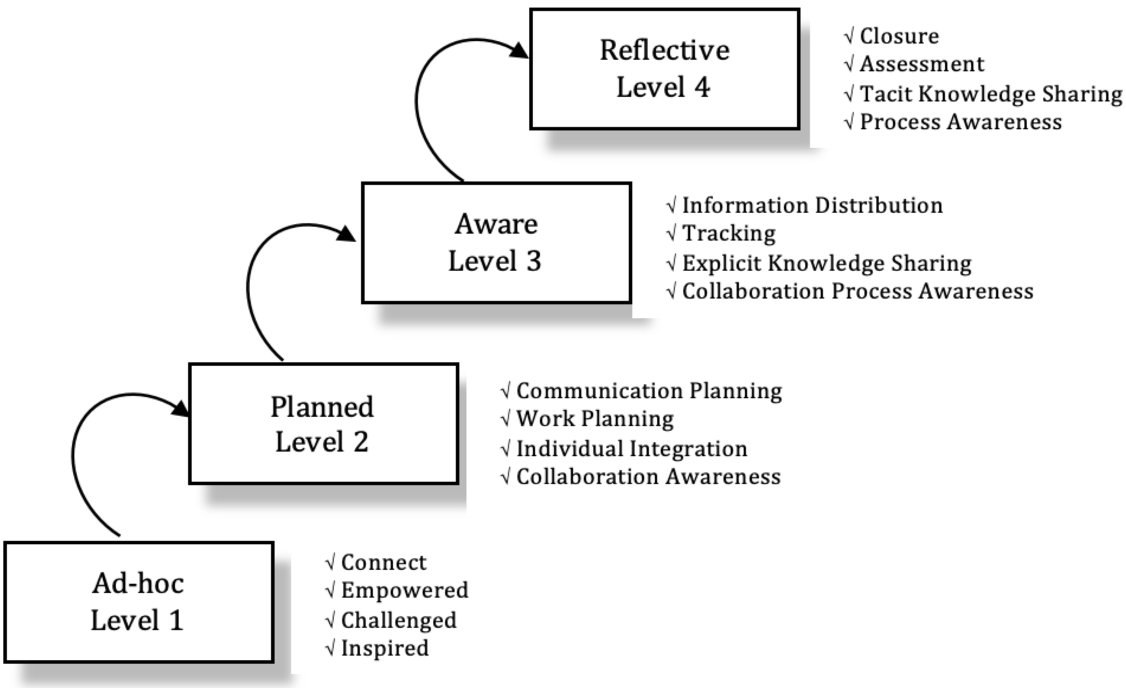


Figure 3.4: Overview of the CollabMM (Magdaleno, Araujo and Borges, 2009).

3.7. Research Collaboration Solution Support with Reference Model

A first issue arising in the attempt to consider CollabMM as a reference model is the identification of main relevant aspects for collaboration to be considered in a business process. The Groupware research area boasts of extensive literature discussing what the main aspects comprising group interaction should be. There is consensus in literature on four supporting aspects namely, communication, coordination, awareness, and group memory (Araujo and Borges, 2001). These are described as follows:

- *Communication planning:* collaborating group members agree on their channels of communication. Stakeholders need to have effectively communicate to coordinate their work, assign tasks, decisions and solve problems. Within a group, the communication can be performed in real time (synchronous) or in different times (asynchronous). In synchronous mode, participants must be simultaneously available, and the message sent is immediately received. In asynchronous mode, time is more flexible, messages can be received in a future and unknown moment. Asynchronous communication is normally used when it is desired to help participants to have time to think before continuing the communication process, while synchronous communication values the speed of communication.

- *Co*-ordination - organise the group to guarantee that tasks are performed as expected, such as expected period, desired sequences, and outcome accomplishing objectives. Co-ordination should avoid conflicting tasks and provide productivity to the group. Co-ordination comprises the pre-articulation of tasks, their follow-up and the post-articulation or wrap-up of group execution. Co-ordination may also deal with interpersonal conflicts such as competition, lack of orientation, hierarchy influences and lack of responsibility. Co-ordination means 'to keep the group alive', stimulating contributions, and establishing group dynamics.

- *Group memory* - record of information related to the development of group activities; memory preservation of both the formal knowledge (obtained through documents, artefacts etc.,) and the informal knowledge (decisions, ideas, comments etc.,) (Link et al., 2007) the rationale through which artefacts had been created.

- *Awareness* - understanding the activities of others such as common interests to contextualise own activities (Dourish and Bellotti, 1992). Stakeholders should clearly understand the group's common objective, the role of each member in the group, what must be done and what the results and impacts of each member's activity are.

The present work starts from this initial classification to organise specific practices which can be embedded into business processes as an attempt to improve the collaboration, based on the literature in groupware research. The CollabMM, as a reference framework, may not be perfectly suited framework for a research collaboration between universities and technology firms without its utility however, it is a good fit as a skeletal background.

3.8. Significance of the DSR Paradigm to the Research Questions

Research is well-recognised as an activity that contributes to the understanding and provision of a solution(s) to a phenomenon. A phenomenon, typically, is a set of behaviours of entity(ies) that the researcher or a research group find interesting to provide solution(s) using research questions (Manson, 2006). The set of activities a research community considers suitable to provide understanding and / or knowledge are its research paradigms or methods or techniques. Some research communities such as in pure science that features deductions from theories and experimentations, historically have near unanimous agreement on the research methods to probe and study any phenomena of interest. These are considered paradigmatic communities. Other research communities are bound into various nominal communities through an overlap in the sets of phenomena of interest and / or overlap in methods of investigation. These are regarded as pre-paradigmatic or multi-paradigmatic research communities. Research of phenomena in the information and communication technology (ICT) based disciplines, such as, information systems (IS) are examples of multi-paradigmatic communities. The paradigm of the research methods and standards in the multi-paradigmatic communities is influenced by the aims, objectives, solutions, and the formulated research questions.

The two research questions are: RQ1: What are the key indicators to reducing barriers to dynamic research collaboration between UK universities and digital technology firms? and RQ2: How can UK universities and digital technology firms have value from dynamic research collaborations?

The two research questions are formulated and structured to develop solutions that would enhance the recognition of the significance of the need for research intensive local environments and within the ecosystems that could be used by stakeholders to have holistic understanding of research collaboration. The exploration of the contrasts in dynamic research collaboration and assist in the design of solutions as well as the evaluation of the designed solution artefacts requires the use of a paradigm that can answer the research questions.

3.9. Significance of DSR to Self-assessment Framework

UK universities should not only focus on educating the nation but also provide ideas for technological economic development through having impactful entrepreneurial research collaborative initiatives with organisations (Ordorika and Pusser, 2007). In the USA, universities have played historical roles in the technological development of the country; for example, serving as incubators of innovative and creative ideas and transferring knowledge to emerging technical expertise needed for nation-building (Pucciarelli and Kaplan, 2016). Following examples of several universities in the USA, some universities started the development of knowledge transfer clusters and entrepreneurial centres that are used as alternative standard for growing commercialisation of knowledge by for-profit service providers (Markman et al., 2008). According to Dahlstrand (2017) the numbers of such developments with knowledge transfer clusters are increasing while becoming a benchmark for academic respectability and acceptance in UK universities.

In the effort that universities want to be entrepreneurial and technology firms to be market-relevant in the 21st century digital knowledge economy, knowledge transfer clusters are increasingly providing new resources, competences, and capabilities to extend university's quintessential traditional roles (Altbach, 2009; Rajaeian et al., 2018). Therefore, universities and digital technology firms should regularly assess and evaluate their collaborative progress against set priorities, commitments, and aims, by using relevant assessment tools (Camilleri, 2017). However, the multifaceted issues facing universities are perceived in the form of "wicked problems" (Altbach, 2009); that is, "problems" that are contradictory and incomplete in the effort to respond to changing societal requirements with solutions that are tough to determine due to the complexities in variable interdependencies. These complexities cannot be addressed by theory development or testing *per se*, therefore, cannot be easily classified within the quantitative or qualitative paradigms. There is the need for a methodology that produces explicit applicable research solution suitable for a specific knowledge domain. Designing and evaluating an effective solution for a dynamic research collaboration, between universities and digital technology firms, should be motivated through a methodology that gives the right capabilities, and not concerned whether a particular solution fits theory A or theory B if it works.

A methodology is "a system of principles, practices, and procedures applied to a specific branch of knowledge" (DMReview, 2007). Researchers in the IS community need a methodology to produce and present high-quality research that is accepted, valuable, rigorous, and publishable in IS research outlets. For IS research, the acceptable methodology that may assist would include three elements: conceptual principles to define what is meant by the research, practice rules, and a process for carrying out and presenting the research (Peffers *et al.*, 2008). It is significant for this thesis to have an effective methodology framework to address the questions associated with effective assessments by stakeholders in dynamic research collaboration between UK universities and digital technology firms.

Fundamentally, there is a mismatch in the nature of the problem facing on one hand, UK universities, such as, research funding, and on the other hand, digital technology firm, such as expert skills (Eve and Schenk, 2006). The nature of the dichotomy of these problems requires the use of an adequate paradigm to answer the research questions. Using the natural science or behavioural science paradigms will not provide the opportunity for the designing of an artefact that can be evaluated and used as an evaluative framework with impact value that faces dynamic research collaboration.

However, there is a third paradigm, i.e., Design Science Research (DSR), which involves a rigorous process to design artifacts to solve observed problems, to make research contributions, to evaluate the designs, and to communicate the results to appropriate stakeholders (Hevner et al., 2004). Such artifacts may include constructs, models, methods, assessment tools, and instantiations (*ibid.*). Artefacts may also include social innovations (van Aken, 2005) or new properties of technical, social, or informational resources (Järvinen, 2007). In short, this definition covers any designed object with an embedded solution to an understood research problem.

DSR came into focus in the early 1970s as an alternative paradigm to the natural sciences' positivist paradigm and the behavioural sciences' constructivist/interpretivist paradigm. The paradigm was increasingly used in various disciplines such as, information systems, engineering, architecture, and increasingly used to design framework for undertaking research, and has recently been used in the field of education (Peffers *et al.* (2008).

From all the study on the use of suitable paradigm in the IS domain, according to Simon (1969), DSR has three characteristics:

- Firstly, it functions at the boundary between the problem space and the solution space, both of which should be explored as part of the research. This makes DSR relevant for problems that are not easily defined theoretically.
- Secondly, utility is significant to DSR. One of the descriptions of utility is by Berman (2013) and Read (2007), which state that the solution should be useful, profitable, or beneficial. This is in contrast with the positivist and constructivist/interpretivist paradigms, whose chief concern is the discovery of 'truth', either absolutely or triangulated from multiple socially constructed 'truths'.

- Thirdly, DSR is creative, iterative, and evaluative. It is not sufficient for research to produce a novel solution; that solution must be evaluated for utility and must be improved on until the desired level of utility is reached, with this desired level defined by practitioners.

These characteristics show that DSR is applicable to various fields of academic disciplines, i.e., where the goal of research is to devise a course of action aimed at changing existing situations into preferred ones; concerned not with how things are, but with how things should be.

Although Design Science has, to the best of our knowledge, not been used in the domain of dynamic research collaboration, it has been proved and accepted through academic rigor in other research domains to have the ability to address the problems associated with effective assessments by stakeholders in dynamic research collaboration between UK universities and digital technology firms. DSR, as a research paradigm in IS, offers the potential to change the interface between research and practice. If utility is the starting point for research into dynamic research collaboration, then academic researchers would be addressing problems that are of direct value and have relevance to the goals of university researchers and entrepreneurs in technology firms. The outcomes of such research would, therefore, be easily adopted in practice.

3.10. DSR Paradigm for Innovation

Proponents of DSR, such as Simon (1969), called for a research paradigm that had "a science of design, a body of intellectually tough, analytic, partly formalizable, partly empirical, teachable doctrine about the design process" (p.58). Concerns expressed by proponents of such a paradigm was that emphasis was on natural science teaching and methods at the detriment of professional competencies in the fields of engineering, business, medicine, law, journalism, and information system damaging the "sciences of the artificial" (p.56). Simon (1969) drew the distinction between natural science's role to teach about natural things, and the role of the above professional schools to teach about artificial things, "how to make artefacts that have desired properties and how to design" (p.55). A program was designed to redress the imbalance with engineering academic faculties responding to Simon (1969) call by setting up research centres in business schools concerned with computer-aided design, such as computer science, architecture, and operations research groups (Simon, 1996).

3.11. Summary

This chapter proposed the DSR paradigm as a novel framework for conducting dynamic research collaboration between UK universities and digital technology firms to address the dichotomy between theory and practice in the management of research collaboration. The principles of the paradigm are:

1. Design Science Research enables the operation of an interface between the problem and the solution spaces, both of which should be explored as part of the research.
2. The chief concern is utility.
3. Design Science Research is creative, iterative, and evaluative.

Although there is debate in the literature concerning the purpose of design science research, this research is undertaken with the purpose of exploring a solution in order to better understand the problem, and as such the solution is a means to an end. Accordingly, the solution need not be optimal or satisfactory as long as it has sufficient practical adequacy to illuminate the problem. The role of theory is to be used in the construction of the solution.

This research used Peffers *et al.* (2008) design science research methodology, which consists of six stages:

1. Problem identification and motivation.
2. Define the objectives for a solution.
3. Design and development.
4. Demonstration.
5. Evaluation; and
6. Communication.

This research has three iterations of stages two to five.

The problem identification and motivation occurred in Chapter two. The objectives for a solution are addressed by identifying three constraining criteria. The solution must:

1. Tease out the individual first-order factors of quality.
2. Act as a roadmap; and
3. Be useful to practitioners and be consistent with existing theory.

A review of a maturity model as a reference model and prior studies demonstrated that a Collaboration Maturity Model has the potential to fulfil all three of these criteria, and therefore provide a solution to the problem of practitioner engagement with issues of collaboration culture.

CHAPTER FOUR

ITERATION ONE – AMBIT DESIGN OF SOLUTION

4.1. Introduction

In this chapter, the various constructs and elements for the scope for a possible solution artefact are identified and captured through the Systematic Literature Review approach in Chapter Two. The constructs are then developed into an artefact. The constructs and elements used as increments for this iteration are selected to ensure that the thematic constructs concerning research collaboration derived and are consistent with both existing theories and practice. It is important to first set out the understanding of the characterisations of collaboration in UK universities, thereby, facilitating the analysis of the identified linkage to the enthusiasm for research collaboration and the resistance by digital technology firms.

Collaborative (or participatory) research is a function whereby researchers can address their mutual expectations on / or provide solutions to phenomena by working together in with systematic methods to achieve common goals that can generate new scientific knowledge (Salter and Martin, 2001). A collaboration that is dynamic conjures up a type of partnership with compulsive synergy that can happen between digital technology firms and universities researcher collaborators (Lasker et al., 2001). This is derivative of a form of partnership that values scientific knowledge transfer and equally strive to ensure the knowledge outcome gives opportunity for new skill sets as well as facilitate values to stakeholders. Relevant literature that considers collaboration between university stakeholders and digital technology firms (including Small Medium Entrepreneur) were identified, selected, logically categorised, and subjected to interpretative synthesis. Elements of collaborative activities in the maturity levels with regards to individuals and organisations in research collaboration with the barriers to be dynamic were used to generate the initial underlying constructs of the framework.

The initial underlying constructs in this first iteration were systematically examined to determine a solution solely framed within maturity levels and practice areas. Focus was placed on the elements in a collaboration process that often impacts the successful completion of academic collaborative initiatives, and those that promote engagement between actors and stakeholders. The artefact produced in Iteration One is an explicit description of the process and practice areas that make up a research collaboration environment characterisation.

This design of the artefact in this iteration followed the objectives of a solution (see Figure 4.1) that would assist in laying the foundation of the composition for the design of the artefacts in subsequent iterations. This iteration satisfies a problem-solving search process with an overall organised approach that meets the solution criteria for a dynamic research collaboration between UK universities and digital technology firms. The designed artefact is consistent with theories and literature that were used to develop the constructs for further increments. Therefore, in this iteration, the enhancements in the artefact will need further incremental improvements.

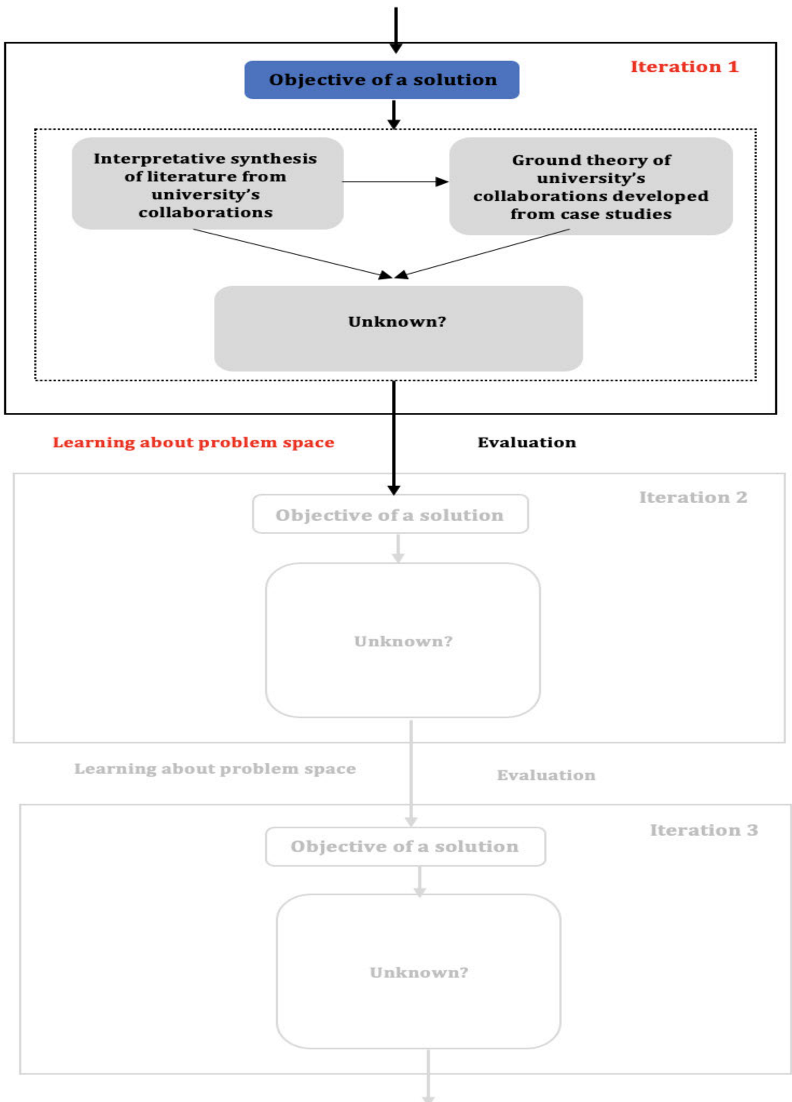


Figure 4.1: Iteration One - Artefact Scope of a Solution

Section 4.2 describes the systematic approach used to appraise and review the literature from where the constructs or elements that were to be used in the designing of the first iteration iteration. Section 4.3 further details the development process that will be used in the designing of Iteration One. Section 4.4 synthesised the details of the constructs apprised from literature and arranged them for the development of the enhancement needed for the Iteration One. Section 4.5 covered the development of the environment of research collaboration in the university and digital technology contexts while the enhancement of the development, the demonstration with the levels of collaboration maturity and its evaluation. Section 4.6 present the reasoning for the development of the enhancement with the collaboration maturity model. Section 4.7 showed the details of the initial while, Section 4.8 was used to evaluate the utility of the first iteration for this research. Section 4.9 presents the learning of the problem from Iteration One, including the collaboration management process such as the communication element of the artefact, evaluation of the artefact in supporting a solution, and the description of the learning that has occurred about the problem space. Finally, section 4.6 summarises the chapter.

4.2. Research Design

The Systematic Literature Review (SLR) approach, used in Chapter Two, was initially used to perform an organised search and selection of the relevant literature from the domains of collaborations by universities with external partners within and without its environment, success factors and barriers that affects the university collaborations with the manufacturing sector of the economy, external partnerships by universities, and the collaboration maturity model that assists to put in the relevant perspective the levels into understanding of the research collaboration between UK universities and digital technology firms. The SLR approach is a common standard research practice used in pure science to search, appraise, and summarise the findings of primary studies that included statistical analysis (meta-analysis) that needs the pooling of results (Higgins and Green, 2011). A conventional literature review search without an approach is characteristically seen as reductive, therefore, not suitable to apply to qualitative literature where richness and copious descriptions are significant over totalising concepts (Kitchenbam, 2004; Walsh and Downe, 2005; Walker and Myrick, 2006). Sandelowski et al. (1997) suggested in support of competent approaches, such as SLR, that the synthetisation of prior literature in qualitative research was essential as it will assist researchers to avoid reinventing the wheel and ensure the understanding gained from prior studies are useful and re-used.

Glaser and Strauss (2017) in advocating for appropriate organised approach to synthesis literature, proposed hermeneutic method that helps to give deep understanding to a phenomenon; described as literature interpretive synthesis. Walsh and Downe (2005) viewed the interpretive synthesis process as the “opening up of spaces for new insights and understandings to emerge” (p.205). Overall, this approach is largely useful for the development of the concepts and theories that support and link concepts, i.e., by induction and interpretation (Dixon-Woods et al., 2006). This method is, therefore, applicable to synthesis of qualitative research and has been adopted in this study (mainly relating to papers taken from search engines such as Scopus, Google Scholar, Microsoft Academic, Core, and Semantic Scholar).

4.3. Development of Constructs for First Iteration

The method for interpretive synthesis (Walsh and Downe, 2005; Dixon-Woods et al., 2006) follows the same steps as that used by SLR (Higgins and Green, 2011; Kitchenbam, 2004); though not with the same techniques used for undertaking these steps. Although the steps are presented in a linear manner, Dixon-Woods *et al*. (2006) emphasised that the process should be characterised as iterative, interactive, dynamic, and recursive rather than put in a fixed sequenced order. The similarities between this process and those for research methodology (design science), as well as the method used in this research (grounded theory), is not lost on the researcher.

4.3.1. Searching the Literature

One of the defining conventional characteristics of SLR approach is its importance as a strategy for explicit searches that reflects the principal requirement that such strategies should be transparent for it to be replicated (Tranfield et al., 2003; Kitchenbam, 2004; Kitchenbam et al., 2009; Higgins and Green, 2011). SLR exclusively focuses on primary research published in peer-reviewed academic journals and comprehensively indexed in electronic bibliographic databases. The published search strategy, therefore, involves highly structured and protocol-driven searches across a range of electronic bibliographic databases.

Kitchenbam et al. (2009) are amongst other research pointed out the need for searches and retrieval of qualitative research or theoretical literature through an exhaustive process. In interpretive synthesis, the search and retrieval may both be synthesised along with quantitative research. As Kitchenbam et al. (2009) illustrated however, this is not a straightforward process as it may also contain literature with quantitative research approaches, books, book chapters, research reports, working papers, thesis, and other grey literature. Some of these sources may not be comprehensively indexed in electronic bibliographic databases at all. In addition, in the genre of 'business' or 'technology innovation', leading experts may publish their work as non-academic books, online sites, podcasts, speaking tours, conferences talks, or as added documents relating to their consultancy which are only available to organisations that subscribed to them, usually at enormous expense. Search strategies must therefore, supplement bibliographic database searches to include back-tracking of references, citation searching, appeals to known authorities in the area for advice about the existence of more obscure publications, probing of both physical and online literature aggregators (i.e., bookshops and Google), and an element of providence.

The search strategies for the first iteration of this research included:

- search of electronic databases (ABI Inform, Academic Search Complete, Business Source, Emerald, Google Scholar, Sage, Scopus, Web of Science)
- search of online websites (using Google; Science.gov)
- search of library catalogues in University of Reading; University of Westminster; British Library; WorldCat)
- browse shelves of bookshops (Blackwells in London and Foyles in London)
- reference chaining through prior literature in the domain of the phenomenon
- contact and discussion with experts (from Henley Business School, University of Reading; Knowledge Transfer Centre University of Reading; Henley Business School Informatics Research Centre; University of Reading Department of Computer Science; Department of Digital Business at Westminster Business School; University of

Westminster Digital Business Research Group; and visiting speakers at seminars as well as workshops on digital technology developments).

In addition, studies that are notably on business investors, digital technology, innovation strategy was serendipitously discovered online through the persistent searches of the researcher. Some examples of the sources searched used in this thesis are presented in Appendixes A and B for increment one in the first iteration of this research.

4.3.3. Sampling of the Literature

Several literatures present different viewpoints regarding whether sampling is necessary or appropriate in the interpretative synthesis process. Dixon-Woods et al. (2006) agree with Barroso et al. (2003) that the search process should be comprehensive enough to locate articles that "while not ostensibly about [the research question] were nonetheless important to the aim of the review" (p.37). Therefore, in the increment for this iteration, the number of pieces of literature retrieved was fewer than 170, so no sampling was used.

4.3.4. Determining the Quality of Literature

The SLR conventional approach uses assessment of study quality in three ways (Higgins and Green, 2011). Firstly, studies included in a review could be limited to a specific research design (usually the use of non-probability sampling technique where selected samples are based on the subjective judgement of the research rather than randomised controlled trials) (Crossman, 2018; Cresswell and Plano-Clark, 2011). Secondly, inclusion criteria are developed a *priori* knowledge and studies that fail to meet these criteria are excluded. Thirdly, a structured quality checklist could be used for the appraisal of studies included and assess the effects of weaker papers.

There have been differing views on the appraisal of the literature that are good for inclusion in interpretive synthesis (Dixon-Woods et al., 2004; Dixon- Woods et al., 2006). Some researchers proposed a set of criteria specifically designed for qualitative research (Lincoln and Guba, 1985; Seale, 2002). Other researchers, however, are of the view that it is impossible to 'cast in stone' criteria for the quality of qualitative research, as judgements of quality are historically culturally dependent, and may vary depending on the region as well as circumstance (Schwandt, 1996; Sandelowski *et al.*, 1997).

Dixon-Woods et al. (2006) however, recommend the exclusion of literature that are not relevant while, pointing out that the distinctive characteristic of interpretive synthesis is its emphasis on fundamental critique instead of a more limited sense of critical appraisal in which each study is judged against standards of its type. This indicates that studies should be treated objectively in its own right. Further suggestion by Dixon-Woods *et al*. (2006) was that this "may involve the identification of the research traditions or meta-narratives that have guided particular fields of research [...] as well as critical analysis of particular forms of discourses" (p.40). Judgements and interpretations of literature credibility, therefore, are undertaken as part of the synthesis, rather than as a pre-cursor.

This phase of this study follows Dixon-Woods' suggestion. Examples of the literature and books excluded are presented in Appendix A. The interpretive synthesis of the literature on the nature of a barrier to research collaborative effort and dynamic research collaboration for increment 1 in Iteration 1, therefore, included 35 items of literature (examples are listed in Appendix B). This literature includes 42 journal articles, 8 books, and three sets of documents that were presented as part of 'consultancy' by a Knowledge Transfer Centre in the UK. Examples of the information derived from the sources that are selected for the interpretative synthesis in the Iteration 1 are listed in Appendix C.

4.3.5. Conducting the Analysis

Noblit and Hare (1988) building on the work of Turner (1980, cited p.25) suggested that all explanations are comparative. It was proposed that translating multiple studies into one another's terms could be done with interpretive synthesis. Depending on how the studies are related, there are three different types of interpretive synthesis that are described as follows:

1. Reciprocal translation analysis is where studies to be synthesised have roughly similar paradigms. Each study is first rendered into the key concepts, themes, organisers, and metaphors that the author used to explain what is taking place. Each study is then translated into the metaphors of the others and vice versa. These translations may reveal that the metaphors of one study (or a set of metaphors not drawn from the studies) are able to represent the set of studies. However, the uniqueness of the cases may mean that it is not possible for a single

set of metaphors to adequately express the studies. In this case, understanding comes from the attempts at translation, rather than from the metaphors alone.

2. Refutational synthesis is where studies refute each other. Once again, each starts with the identification of the major metaphors that the authors use to construct their interpretations. This is followed by the identification of the metaphors in the refutation of the other work. This enables the studies and refutations to be translated, or, if they do not translate, to determine how the ideas affect or impact the interpretations.

3. Line-of-argument synthesis, where studies successively build a line of argument. The purpose of this synthesis is to build a whole from a set of parts. Following the translation of the studies into one another, a grounded theory is developed to put the similarities and differences between the studies into an interpretive order. Dixon-Woods et al. (2006) term this synthesising argument, where evidence from across the studies is integrated into a coherent theoretical framework comprising a network of constructs and the relationship between them.

Noblit and Hare (1988) stated that "there is little reason to attempt to synthesise them" (p.38) in the description of a fourth situation where studies are about different things. Dixon-Woods et al. (2006) however, in a differing view pointed out that although varied body of literature may be subjected to interpretive synthesis, their translation as the core concept was unsuitable. In its place, they proposed the use of synthetic constructs. With this, underlying evidence is transformed into a new conceptual form as "synthetic constructs are grounded in the evidence but result from an interpretation of the whole of that evidence and allow the possibility of several disparate aspects of a phenomenon being unified in a more useful and explanatory way" (p.39).

The translation of academic engagement with non-stakeholders outside the academic community or research collaboration, therefore, is a multi-dimensional concept (Rossi et al., 2017). For example, collaborative initiatives such as partnership scholarships with external stakeholders (van de Ven, 2007), relational scholarship integration (Bartunek, 2007) and mode 2 research (MacLean et al., 2002) have complex interactions that are not linear. Generally, there are varied academic engagements that are relevant and impactful that involves or requires close interaction between academics and external stakeholders, however, those with technology firms' practitioners that may be subjected to several interpretations. In this phase, the interpretive synthesis involves a diverse body of literature that appears to be subjected to different interpretations on these collaborative interactions and relational scholarships; often static and in one direction of flow from the environment to the goal of the initiative.

Drawing primarily on the work of Dixon-Woods et al. (2006), the approach for this study follows the iterative process that starts with locating the literature, detailed reading and gradually identifying recurring themes in relational scholarship engagement to develop the increment one for the first iteration. It is then followed by the generation of themes that help to understand the phenomena being described in the literature, with constant comparison of these theoretical structures with the literature. Finally, the relationships between the categories of the constructs are determined and identified.

The generation of the themes starts with the categorisation and identification of the relationships between the constructs that are not easily specified. Indeed, it cannot be directly measured or observed. It involves a "creative leap that the agile mind makes in the struggle to comprehend observations and to link them together" (May, 1994, p.13). An outsider may view this as mystical, as May (1994, p.14) observed, and it could be described as "magic" as it is found to operate within the context of careful and rigorous attention to the technique used (Perkins, 1981). Technique and rigor, are however, bereft to fully explain what moves the researcher from simple description to understanding (May, 1994). May's view was drawn from Benner's (1984, cited p.17) observation that experts view situations holistically, and often use past experiences to move beyond methods as they confront information that must be understood. This thesis attempts to demonstrate the conditions necessary for the 'dynamic magic' to occur in the research collaboration that occurs between UK universities and digital firms.

4.4. Output of Iteration One

The constructs identified in literature using SLR for Iteration One are categorised and loosely presented in no order in Figure 4.2. As shown, there are two main concepts in a static unidirectional flow with fifteen elements in clusters.

The illustration in Figure 4.2 attempts to demonstrate the interpretive synthesis of the formed various elements in literature that make up of the two key constructs. However, as stated earlier, the constructs are not exhaustive and the full explanation as well as the transparency of this process is not possible because of the creative, inductive, and interpretive in the process involved. The next stage of the synthesis is to generate the synthetic constructs into transforming conceptual form that will represent the first artefact.

The interpretative synthetisation for the themes is arranged in a process flow to simplify a complex system that exists in the form of systems thinking as shown in Figure 4.2 (Haberfeliner et al., 2019) through the externality of business process modeling (Recker et al., 2009), conventional strategy for strategic advantages (Pohl, 2020), and vector interpretation of visual language (Bowden et al., 2004). The sequence of the collaboration Environment and Goal are intended to understand the development of the flow of the partnerships in research collaboration that can proffer solution to the barriers or encourage the enablers to be dynamic as opposed to the conventional reactive and static interactions inherited from the academic engagement and R&D approaches currently adopted by universities with academic non-stakeholder.

The starting point, is the context where organisations, practitioners, and actors involved in all collaboration, including research collaboration, are located. The collaboration outputs are the reasons for building of an efficient and consistent research collaboration management process to assist in the creation of values such as profitable business outcomes for organisations and actors. Values from the output of such collaborative efforts are considered the ensuing ‘stocks’ for organisation resources such as innovative, scientific, and digital outputs that can be used for competitive advantage (Heeks, 2006). For UK university actors, they represent academic achievements, seminal journal publications, and contribution to knowledge.

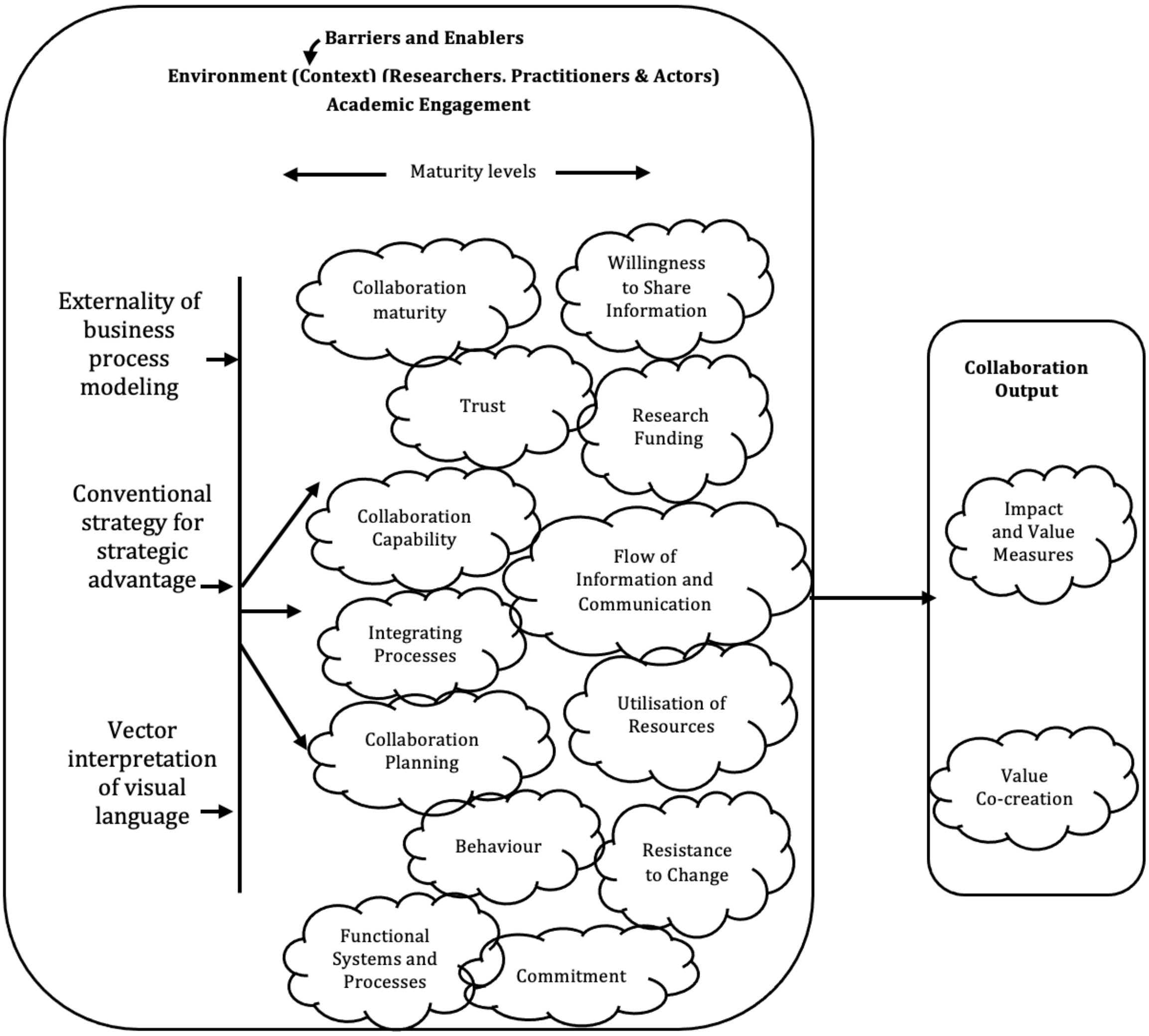


Figure 4.2: Visual Representation of Synthesised Constructs of the Collaboration between Universities and Industries

The elements within the interpretive synthesis are made up of various properties that are viewed as concepts that are linked. They are inter-linking channels or pathways for the process to follow from vision or ideas in both universities and technology firms in the environment into tangible co-created value products. Development extensions are what progresses from collaboration management process for the aligning and clarity of the solution thereby assist to have a needed output.

4.5. The Artefact, Demonstration and Evaluation

In the presentation of a solution, this section improves on the skeletal representation from all concepts and themes in the Research Collaboration Building Blocks (in Figure

4.2) along with the maturity levels used to measure the development of the interest to collaborate for business solutions by UK universities and technology firms in 4.3.

4.5.1. The Artefact

Academic research is ideally a nous practice (Rank et al., 2004). Initiating and managing a collaboration initiative for value outputs that can be used for competitive advantages is equally intellectual complex. In this research, from the constructs that are identified from the synthesisation of literature on collaboration between universities and external entities, 15 significant constructs are grouped into collaboration maturity levels. The 15 constructs are used for the development of a dynamic research collaboration artefact that has several identifiable checkpoints on the way to the final output as shown in Figure 4.3.

Noteworthy, in a collaboration initiative are grey and not well-defined interactions in the communication and relationships between one maturity level to another that have the potential to promote and provide knowledge transfer for created value that promotes the environment (Dahlstrand, 2017). For example, the creation of values to meet the changes, challenges and fluidity of digital technology development for the contemporary social business environment. Another that may not be easily defined is the resistance to change within a research group that may have an impact on the value delivered from the collaborative initiatives. A bridge for a dynamic collaboration for universities and technology firms, therefore, is created by strong management of the process, skills of actors in the organisation, communication process, and access to network (Ma et al., 2020); the amount to which these categories are bound together to form a cohesive background is determined by organisational alignment (development of a maturing behaviour in the organisations ensures value is aligned to the outcome of the initiative).

4.5.2. Demonstration

The constructs shown in Figure 4.2 used to design the artefact in Figure 4.3. This artefact is evaluated and applied to ensure it as a solution or observe its deficiency as a fit-for-purpose of the dynamism in research collaboration engagement. This consist of two parts of the developed iteration shown in Figure 4.3. Firstly, the evaluation of the solution for utility with the constructs and the elements as well as the practice areas from literature as shown in Figure 4.2. Secondly, the result of the interpretative synthetisation of literature for the themes in increment one for the first iteration are aligned with an equitable maturity model as learning from the problem space that has occurred, and the implications of the result for Iteration Two.

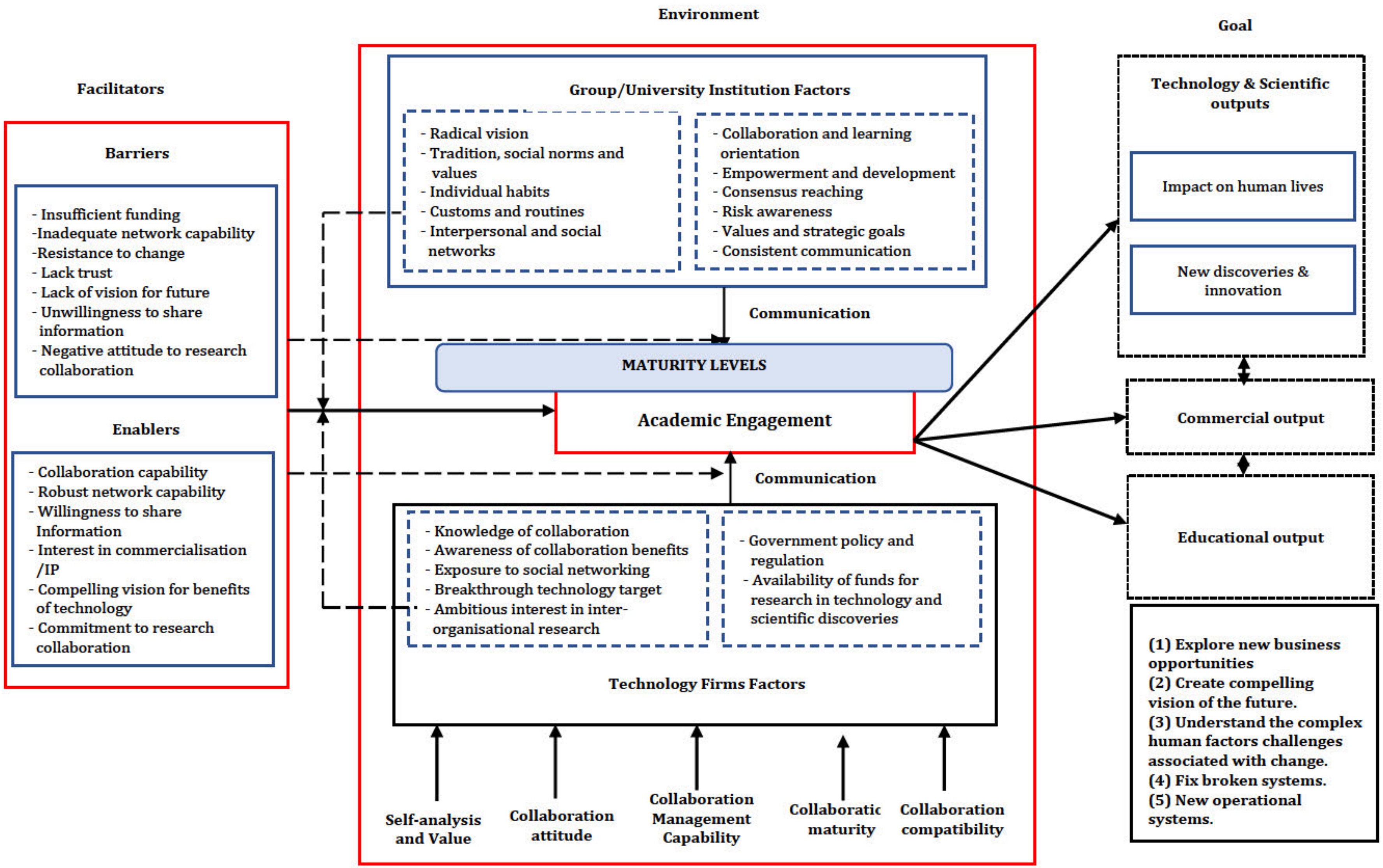


Figure 4.3: Static Research Collaboration

4.6. Reasoning for Development of the Collaboration Maturity Model

The needs / reasoning for the Collaboration Maturity Model (CMM) is four-fold. Firstly, it intends to be a roadmap to enable universities and technology companies determine where they are on the journey towards achieving a ubiquitous culture of research collaboration, and the appropriate direction of travel to a continuous level of collaboration in the university environment (Nomura, 2005). This is profitable to know as an organisation will know on a collaborative diagnostic map where to go and the suitable step to take to get to level of efficiency.

Secondly, used as a framework, it will encourage the management of an organisation to prioritise actions that can lead to added value. Literature contains several suggested knowledge and management tools and techniques such as performance management frameworks and performance appraisals that are proclaimed to assist organisation improve (Rao, 2005; Knechtli, 2005; Anna, 2015).

Universities are public funded with limited resources. There is, therefore, a struggle of prioritisation on the best investment for value. When an organisation knows its location in the collaboration maturity landscape, managers can take strategic approaches to improve and make sense in terms of what is appropriate and what may produce the strategic objectives. A score that is satisfactorily in most areas but low in a few areas may prompt research groups, universities, and technology organisations to concentrate on improvement techniques in the low scoring areas. In addition, it can assist researchers to avoid expensive irrelevancies just because they are the next big thing - after all, it is pointless trying to develop a balanced scorecard if your research group does not have a strategic plan.

Thirdly, the Collaboration Maturity Model is used to clarify the ambiguities in the need for a tool that can be used for self-assessment. Universities, as an organisation, assess inputs, outputs, and combinations of the two; staff research publications; student satisfaction; the diversity inclusivity; value for money; return on investment; and impact on their environment, or society, and everything in between. It is certain that universities should want to assess their research collaboration affiliations. However, researchers and practitioners familiar with the higher education system will realise that the list of things assessed is somewhat disingenuous. Although, universities assess their inputs, very few, however, measure their collaboration impact on the development and production of innovative technologies while, several technology companies do not understand the role of university researchers in the development of their business ideas. All these are related to the ease of measuring, where it is quick, easy, economical, and less time consuming not to make only the most innovative and committed to want to measure. The Collaboration Maturity Model levels as an accompanying assessment instrument are intended to make it quick, cheap, and easy to measure the organisation and group's research collaboration maturity.

Fourthly, the Collaboration Maturity Model is intended to provide a common language shared by a community of practice to be used in the artifact to assist in self-assessment for improvement. There are several maturity models such as the Quality Maturity Model (QMM) that according to Town et al. (2015) that gives a roadmap through its maturity levels to a culture of quality, however, did not enunciate all the needed constructs in the descriptions and definitions of research collaboration between universities and digital technology firms. Similarly, the Relationship Management Maturity Model (RMMM) that Martin et al. (2005) explained that through its maturity levels, its focus is mainly on improving effective communication in a process without necessarily improving the sharing of critical knowledge transfer in information systems partnership between businesses and IT organisations (Dahlstrand, 2017). The collaboration maturity model levels need to be able to ensure that stakeholders understand the process and self-assessment steps toward the implementation of an efficient collaboration management.

4.6.1. The Collaboration Maturity Model (CMM) Levels

For this thesis, an identifiable and efficient five levels from literature are relevant for an efficient collaboration management. These levels are 1) ad hoc, 2) aware, 3) defined, 4) managed and 5) continuous. These five levels are characterised as:

1. **Ad hoc** - The management of the collaboration process is often improvised and chaotic. Few processes are co-ordinated toward a defined goal, with success depend on effort and heroics of individual. For this thesis, this level means: Collaboration is achieved in an ad hoc way; Partner's satisfaction is reactive and unpredictable; Research collaboration depends on the capabilities of individual researchers, and varies with their innate skills, knowledge, and motivations;

Training for quality is ad hoc and reactive to an inability to undertake a specific task adequately.

2. **Aware** - Processes are in place so that partnership success can be replicated with another (or the same one on different occasions). For this thesis, this level means: Collaboration strategies and procedures to implement the plans are established; There are effective management processes to allow the organisation to repeat earlier success in research projects; Such management processes are practised, documented, enforced, trained, measured, and able to improve; Training for collaboration is provided as a programme of training for specific project tasks, and / or is reactive to events.
3. **Defined** - Collaboration processes are actively encouraged, documented, and harmonised. All work derives from the organisational strategy. For this thesis, this level means: There is a defined, documented organisational strategy, from which all work processes are derived; There is an organisation-wide understanding of the research development activities, roles, and responsibilities of each member of the organisation and how they fit into the organisational strategy; Training for collaboration is a cycle of training needs assessment and programme provision.
4. **Managed** - Detailed measures of the process of encouraged collaboration with external stakeholders are collected, understood, and controlled. For this thesis, this level means: Collaborative measures are part of every documented work process; These measurements form the basis for evaluating products and processes; Changes are implemented to improve collaborative efforts in services and processes; The organisation sets quantitative goals for collaboration for development and project success; Training for collaboration is a cycle of training needs assessment, programme provision, and measurement of the effectiveness of the programme.
5. **Continuous** - Continuous long-term varied research collaborations between UK universities and technology companies occurring frequently without government interventions. The improved partnerships enabled by feedback and active piloting of several innovative ideas. Future requirements are anticipated so there is no drop-in performance. For this thesis, this level means: The entire organisation is focused on continuous improvement in every collaborative effort and process; All staff and researchers are encouraged to continuously improve themselves and

their work; the organisation can identify weaknesses, the means to strengthen the process proactively, and the goal of preventing problems as well as innovations that exploit the best practices are identified and transferred throughout the organisation.

4.6.2. Collaboration Factors and Mapping to Collaboration Maturity Model Levels

The constructs synthesised from literature (see two examples of the literature in Table 4.1) were organised, in no preferential manner, into the five levels of the collaboration maturity model. The examples of the other literature used in the derivation of the constructs are shown in Appendix C.

Table 4.1.: Two Examples of the Constructs from Literature Interpretative Synthesis

Author	Aggestam, L.
Title	Towards a Maturity Model for Learning Organizations – the Role of Knowledge Management
Reference	(2006). 17th International Conference on Database and Expert Systems Applications.
Concepts	• Environment promotes a community of collaboration learners. • Culture begins with leader who inspires the vision. • Must be linked to organisational aims.

Author	Baldridge
Title	Criteria for Performance Excellence
Reference	(2007). Gaithersburg, MD: Baldridge National Quality Program.
Concepts	• Visionary leadership. • Customer driven excellence. • Organisational and personal learning. • Valuing employees and stakeholders. • Agility. • Focus on the future. • Managing innovation. • Management of performance level. • Social responsibility. • Focus on results and creating value. • Systems perspective

40 practice constructs were identified and derived from the various literature that categorises the collaborations between universities and external stakeholders. The constructs identified are used to constitute the foundation of the elements for the design of the first iteration solution to research collaboration shown in Table 4.2.

Table 4.2.: 40 Practice areas of Collaboration

1.1 Strategic collaboration plan
1.2 Management of collaboration alignment (achieve strategic plan)
1.3 Progress monitoring
1.4 Performance measurement
1.5 Research project management process
2.1.1 Partners - Gathering feedback
2.1.2 Partners - Collation of feedback
2.1.3 Partners - Action as a result of feedback
2.2.1 Organisation - Gathering feedback
2.2.2 Organisation - Influencing organisational decisions
2.3.1Wider context - Involvement of staff in profession
2.3.2 Wider context - Gathering feedback
2.3.3 Wider context - Contribution to profession
3.1 Staff empowerment
3.2 Staff involvement in change
3.3 Nature / level of learning
3.4 Attitude to mistakes
3.5 Attitude to risk
3.6 Staff encouragement to innovate and creativity
4.1 Attitude to change
4.2 Perception of drivers for change
5.1 Definition of collaboration (including locus of control)
5.2 Attitude to research collaboration improvement
5.3 Perception of responsibility for research collaboration improvement
5.4 Types of collaboration improvement initiatives
6.1 Vision and value setting
6.2 Trust
6.3 Inspiration and motivation
7.1 Attitude to staff (as an asset)
7.2 Training provision
7.3 Development of staff
7.4 Recognition of staff
8.1 Vertical alignment
8.2 Horizontal alignment
8.3 Consistency
8.4 Communication flow
8.5 Staff recognition of where they fit into the overall scheme
8.6 Structure
8.7 Alignment of attitude to research collaboration and creative innovation
8.8 Alignment of attitude to change

The categorisation of the 40 constructs in Table 4.2 were derived inductively from the activities and projects that are associated with collaborative efforts by universities with both its internal and external environments for various economic developments. The inductive approach allows the data from the literature to determine the factors and categorisation of the constructs with a semantic approach used to analyse and interpret the explicit contents of data in the literature on university collaborations identified through the systematic Literature Review approach in Chapter Two to determine the factors. A latent approach was then used to analyse the underlying subtext of the 40 constructs with an eight manageable construct factors being produced as shown in Table 4.3.

Table 4.3:
8 Factors Synthesised from Literature for 40 Collaboration Practices

Construct Themes		Examples of Literature
1.0	Management of research organisation	e.g., Sunders and Lewis (2017)
2.0	Environmental assessment/sensing	e.g., Petrick and Martinelli (2012)
3.0	Learning organisation	e.g., Ng (2004); Rowley (2000)
4.0	Attitude to change	e.g., Musteen et al. (2010); van den Heuvel et al. (2015)
5.0	Attitude to research collaboration and innovation	e.g., Petrescu et al. (2014)
6.0	Leadership	e.g., Kramer and Crespy (2011); Matthew and Sternberg (2006)
7.0	Investment in staff	e.g., Dodgson (2014)
8.0	Alignment	e.g., Levy et al. (2001); Lozano (2008)

From the analysis through the intersection of the theoretical assumptions, disciplinary knowledge, and the content of the data the 8 Factors are those affecting collaboration between universities and external parties from literature (Patel et al., 2012). The factors are derivatives of the research question. This has guided what we want to know in relation to the purpose or intent of our research (e.g., knowledge generation). The factors also reflect the epistemological and ontological positions (Demuth and Terkildsen, 2015) of the research. The 8 factors clustering can impact or influence the facilitators of the contextual and procedural elements as well as activities in the maturity levels in research collaboration between UK universities and digital technology firms (Gillam et al., 2016).

Two of the factors, Management of research organisation and Attitude to research collaboration and innovation are used as examples from the full detailed Collaboration Maturity Model with their maturity level descriptors are presented below in Table 4.4. A random snapshot of the factors is shown for illustration purpose.

Table 4.4:
Extract from the CMM showing maturity descriptors

1. Management of research organisation	
1.2 Management alignment	
Level 1	Actions are solely reactive to events.
Level 2	Strategic collaboration plan includes breakthrough improvement processes. Many actions are unrelated to the strategic plan and are reactive to events.
Level 3	Strategic plan includes breakthrough improvement processes. Some actions are unrelated to the strategic plan.
Level 4	Strategic plan includes breakthrough improvement processes.
Level 5	All improvement processes both incremental and breakthrough, flow from the strategic plan, and it is updated to reflect new developments.

5. Attitude to research collaboration and innovation	
5.2 Attitude to research collaboration improvement	
Level 1	Collaboration is the responsibility of everyone to do their best to adhere to procedures.
Level 2	Collaboration is the responsibility of people serving customers face-to-face to be 'nice'.
Level 3	Collaboration achievement is the responsibility of the management of the service (or the quality officer if there is one), thought it may be explicitly devolved down for specific areas.
Level 4	Collaboration for a particular area is the responsibility of the people in that area.
Level 5	Collaboration for the whole library is everyone's responsibility.

A more detailed description of the CMM Management of the Research Collaboration described below in Table 4.5. A fuller description of each of the factors in all the five levels of the CMM are explained in Appendix D.

Table 4.5:
A Snapshot of CMM – Management of Research Collaboration

	Level 1: Ad hoc	Level 2: Aware	Level 3: Defined	Level 4: Managed	Level 5: Continuous
1.1 Strategic collaboration plan	There is no strategic or collaboration plan with external stakeholders	There is limited network formed with strategic plan.	The strategic plan is derived from (mediated) environmental sensing.	The strategic plan is derived from unmediated environmental sensing.	The strategic plan is derived from environmental sensing (customers; organisation; and wider context).
1.2 Management of collaboration alignment (achieve strategic plan)	Actions are solely reactive to competitors and events.	The strategic plan includes breakthrough improvement processes. Many actions are unrelated to the strategic plan and are reactive to events.	The strategic plan includes breakthrough improvement processes. Some actions are unrelated to the strategic plan.	The strategic plan includes breakthrough improvement processes.	All improvement processes, both incremental and breakthrough, flow from the strategic plan and updated to reflect new developments.
1.3 Progress monitoring	There is no monitoring of progress in achieving goals.	There is no monitoring of progress in achieving goals.	There is (infrequent) monitoring of progress in achieving goals, but no corrective action taken.	There is monitoring of progress in achieving goals, and some corrective action is taken.	Progress in achieving goals is closely monitored and corrective action taken where necessary.
1.4 Performance measurement	Goals for individuals, teams and researchers are poorly defined, if present.	Goals for specific high-level managers are linked to the strategic plan. Goals for most staff are poorly defined if present.	Researchers, Principal Researchers, and senior staff have goals, some of which are related to the strategic plan.	Goals for achieving the strategic plan are cascaded down throughout the university's postgrad schools and tech firm to all appropriate staff.	Goals for achieving the strategic plan are cascaded throughout the university's postgrad schools and tech firm. Staff have individual goals on both improvement and "business as usual" targets.
1.5 Research project management process	Awareness of only basic processes are known but not used for collaboration analysis ("we have more books than X") if at all.	Basic processes are known but not used for collaboration analysis	Partner's feedback and internal processes (e.g., time taken for higher impact publications) used to determine impact factor.	A range of impact factor indicators are used to determine if collaboration is performing. Key Indicators may exist but not fully aligned with metrics used or strategic aims.	A range of balanced performance measures are used to monitor how collaboration is achieving its aims. Metrics closely align with Key Performance Indicators, which closely relate to strategic aims and mission. Performance measures are regularly evaluated to determine whether they continue to measure performance accurately and appropriately.

In the assessment of each factor, a score of 0 to 5 is given for its measurement. This score locates the research group or the organisation on the 'collaboration roadmap'. This approach of scoring of the factors makes it possible to know the level of where a research group and organisation is located. The rubric-style presentation of the model clearly clarifies the next step to be taken to a higher level of collaboration maturity for each of the 40 factors.

4.6.3. CMM Factors Assessment

The levels in the Collaboration Maturity Model are indicators of where researchers, research groups, and organisations are and used to self-assess their preparedness to collaborate in digital research using available tools. A freely available competent tool can be used in contrast to other measuring models where details of the evaluations can only be accessed with a fee or assessment done through paying a consultancy fee.

Assessment with the CMM produces a score from 0 – 5 (0 or 1, if the descriptors for level 1 are not met) for each of the 40 factors to produce a profile of research collaboration culture. A technology company or research groups in a university environment with a strong and ubiquitous technology bias research collaboration process will score the maximum 5 for all factors for the level 5 on the model. This maximum level 5 may be considered a utopia to reach however, it is reachable while, the factors at other levels have different score. A sample of the scoring of the factors is shown in Table 4.6.

Table 4.6:
Sample of Assessment of Static Research Collaboration with CMM

Factors	2019 score	2022 score
...		
6.0 Leadership		
6.1 Vision and value setting	1	
6.2 Trust	3	
6.3 Inspiration and motivation	2	
7.0 Investment in training		
7.1 Attitude of researchers and staff	3	
7.2 Training provision	4	
7.3 Development of staff	3	
7.4 Recognition of staff	2	

Research collaboration maturity level starts at the Ad hoc level yet hold the potential to achieve continuous collaboration. Feedback on elements, according to Schein (2017), are dependent on the assumptions and attitude of the group or organisation.

The collaboration profile enables research groups and the UK universities to see their areas of strength and weakness. Managers and lead investigators in the research groups can strategically plan improvement activities. The profile also enables the UK universities and technology firms to see where improvements have been made by repeating the CMM assessment, thereby, evidencing the impact of the improvement activities.

Consequently, the potential of the results of the first increment, the interpretative synthetisation from literature aligned with the equitable CMM as a solution for a high-reward dynamic research collaboration will be efficiently demonstrated through review of the categorisation within the five maturity levels between universities and industry. Possible (solicited) adoption of the artefact by a group of academic researchers that are interested in sharing ideas with practitioners as non-stakeholders. Following this demonstration, the solution as evaluated, both in terms of utility of the artefact and the learning that has occurred about the problem space requires further iterations.

4.7. The Initial Artefact

Collaboration is a complex concept. Collaboration partners are almost by definition the early adopters of the novel approach, new technology, or new hypothesis by technology firms. Similarly, collaboration between UK universities and technology firms encourages experienced and distributed intelligence of a group that increase the chances of the development of innovative solutions more efficiently.

Consisting of 40 practice areas and grouped into eight elements, research collaboration between UK universities and technology firms is a developmental journey with several identifiable checkpoints along the way. Achievement of higher levels of collaboration culture maturity on the CMM requires an efficient inexpensive tool that can be used as a roadmap that have direct correlation between reality of the organisation's collaboration culture and the impact factors that encourages greater creativity without compromising on results of achieving "group genius".

An organisation of culture of collaboration is doing things right; doing the right things; using learning; suited to the environment (seeking change in a fluid environment); and explicitly and appropriately aiming to improve research collaboration. This culture is created by strong leadership and the people in the organisation; and the amount to which these categories are bound together to form a cohesive culture is determined by organisational alignment.

Applying the five levels of that underlie and influence this phenomenon, the maturity reference model was used in the journey to a culture of research collaboration. These levels are Ad hoc, Aware, Defined, Managed, and Continuous. They apply to each element of the concept with the score of each element correlated to the others, especially within the same category, they are sufficiently independent that an organisation may have a range of scores on the Collaboration Maturity Model across different elements.

Table 4.7.: The Collaboration Maturity Model Outline (Level 1 – Ad hoc; Level 2- Aware, Level 3 – Defined, Level 4 – Managed, Level 5 – Continuous)

	Level 1	Level 2	Level 3	Level 4	Level 5
Management of the organisation					
Strategic plan					
Management of alignment (achieve strategic plan)					
Progress monitoring					
Performance measurement					
Research project management process					
Environmental sensing					
Partners (bottom up)					
Partners - Gathering feedback					
Partners - Collation of feedback					
Partners - Action as a result of feedback					
Partners (top down)					
Organisation - Gathering feedback					
Organisation - Influencing organisational decisions					
Wider context (inside out)					
Wider context - Involvement of staff in profession					
Wider context - Gathering feedback					
Wider context - Contribution to profession					
Learning organisation					
Staff empowerment					
Staff involvement in change					
Nature / level of learning					
Attitude to mistakes					
Attitude to risk					
Staff encouragement to innovate and creativity					
Attitude to change					
Attitude to change					
Perception of drivers for change					
Attitude to research collaboration and innovation					
Definition of collaboration (including locus of control)					
Attitude to research collaboration improvement					
Perception of responsibility for research collaboration improvement					
Types of collaboration improvement initiatives					
Leadership					
Vision and value setting					
Trust					
Inspiration and motivation					
Investment in staff					
Attitude to staff (as an asset)					
Training provision					
Development of staff					
Recognition of staff					
Alignment					
Vertical alignment					
Horizontal alignment					
Consistency					
Communication flow					
Staff recognition of where they fit into the overall scheme					
Structure					
Alignment of attitude to research collaboration and creative innovation					
Alignment of attitude to change					

A skeletal structure of the Collaboration Maturity Model is presented in Figure 4.5.

4.8. Evaluation of Utility of Iteration One

To evaluate the utility of the Static Research Collaboration artefact that is designed from a derivation of the clustering of impact or influence on the facilitators of the contextual and procedural elements as well as activities in research collaboration between UK universities and digital technology firms (see Figure 4.3). The demonstration of the design was framed to assist in the gathering feedback on the utility of the model. The collaboration maturity model was used as an evaluation instrument to assess the utility of the artefact from selected literature on research collaboration with the following questions for several collaborative research initiatives:

1. What is research collaboration and the best way to assess it?

2. How do we determine if partnerships with external stakeholders have been strengthened or if new linkages have been formed because of improved communication?

2. How do we describe a "environment-wide collaboration process" and how can it be measured and/or characterise its development over time?

3. What does it mean to "link" external non-stakeholders in academic engagements within the five levels of the collaboration maturity model?

4. Is strategic collaboration and alignment becoming increasingly seamless or static over time?

5. What maturity level of collaboration is needed to achieve outcomes?

6. What is the point at which efforts to increase collaboration are simply a waste of resources, without increasing desired outcomes?

The assessment of the interaction and the underpinning approach of collaborative engagements in the advancement of digital technology in the UK is compelling and effective strategies for promoting critical thought, encouraging reflective analysis, and generating a sense of linking the development of collaboration to the way forward for the economy (Ankrah and AL-Tabbaa, 2015). Without a basis on the side of trust, efficient inter-personal connections, and effective communication between people, strategic partnerships will not have a solid foundation on which to stand. According to Bailey and Koney (2000), "Although strategic alliance research focuses on organisations, the implementation of inter-organisational efforts has as much to do with individual relationships. For this reason, it is important to emphasize the human [...] elements of the process" (p.29). Collaboration, therefore, according to Myoken (2013) depends on positive personal relations and effective emotional connections between partners. For example, one of the elements is trust which is developed between partners only when there is time, effort, and energy that is put into the development of an accessible and functioning system for communication. Conflicts needs to be recognised as a significant occurrence, normal, and even expected as the various levels of maturity integration and personal involvement increases because of resistance to change. Evaluation can be articulated from the point of collaboration personnel and practitioners' relationships that are successful when individual members connect on a personal and emotional level with one another. Ultimately, as Austin (2000) makes clear, "alliances are successful when key individuals connect personally and emotionally with the alliance's social purpose and with one another" (p.173). Therefore, a static intra- and inter-personal requirement of individuals should be addressed for a solution to a proposed dynamic research collaboration that have steps towards fixing the 'wicked problems' that is underpinned by the successful performance of the value of the output.

It is noteworthy that researcher in this domain agreed that collaboration usually begin informally and from informal conversations (Gaughan and Bozeman, 2002). Similarly, the proximity of technology firms to the university or knowledge transfer centres was regularly cited in literature as the foremost likely factor that encourages informal communications and enhance the progress to a formal collaboration (Link et al., 2007). Studies also by several scholars such as Myoken (2013) demonstrated that collaboration decreases exponentially when there is considerable distance in the environment that separate pairs of institutional partners.

Universities in the UK like the rest worldwide are regularly expected to be matured to the highest level to fulfil more and more roles, often with fewer resources (Altbach, 2009). As a result, academic research, like the rest of the university missions, have become dispersed and with it the quality of research collaborative initiatives may decrease (Clark, 2004). Faced with low resources and pressure of this digital era, there is a shift in the focus of the function of universities that were well-known as institutions devoted essentially to teaching into increasingly expanding their roles by their struggle to be entrepreneurial and market-relevant through various research collaborative initiatives with external partners (Clark, 2004; Geiger, 2004; Pucciarelli and Kaplan, 2016). The academic drift in UK universities in the 21st century raises concerns because, often, there is less focus on the evidence of measurement of the productive value of this core academic function that will be intellectually tough, analytic, formalizable and teachable (Ankrah and AL-Tabbaa (2015).

Evaluation of Static Research Collaboration focused on three UK universities that are well-known for research publications and collaboration experience with industry and another three universities with focus on teaching with little emphasis on collaboration with external stakeholders as the form of knowledge transfer. Using the two foremost global universities' rankings annual publications, QS and Times Higher Education world university rankings, the six universities were then ranked to understand their awareness of the importance for supporting indigenous firms such as increasing move into more dynamic and high-opportunity industries. However, the characteristics of collaboration with universities may be very specific depending on whether the industry partner is engaged with partners in mature or emergent activities. To support evaluation, alongside the three universities, two digital firms, who have been involved in collaborations through knowledge transfer centres in the UK, were considered. Although this study focus is on individual researchers, practitioners, and actors in the context of the environment, there are however, several institutional factors that influences the behaviour of these individuals in embracing academic engagement collaboration. For example, adequate research funding in an institution may necessary be followed by encouragement to individual researchers to start engaging in informal communications or an approach to external institutions.

Several studies agree that the key enablers for research collaboration are still rooted in a static direction for both formal and informal communication. While the barriers are addressed in terms of trust and funding hinders knowledge transfer often characterised lack of strategies for innovation inputs, networking, and collaboration for innovation development (Sørensen et al., 2016). Some literature, such as Robertson and Patel (2007) and von Tunzelmann (2009) suggested that this may be attributed to the culture of the institutions that does not encourage interactions and projects with industry firms. Other studies also proposed that this may be due to the focus on institutional training development agenda that show a slightly higher average number in some organisational outputs through new innovative products, seminal research publications, and process improvements (Albatch, 2009; Miandar et al., 2020). There are suggestions that this may scale up and result in technological spillovers from these projects, which in addition to the main goal of product development, often achieve complementary new or improved processes. These suggestion and suppositions need to be tested if they are significant indicators for dynamic research collaboration.

Some researchers have indicated preference for a framework that outline the dynamism of the interactions as a demonstration of what occurs in practice and would be useful to actors. Amongst such study is D'Este and Perkmann (2011) that suggest knowing what happens in the interaction process should not be stand-alone but also have features that would assist in the choice of partnerships and an improved collaboration assessment technique. Generalised statements that refer to the interplay in research collaboration are assumptions with no empirical evidence, however, taken at their face value, have innumerable implications for the profile and proper definition of the co-created value of the collaborative effort. In view of laying the foundation for an effective artefact for future technologies targets, there is the need for using a far-reaching maturity tool, such as the collaboration maturity model to examine types of interactions that are visionary toward dissolving the traditional collaboration boundaries and barriers. Similarly, encourages the driving role of new actors in research and innovation, including excellent young researchers, ambitious high-tech SMEs, and first-time participants.

4.9. Learning About the Problem

The design science paradigm is used in this research for the purpose of exploring the problem space that aims to identify and remove static activities in research collaboration process between UK universities and technology firms. Making efforts for the process to be dynamic there is the need to introduce a clearer and radical vision that enables new interactions concept that challenges the current paradigms. In particular, the static research collaboration process is already known with the external factors that influences the actors while, the output concept for the technological breakthrough target is often not innovative and ambitious science-to-technology breakthrough as a first proof of for its vision. Previously unknown are the factors of the problem as presented before Iteration One that within the process of the actors' interactions not leading to high-impact value output. The designing of the artefact and its evaluation therefore support it as ineffective solution and provide information on the need for further increment in the solution space and in turn gives new insights on the problem space. Static Research Collaboration therefore resulted in the learning about the problem space and need to advance on the roadmap to a dynamic research collaboration paradigm.

The development and improvement of research collaboration process is an evolutionary journey, with different collaborative interest elements at different points on that journey. Despite its continuous nature, the development of static of collaboration can usefully be split into an arbitrary number of resolutions. Such a partitioning could be aided from the views of practitioners' understanding of the issue of developing a dynamic collaboration by its similarity to existing concepts of measuring maturity levels. Therefore, further increment was done with selected practitioners to interpret the concept that was lacking in the Static Research Collaboration artefact in Figure 4.3.

4.10. Summary

This chapter presented a Static Research Collaboration increment for this research. The efforts attempted to develop a framework on the amorphous concept of research collaboration that is consistent with both existing theory and practice.

An interpretive synthesis approach was used to interrogate studies on the collaboration historical perspectives of university research and collaborations with partners as well as external stakeholders. This is an accepted approach for developing concepts from qualitative data without losing the richness and the depth of the knowledge in the descriptions that such data provides. The studies were drawn from abstracting and indexing databases using a variety of synonyms for research collaboration and organisational collaboration development, including few documents provided as part of paid for 'consultancy'. Static Research Collaboration increment produces a developed output that is axiomatic of the traditional boundaries of the collaboration that is inherently linked to the static direction of the relationship to be between the environment and the goal without the interaction that can be explored to mitigate the barriers as well as the enablers to deal with the considerable collaboration uncertainties and for choosing alternative directions and options.

Finally, considering the phenomenon in this research, the problem space is explored with the elements in the collective impact on the facilitators of the contextual factors that influence collaboration between universities and external parties within and outside its environment (Gillam et al., 2016). The elements that cause this collective impact have the following essential characteristics leading to amending the solution going into Iteration Two:

- Radical vision: the solution must address a clear and radical vision, enabled by a behavioural concept that challenges current paradigms. Elements of interactions to advance on the roadmap to the development of a well-established research collaboration paradigm, even if high-risk and will not be funded by Higher Education Funding bodies.
- Breakthrough technological target: the solution must target interactions for novel and ambitious science-to-technology breakthrough as a first proof of concept for its vision. Research collaboration with clear technological objective.
- Ambitious interest in research collaborations by technology firms for achieving technological breakthrough and creative innovations that opens new areas of investigation. Projects with only low-risk incremental research, even if interdisciplinary, will not be funded. It is a huge shift to go from the idea that the future awaits us, to the future is not certain.

In the development of Iteration One, investigating the interplay and interactions of the partnerships in the collaboration management process starts with the use of SLR for the levels of the collaboration. Academic studies used to evaluate this point need to include the examination of the interaction process in the academic engagement - as they are significant to ensure the process for a research collaboration can be made dynamic.

CHAPTER FIVE

ITERATION TWO – FACILIATING DYNAMIC RESEARCH COLLABORATION

5.1. Introduction

The purpose of this increment is to design a solution to improve the constructs of the process consistent with the healthy inter-personal connections for dynamic research collaboration between UK universities and digital technology firms. This will assist in producing a 'roadmap' to enable practitioners to identify, assess, and improve their collaboration management process. In this second iteration, the research collaboration process is improved with evidence-base appraisal of the research inter-personal connections from the lesson learned in the problem space in Iteration One. The static unidirectional flow of the traditional collaboration process is considered not to be a fit for the stimulation and improvement of UK high-technology innovation and knowledge-intensive performances that are significant to enable the country to participate against other high earning, low-wage, emerging economies such as China and India.

For Iteration Two, the grounded theory technique of axial coding was used to synthesis the documentary and literature data gathered in Iteration One thereafter, interviewed participants as case studies from three UK universities and technology organisations. Interviewees represented were from core research levels of the organisational hierarchy in the UK universities and collaborating technology firms while, the semi-structured interview questions were drawn from the output of Iteration One. This increment used the grounded theory method of Charmaz (2006) to analyse the transcripts of interviews.

The output of Iteration Two will produce further understanding in line with phenomenological perspective through concreate descriptions that reflect the extensive characterisation of the interpersonal connections in academic engagement rather than reflections and theorisations. The inter-linked academic engagement activities include industrial research; publicly funded basic research; user-driven research; knowledge transfer; institutions governing intellectual property and standards; supply of venture capital; education and training of scientists and engineers; innovation policies of government departments; science and innovation policies of RDAs; and international scientific and technological collaboration (Lockett et al., 2002).

The presentation of the process is significant to ensure the process for a research collaboration can be made to be dynamic.

Section 5.1 provides a reminder of the research design used in this iteration with an explanation of the methodological approach framework. Section 5.2 details the case study development process, covering the application of the research design. The interview constructs were presented in Section 5.3. The section included the communication of the artefact, an evaluation of the artefact to support a solution, and the description of the learning that occurred around the problem space. Section 5.4 presented the culture construct in the solution. Section 5.5. presented the development of the artefact of Iteration Two while Section 5.6 included the demonstration and evaluation of the output of Iteration Two. Section 5.7 was used to explain the utility of the artefact and Section 5.8 on what were learned about the problem. Finally, Section 5.9 summarises the chapter.

Figure 5.1 Illustrates how this iteration relates to the research design.

5.2. Research Design

This section describes the study approach, i.e., Grounded Theory, for Iteration Two covering both the theory and application of the methodological framework, data gathering, and analysis. Also, the design for this DSR iteration focussed the coding (the stopping point in Iteration One) on to axial coding (Strauss and Corbin, 1998; Corbin and Strauss, 2008), to elicit the dimensions of the properties that are the specific or general attributes of the categories.

5.2.1. Methodological Framework

Glaser and Strauss (2017) developed the systematic methodological procedure of the grounded theory primarily to assist social scientists to use it to generate theories. Within grounded theory, the researcher does not deduce testable hypotheses from existing theories in advance and test them against the data, but systematically analyses the data to construct theories ‘grounded’ in the data themselves (*ibid*).

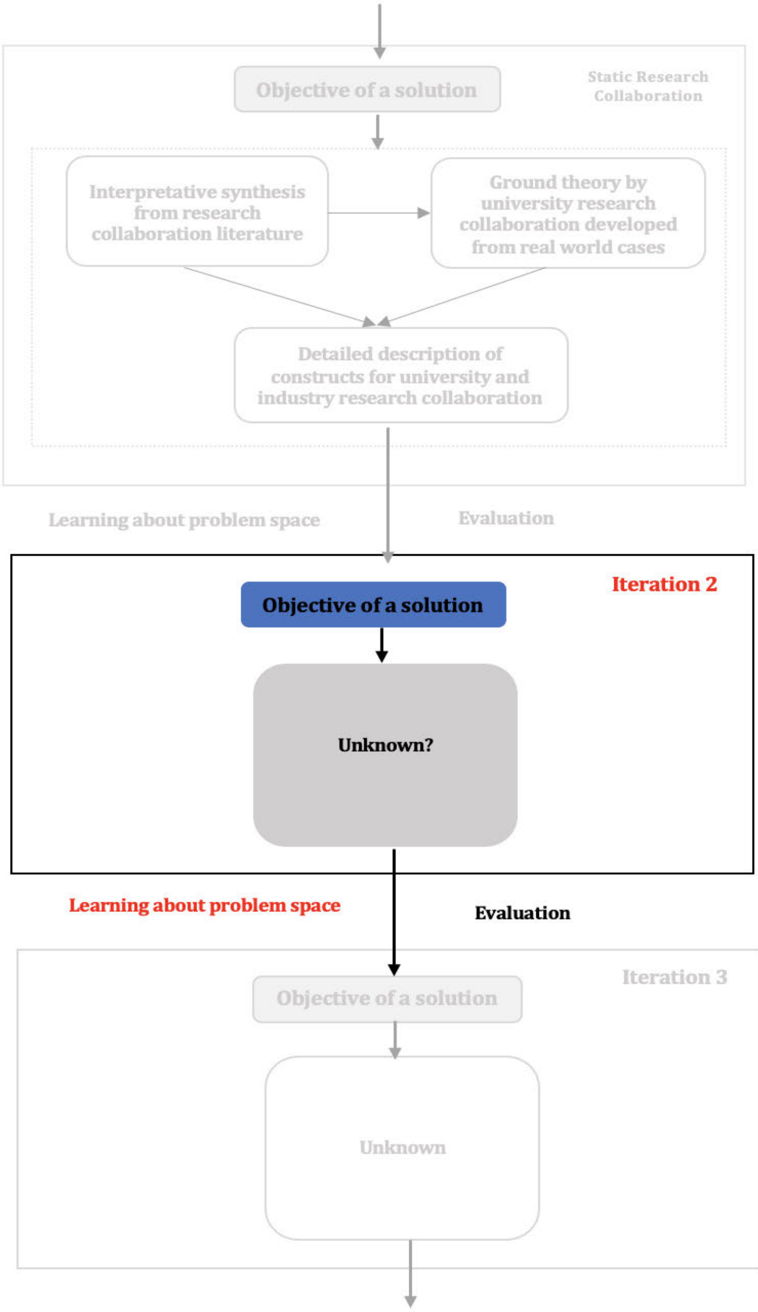


Figure 5.1: Research Design for Iteration Two

Since their original publication, Glaser and Strauss have expounded how to apply the grounded theory methodology. On one hand, Glaser remained faithful to the initial description of grounded theory as a constant comparative method where the analyst begins analysis with the first data collected and constantly compares indicators, concepts and categories as the theory emerges (Glaser, 1992). On the other hand, Strauss, took in the direction towards verification described as an approach for looking systematically at qualitative data aiming at the generation of theory (Strauss and Corbin, 1998).

A student of Glaser and Strauss, i.e., Kathy Charmaz, has developed her own interpretation of grounded theory that "returns to the classic statements of the past century and re-examines (sic) them through a methodological lens of the present century" (Charmaz, 2006, p.xi). This interpretation is rooted in pragmatism and relativist epistemology and assumes that neither data nor theories are discovered but are constructed by the researcher because of his or her interactions with the environment and its participants (Charmaz, 2006; Bryant and Charmaz, 2007a).

This research follows Charmaz's interpretation and approach to grounded theory as conducted in accordance with the logical nature of the DSR paradigm. The process in this interpretation fits and supports the use of grounded theory where it is not the only methodology as well as part of an incremental and iterative research process to assist in designing an artefact as a solution to a 'wicked' problem.

There are three frameworks for collecting data within a grounded theory approach (Bryman, 2012); i.e., case study, pseudo-case study, and longitudinal. A case study involves the detailed and intensive analysis of a single case and its context. The case could be a single community, a single family, a single person, a single organisation, or a single event. A pseudo-case study examines the distinct experiences of various people / communities / organisations within a distinct concept (e.g., technology acceptance). A longitudinal study entails the investigation of a sample of at least two occasions, separated in time, to map change. This research increment uses a pseudo-case study approach, where rich data on what constitutes the inter-personal connections during research collaboration between UK universities and technology firms was gathered with the intent for it to be more dynamic.

The most common approach for gathering appropriate primary data within the grounded theory method is the use of interview, unstructured and semi-structured (Charmaz, 2006; Bryant and Charmaz, 2007b; Bryman, 2012) because they yield rich insights into respondents' experiences, views, opinions, aspirations, attitudes, and feelings. For an unstructured interview approach, there are no set of prompts but a single question or a list of general topics, and the interviewee is encouraged to respond freely without the interviewer knowing what aspect the individual would focus on in advance, but it will emerge while spending time with the interviewee (Bryman, 2012). The aim is to elicit detailed answers to gain insight into what the interviewee considers to be relevant and important, without the interviewer focusing on what they believe to be relevant within the discussion. In contrast, a semi-structured interview approach, entails the use of a list of questions as a guide for the interviewer (Brinkmann, 2014). The questions may not follow exactly the order outlined in the schedule and questions may be asked that are not included in the guide, in order to follow up replies (May, 2011). The interview process is flexible, however, generally all questions on the schedule are asked and similar wording are used for each interviewee. Semi-structured interview is consistent with the chance of the interviewer becoming a viable knowledge-producing participant in the process of the potential notion of sensitising the concepts in grounded theory (Brinkmann, 2014).

As detailed above, a semi-structure interview is used to elicit information from interviewees on their views on making dynamic the research collaboration during academic engagements beyond the nuance of the emerged barriers and enablers themes in Iteration One. For example, making explicit the trust element, it can be derived from commitments, value norms, and behaviour from the individuals in the organisation along with the policy, procedures, and practices of the organisation (Schein, 2010). Data concerning the trust element can be found in the organisation documents declaring an interest to collaborate with external stakeholders in the strategic plans (Scott, 1990). These documents may be online public documents, such as annual reports; or internal documents, such as procedural manuals and produced by routine, regular or special administrative practices (Hakim, 1983).

For the development of a conceptualisation of a dynamic research collaboration that is more explicit than the output from Iteration One while, reflecting what occurs in practice, the data will be from UK universities and technology firms through two methods: semi-structured interviews, where questions are explicitly taken from the output of increment one, and the administrative documents of knowledge transfer centres.

5.2.2. Data Gathering

The logic in the Charmaz (2006) grounded theory perspective was that the techniques should assist in data gathering and its evaluation. The researcher is advised to "adopt methods that hold a promise of advancing your emerging ideas" (p.16) and encourages letting the research problem shape the appropriate data collection method selected. However, there was a caveat that although methods are merely tools, they do have consequences since "how you collect data affects which phenomena you will see, how, where and when you will view them, and what sense you will make of them" (Charmaz, 2006, p.15). The recommendation given for a key to a credible grounded theory research adhered to in this study is to gather rich, substantial, relevant, suitable, and sufficient data that are evaluated, analysed, and transformed into the solution.

5.2.3. Undertaking Semi-Structured Interviews

The first stage in designing a semi-structured interview study after the specification of the research problem, is to choose the cases or organisations where the research will be conducted (Brinkmann, 2014). The location(s) chosen must be relevant to the research problem and are accessible to the researcher. If there are options that fit these criteria, some locations that are likely to provide contrasting information can be used to assist in the testing of tentative differing explanations (Rubin and Rubin, 2012).

The next stage is to choose the interviewees. Potential participants must have first-hand experience of the phenomenon being researched and be knowledgeable in the domain as well as have complementary experiences to hold and argue different points of view to each other in line with phenomenological perspective (Kvle and Brinkmann, 2009; Rubin and Rubin, 2012). This gives the opportunity for the results of the research to be fresh and real, with deductions that are balanced and credible (Rubin and Rubin, 2012). This is essential if the result of the research is to have utility.

The third stage is to write the interview questions. The questions need to explore in detail each part of the research question (Kvle and Brinkmann, 2009; Rubin and Rubin, 2012). To avoid nuanced results, a semi-structured interview question can be open-ended to obtain copious details, such as contrasting views (Foddy, 1993). The researcher can also use follow-up questions to elicit variety of examples. The key drive of an interview with semi-structured questions, is to investigate a theme or themes in depth. Rubin and Rubin (2012) describe a number of questioning techniques that contribute to this: (i) using “how” and “what” in the questions to explore the interviewees experience; (ii) asking for clarifications or meanings when interviewees use professional terms, this enables the interviewer to understand the interviewees conceptualisation of the term in use; (iii) asking about apparent contradictions; (iv) asking two related questions together, to indicate that the interviewee is looking for a full exploration of the topic. Semi-structured questions are designed to obtain data that provide abundant information to the research results that promotes its utility. Ample information can be elicited through asking for descriptions of iconic and expressive instants, and by asking questions about a highly charged applicable incident (Rubin and Rubin, 2012).

The final stage is to draft the interview schedule (see Appendix E) and a consent mail sent individually to the participants (see Appendix F). There are four parts to an interview (Rubin and Rubin, 2012). At the start of the interview, the interviewer should introduce themselves and the topic, endeavouring to make a personal connection with the interviewee to gain their trust, thereby have open responses. Experts on the interviewing method (Kvle and Brinkmann, 2009; Rubin and Rubin, 2012) suggest viewing the interview as a form of conversation, and that the interviewer should choose a role for themselves that is meaningful to the conversational partner and understood and accepted in their world. The interviewer should emphasize that there are no right or wrong answers to the questions, and the interviewer is interested in their experiences.

The second part of the interview should utilise easy questions, central to the research topic, that are not controversial making the interviewee to feel confident in their views (Rubin and Rubin, 2012) (see Appendix G). The interviewer should reinforce the trust established at the start of the interview through empathetic responses, such as, the use of non-verbal communication cues, statements of understanding, or further short examples that makes the topic to be clearer (*ibid*).

In the third part of the interview, the interviewer can ask more sensitive and / or conceptually difficult questions. The interview should finish with less stressful questions and end with an invitation to the interviewee to freely comment on the topics of the interview (Kvle and Brinkmann, 2009)

5.2.4. Other Considerations

Using a grounded theory method means entering the 'world' of the interviewee. In doing so, the time given by an interviewee is a significant obligation to the interviewer (Blumer, 1969). One way to show appreciation to a participant is often through respect and recognation (Charmaz, 2006). Another way of respecting participants by ensuring that confidential data collected remain confidential. Documents that are not in the public domain may be sensitive or have strategic or competitive implications. In this research, private information in hard copy and electronic format, therefore, remained confidential and were kept securely. An agreed embargo on the reporting of some exact text or information from such documents are maintained such as individual views that may be inflammatory, controversial, or reflect badly on colleagues of the participant, or their institution that were expressed during the interviews. It is significant therefore, to ensure that identities of participants remained anonymous and unidentifiable throughout the study. In addition to obtaining informed consent before the start of the interview, particular attention was drawn to the use of vignettes. Transcripts of the interviews, and the original electronic recordings were kept securely and confidentially in accordance with the guidelines for the handling of data in the University of Reading Research Ethics Committee document.

5.2.5. Research Approach and Data Analysis

Reasoning is the process of using existing knowledge to develop explanations, make predictions, or draw conclusions. The three methods of reasoning in research are the deductive, inductive, and abductive approaches.

Deductive reasoning starts with the assertion of general rule and proceeds from there to a guaranteed specific conclusion. In deductive reasoning, if the original assertions are true, then the conclusion must also be true. Inductive reasoning, however, begins with observations that are specific and limited in scope but progresses to a generalised conclusion that is likely not certain considering accumulated evidence. Conclusions reached in the inductive method are not logical necessities; no amount of inductive evidence guarantees the conclusion. This is because there is the possibility of not knowing if all the evidence has been gathered, and there is no further bit of unobserved evidence that might invalidate the research proposition. Abductive reasoning characteristically begins with an incomplete set of observations and proceeds to the likeliest possible explanation for the set. Abductive reasoning has the type of conclusion that is dependent on the information at hand, which often is incomplete.

Reichertz (2007) viewed the research principle behind grounded theory as neither *deductive* nor *inductive* but a combination of both in *abductive* reasoning. This indicates a research practice where data sampling, data analysis and theory development are not separate, but different steps to be repeated until the phenomenon being researched can be described and explained. As such, the saturation point is reached when there no new data that changes the emerging theory.

The major analysis tool in grounded theory is coding. Coding is the practice of repeatedly going through the data, considering the abstract of what is going on through constant comparison. A code "sets up a relationship with your data, and with your respondents." (Star, 2007, p.80). Coding is abductive as it involves the researcher discovering specific new elements evolving from the data that can be merged or extracted for comparisons (Reichertz, 2007). This analysis is open-ended, indeterminate, and full of uncertainties. However, several researchers on the topic agree that there are three phases of coding (Corbin and Strauss, 2008; Bryman, 2016): Initial coding: 1) used to name each word, line or segment of data; 2) Focused coding: used to identify and develop the most salient categories; 3) Integrative coding: used to reassemble the fractured data to give coherence to the emerging analysis.

Initial coding, also described as open or substantive coding, is essentially to "make fundamental processes explicit, ensure that hidden assumptions are visible, and give [researchers] new insight" (Charmaz, 2006, p.55). It is conceptualisation on the first level of abstraction. At the commencement of a study, everything is coded to extract the problem. Data in the transcripts are coded line-by-line which is the usual coding form for interview data as it gives the researcher ideas that may escape their attention when coding for thematic analysis (Charmaz, 2006). The purpose is to stick closely to the data, using codes that reflect action, so the conceptualisation emerges from the data. This phase ensures the grounded theory has fit and relevance.

For focused coding, the purpose is to determine the adequacy of the initial codes and check the researchers' preconceptions around the topic. Theoretical integration starts with focused coding. Frequent or most significant initial codes are subsequently used to sort, synthesise, integrate, and organise large amounts of data. Firstly, data is compared to data to develop the focused codes. Then data is compared to these codes to refine them. As more data is coded, codes are merged into new concepts, renamed, and modified. The researcher goes back and forth constantly comparing data, modifying, and refining the growing theory. This phase ensures the grounded theory has workability.

Integrative coding, also called axial coding by Corbin and Strauss (2008), and theoretical coding by Glaser and Strauss (2017), is to make connections between categories and relate categories to subcategories, thereby merging the fractured concepts into propositions that work together in a theory explaining the main concern of the respondents. Strauss and Corbin (2008) proposed a prescriptive framework and a set of procedures to achieve this. Glaser and Strauss (2017) however, proposed alternative set of processes to undertake theoretical coding. Charmaz (2006) then suggested that integrative coding does not have to be done by following a prescriptive framework but can be achieved by following the same "simple, flexible guidelines" (p.61) as focused coding.

When comparing many incidents in a certain research domain, the emerging concepts and their relationships are probability statements. The result of grounded theory is not a detailed description of the research domain, but a set of probability statements about the relationship between concepts, or an integrated set of conceptual hypotheses developed from empirical data (Dey, 2007). Validity, in its traditional sense is consequently, not an issue in grounded theory. Instead, it should be judged by four elements: *fit*, *relevance*, *workability*, and *modifiability* (Corbin and Strauss, 2008).

- *Fit* is how closely the concepts fit with the instances they are characterising.
- *Relevance* is the dealing in the study with the actual concern of participants by evoking the "grab" (captures the attention) that involves both the academic and practice interests.
- *Workability* is when the theory works by explaining a greatly heterogeneous research area.

- *Modifiability* is the possibility to alter the theory when there is a more relevant data when compared to an existing data.

Fit, relevance, workability, and modifiability are significant elements in the development, results, and the conclusions in grounded theory.

All the transcriptions were initially coded line-by-line (and examples of this coding are presented. A snapshot of this is shown in Table 5.1 while, further examples are shown in Appendix H.

Table 5.1: Example of the Coding (Initial Code Line-by-Line INST2PR01)

What have been overlooked with regards to efficiency and support of collaboration?	
Single method of obtaining feedback. Formal. Specific team collect feedback Two-way communication with stakeholders Pass feedback on Pass feedback to relevant senior managers Pass feedback to collaboration team members Often pass feedback to Principal Investigator Responding to feedback not a must do Feedback to teams 'Close the loop' Not make changes based on feedback Show have passed feedback on More organised approach than last year 'sent off into the ether' 'close the loop' in theory	Yes, I think our organisation is hopefully already a trusted brand. Sort of over the years, 5-6 years, we perhaps spent money less on collaborative efforts. Now, money is an issue in the end of in the education sector when there was more funding and things were a little bit little bit more comfortable. Feedback on all the issues with universities are communicate to them through the PI. And I think the system works relatively well – we feedback any comments to the relevant senior manager, copied into ****** (for quality) and often the subject of the developing product so they know what is going on. Usually, the senior managers are quite good. They come back with the feedback, and I get them to cc in the chair of the meeting – we try and close that loop. It doesn't work in practice, but at least it shows, at least it gets minuted next time. We have tried to be a bit more organised since last year because we realised things were just being sent off into the ether, but now we do try to close that loop in theory. Then again, some managers are better at it than others.

Following this initial coding, each of the questions coded area were compared within each 'case', and between 'cases' (this inter-case comparison sorted the codes by the two levels of the respondents. This data-to-data comparison produced a list of focused codes presented in a snapshot of this is shown in Table 5.2 while, further examples are shown in Appendix H.

Table 5.2: Example of the Coding (Initial Code Line-by-Line INST1LA2)

How is the framework for communicating ideas to staff?	
Away day SMT communicate ideas at away day Staff asked for feedback Senior staff visit campuses to communicate (one way) ‘latest developments and schemes’	Yeah, is important to move the depth of the concept. That conceptual benefit to tangible benefit. Another question is about the framework. To just kind of elaborate on it. We only use the framework used to coordinate the recent projects. Once the excellent parts have been integrated. Yeah, so I mean, the learning Analytics in project is probably a good example there so. So, one of the things that we do rather than look to build the whole solution, what we've aimed to do is to build a core platform but allow other solutions to plug into that.

All the transcripts were coded again using these focused codes (and examples of this coding are presented in a snapshot of this is shown in Table 5.3 while, further examples are shown in Appendix H. The codes are refined and start to sort them into categories. The final list of categories and sub-categories from this increment in iteration one is presented in the next section.

Table 5.3: Example of the Coding (Initial Code Line-by-Line INST3LA4)

How does the SMT communicate their ideas to staff?	
Always talking to each other We listen and communicate the ideas even if it may not fit Staff asked for feedback Senior staff visit technology firm office to communicate (one-on-one) ‘latest developments and schemes’	We have our away day, and I’m sure they transmit some of the ideas through that. As well as asking for feedback from us. We have regular *********** and ******** come round to the campus and tell us the latest developments and schemes.

5.3. The ‘Case Study’ UK Universities and Technology Firms

This research increment uses a pseudo-case study approach, where data about what constitutes a dynamic research collaboration was gathered from UK University Research bodies. Contacts were made to Knowledge Transfer Centre (KTC) at the Henley Business

School, Westminster Business School, Centre for Digital Business (CDB), and Research Office University of Westminster, Brunel University, University College, London (UCL), JISC, Academic Health Science Networks (AHSN), and Amazon UK requesting participant to take part in the study (see Appendix G). This is a closed list, and so request was sent by email. The email elicited positive responses from 16 UK university researchers and four research practitioners in the technology sector:

- University of Reading
    - Knowledge Transfer Centre
    - Research staff
- University of Westminster
    - Centre for Digital Business
    - Research office
    - Research students
- Brunel University
- Imperial College, London
- JISC (UK Education and Research)
- NHS Digital Health – Academic Health Science Networks (AHSN)
- Amazon UK

All the 20 respondents from higher education institutions and technology sector were used as 'cases' for this research. This was appropriate because this sampling method is recommended in grounded theory research (Charmaz, 2006) to gather relevant, suitable, and sufficient data.

The first eleven respondents to have data collected were chosen for analysis in this increment:

- Knowledge Transfer Centre
- Centre for Digital Business
- JISC
- University of Reading
- University of Westminster
- NHS Digital Health – Academic Health Science Networks (AHSN)

- Amazon UK

5.4. The Interviewees

The output of increment one indicated that vertical alignment of culture, behaviours, investments, and values are important components of dynamic research collaboration. Therefore, it was necessary to conduct interviews with researchers and staff with semi-structured questions on research collaboration between UK universities and technology firms at five levels:

1. Researchers (Senior/Principal Researchers),
2. Member of the Senior Management Academic Health Team,
3. Member of professional research funding bodies,
4. Member of staff at the digital and technology sector research and development (Principal/Senior Researchers)
5. Final year PhD Researchers

Iteration One also indicated that horizontal alignment (i.e., how well the inter-personal connection processes of collaboration are integrated) is another important component of the dynamism of the research collaboration. All the 'case study' research collaboration have a hierarchical structure with fewer knowledgeable staff at the higher level than the one before. To draw a sample that respected this (and so the greater opportunity for structural 'silos' at the bottom than the top), one representative was taken from categories 1 and 2; two representatives from categories 3 and 4; one from category 5 resulting in three interviews for each 'case'.

For pragmatic reasons, some of the interviewees from the universities were chosen through key contacts with their knowledge transfer centres and research centres (usually research experts) following this schema. For the interviewees in the technology sector, contacts were made through those that had and currently collaborating. It is recognised that this method of selection may result in interviewee bias, but it was necessary to facilitate access. It became clear from the interviews themselves that participants had not been selected to show collaboration between universities and tech firms in only a favourable light.

5.4.1. The Interview Questions

The starting point for the questions in the interview schedule was the identification of constructs in the process of the inter-personal connections for research collaboration in academic engagements from increment one (Section 4.4.2). For example, sequestering investigation in the 'process of research collaboration and reducing of barriers to enable dynamic research collaboration' became questions such as "How the process of the collaboration projects initiated, introduced, defined, and organised or implemented in your organisation?" and "What are your suggestions to bypass or overcome these blocks or barriers?"; to obtain the feedback for the elements for the phenomenon. These questions were worded with the domain language that interviewees were familiar with. The interpretive synthesis of prior studies that led to output of Iteration One indicated that one of the properties of collaboration with external parties was usually trust that influences the collaborative initiatives and define the behaviour between the university researcher and the external parties in the technology organisations taking part in the partnership. This behaviour is underpinned by the concept of culture of the organisation or the individuals or the group formed for the collaboration (Schein, 2010). The phrase 'challenges faced' is a controversial term in any collaborative initiative; 'process' is an accepted neutral term with equivalent meaning and so interviewees were asked "On introducing the research collaborative projects, describe who or which party drove the initiatives?". The questions were kept as simple as possible to tease out what elements can instigate the management process and may lead to the success of a research collaborative initiative. Further probe with question such as "On communication with external partners, how was this usually organised?" is an example to understand the significance of 'communication' to the issue of 'trust' as a factor for a dynamic research collaboration.

All these are in confirmation of Schein (2010) findings that interviewees could interpret questions against their own underlying mental schema as their responses gives insight into the underlying tacit assumptions of the organisational and group collaboration culture, the follow-ups questions were worded in general terms and often ambiguous way to assist the respondents to word their responses to their experiences. For example, "On the research collaborative projects what are your organisation and individual expectations for the research projects?" may be answered in terms of how well members of teams get along personally to successful have co-value products and services; the procedures by which specific teams interact; the general attitude towards other teams; or how the interviewee views the place of the five basic characteristics of culture; learned, shared, based on symbols, integrated, and dynamic (Schein, 1983) from the partnership (systems thinking).

Several questions were phrased to act as an interrogative tool for more than one of the properties of a culture, behaviour, and value of the investments that could result in dynamic research collaboration indicated by the outcome of Iteration One. For example, the question “What are your suggestions on what could make the relationships to be dynamic and productive?” may elicit answers relating to the nature of changes made based on maturity of the organisations, the performance indicators for the initiative (obviously), and how problem solving is used based on the culture; and what the organisation is willing to change of itself by sharing of information (rules, insights, principles). The question “Was there an approach or framework used to co-ordinate the research collaboration projects or the partnerships with external parties that you have been involved with?” may elicit answers relating to the attitude to failure of a particular framework or approach; the empowerment of decision making; how individuals in the group are encouraged to continually improve themselves and their work; empowerment of individuals; as well as the attitude to mistakes.

The same questions were put to all the interviewees as shown in Appendix G with minor variations to reflect if they work in the UK university or with a digital or technology related firm.

5.4.2. Interview Schedule

All the interviews began with the interviewer thanking each of the interviewees for taking part in the research and introducing themselves. The ‘role’ taken by the researcher was that of a PhD researcher examining improving the inter-personal connections in research collaboration between UK universities and technology firms and enable the process to be dynamic thereby efficient. The interviewees consented through electronic mail and were assured that there were no right or wrong answers, and that their responses would not be shared with anyone at their institution, except in a general way.

The interviews all started with a general question about the interviewee's opinion on the organisation and personal implementation of the research collaboration they had undertaken that ended with an invitation to the interviewee to add any further comments. The sequences of the questions were generally followed, but in specific order, however, follow up questions were driven by the responses of the interviewee.

The interview schedule is presented in Appendix G. All interviews were transcribed by the researcher into MS Word documents.

5.5. Culture as a Dominant Construct for Solution

Culture was identified as a significant concept from all the responses of the interviewees. Trust, commitment, utilisation of resources, communication, behaviour, and willingness to share information are offshoots of the five basic characteristics of culture (i.e., learned, shared, based on symbols, integrated, and dynamic - as defined by Schein, 1983). Culture is divided in the environment into three distinct levels: artefacts (objects), values, and assumptions. Artifacts are the overt and obvious elements of an organisation, adopted values are the organisation's declared set of values and norms while, shared basic assumptions are the bedrock of organisational culture (Schein, 1983).

Regarding organisations, culture requires from the outset some clarifications of the terms due to the level of confusion over various perceptions of the term organisational culture. The existence of an organisational culture depends on a definable organisation that may also be a formed group in the sense of several people interacting with each other for the purpose of accomplishing some goal in their defined environment. The culture of an organisation, such as, a new group is simultaneously created and by force of the personalities of the individuals involved it begin to shape the group's culture. But that new group's culture does not develop until it has overcome various crises of growth and survival and has worked out solutions for coping with its external problems of adaptation and its internal problems of creating a workable set of relationship rules. An approach to solving problems can become part of the group's espoused culture only if it works over a period (Szulanski and Jensen, 2005). Organisational culture then is the pattern of basic assumptions that a given group has invented, discovered, or developed in learning to cope with its problems of external adaptation and internal integration. For example, the pattern of assumptions that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems.

Any new group has the problem of developing acceptable shared assumptions about the nature of the relationship to the environment in which it exists, nature of the reality of how to survive in it and how to manage nature of the interpersonal attributes, as well as nature of activity to integrate internal relationships so that it can function effectively and make life liveable for its members (see Table 5.1). The external and internal problems however according to Schein (1983) act simultaneously and are often intertwined. For example, a group cannot solve its external survival challenges or barriers without being integrated to some degree to permit concerted activity and it cannot integrate itself without some successful task accomplishment vis-á-vis its survival problem or primary task. The model for a solution for a dynamic research collaboration that has emerged from the respondents is culture of a group that is one of shared assumptions to solutions to problems that works well enough in the collaboration management process that it begins to be taken for granted to the point where they drop out of awareness, become unconscious assumptions, and are taught to new members as a reality or the correct way to view things.

As identified earlier, the interactions in the group, within a specific environment, happens in the collaboration management process level of the collaboration process. To identify the elements of a given culture within the management process, questions such as "What are your suggestions about what could make the relationships be dynamic to impact factors?" was asked, i.e., to create a list of the elements. Follow up questions - about the core mission, goals, the way to accomplish those goals, the measurement systems, and procedures it uses, the way it remedies actions, its jargon and meaning system, the authority system, peer system, reward system, and ideology – were asked to understand the interaction of individuals in the collaborative group. From the responses, it showed that like in most cultures there is a deeper level of assumptions which ties together the various solutions to the various problems and this deeper level deals with more ultimate questions. The real cultural essence, therefore, is what members of the organisation or group assume about the issues shown in Table 5.1 (adapted from Schein, 1983).

From the responses in Table 5.4, it signifies that in a fairly "mature" culture, that is, in a group that the individuals have a long and rich history of previously working together in various academic engagements or where friendship has grown and established from initial social contacts, it shows that group assumptions are patterned and interrelated into a "cultural paradigm". This information is significant to the understanding of how members of the group view the world. For example, the responses from participants from JISC, a body that supports higher education research, indicated that such performing collaboration groups does not allow an overrun of the budget for the research initiatives to occur without informing others and renegotiating and it was not acceptable to be ignorant of the likelihood that there would be an overrun. The group usually know the accepted and correct way to behave are always aware of the process, always take responsibility for what was happening, and always feel free to renegotiate previous agreements the group had made if they no longer made sense.

Table 5.4: Basic Underlying Assumptions Around Which Cultural Paradigms Form

1.	*The group or organisation relationship to its environment.*	Reflecting even more basic assumptions about the relationship of humanity to nature, one can assess whether the key members of the organisation view the relationship as one of dominance, submission, harmonising, finding an appropriate niche, and so on.
2.	*The nature of reality.*	Here are the linguistic and behavioural rules that define what is real and what is not, what is a "fact," how truth is ultimately to be determined, and whether truth is "revealed" or "discovered"; basic concepts of time as linear or cyclical, monochronic or polychronic; basic concepts such as space as limited or infinite and property as communal or individual; and so forth.
3.	*The nature of interpersonal attribute.*	What does it mean to be "human," and what attributes are considered intrinsic or ultimate? Is human nature good, evil, or neutral? Are human beings perfectible or not? Which is better, Theory X or Theory Y?
4.	*The nature of human activity.*	What is the "right" thing for human beings to do, based on the above assumptions about reality, the environment, and human nature: to be active, passive, self-developmental, fatalistic, or what? What is work and what is play?
5.	*The nature of interpersonal relationships.*	What is the "right" way for people to relate to each other, to distribute power and love? Is life cooperative or competitive; individualistic, group collaborative, or communal; based on traditional lineal authority, law, or charisma; or what?

Similarly, respondents from the university cases in this study, explained that individuals in this matured group that thrive on intelligent, assertive, individualistic people believe completely in open communications and with ability to reach reasonable decisions and compromises in confronting their problems, figured out what they wanted to do, and are willing to marshal arguments for proposed solutions while, scrupulously honouring the commitments that were made. On the interpersonal connection level, the group assume "constructive intent" on the part of all members, a type of rational loyalty to group or organisational goals and to shared commitments. These commitments will not prevent individual's independence and to competitively try to get ahead however, playing politics, race bias, hiding information, blaming others, or failing to cooperate on agreed plans are defined as an anathema. If the group assumptions about the nature of reality and truth is based on the need for every individual to keep thinking out in any given situation what he or she thought to deliver the set goals, it will lead to frequent interpersonal tension. In other words, the rule of honouring commitments and following through on consensually reached decisions was superseded by the rule of doing only what you believed sincerely to be the best thing to do in any given situation. Ideally, there would be time to challenge the original decision and renegotiate, however, in practice with time pressure will be such that the subordinate in the group, in doing what was believed to be best, often had to be insubordinate.

In a newly formed group or an organisation that the nature of reality is yet to be defined or the nature of interpersonal relationships are still developing, the paradigm is likely to grow through a storming stage (Tuckman and Jensen, 2010). In this group development stage, often, individuals will begin to disagree and challenge the process, indeed what the assumptions might be, and the essence of the co-created value. There is a higher possibility of underlying assumptions that produces barriers to change, frequent hostility, lack of trust, and conflict manifesting itself at this stage. As some respondents pointed out, it is not usually easy to go through the storming stage in an inter-organisation collaboration. However, it is important to decipher the interactions in the collaboration management process to understand the preconceptions or directions in which "pushes" or "pulls" the group or organisation to be dynamic. The emergence of the Culture as a solution to the barriers to dynamic research collaboration is demonstrated in Iteration Two and embedding collaboration cultural elements in practice.

5.6. The Development

This section details the development of the artefact for Iteration Two using the research design and post-analysis data from Iteration One. The second iteration uses the collaboration maturity model in Table 4.4 (Chapter 4.6) as the basis for developing an instrument to enable a collaborating research group in UK university and technology firms to self-assess their collaborative culture as a location on the model. The Research Collaboration Assessment Instrument and associated instructions as well as schedules, is evaluated for effectiveness and utility. Furthermore, the complete package of artefacts from the output of Iterations One is applied to two case studies research collaborations, and then evaluated and amended to produce the final output of the study.

The input data from the responses are arrange in vignettes from each of the usable 11 case studies (11 interviews in all) and were categorised by the code from the developing themes in the responses. The vignettes are used to clarify individuals' views on the impact of the culture on the success of the collaboration for the delivery of the co-created value as well as to tap meanings and interpretations of general attitudes and beliefs not easily accessible through other methods. The vignettes were grouped, sorted, and arranged into a hierarchical order via a card sort technique. This involved transferring each vignette onto a card, then bundling together the cards where vignettes expressed the same dimension. An example of this is given in Table 5.5.

Table 5.5: Example of Vignettes That Express the Same Dimension of culture Property: Culture of Collaboration

INST2	INST8	INST3
"From time to time. Hmm .... actually, it depends on who you talk to. Amongst other people in [the research team] there is a lot there, not senior management."	"I would say yes. I have never felt that I haven't."	"Probably some of the time, maybe not all of the time because that is the way creative innovation should start."

The responses from interviewees demonstrate that a solution with the characteristics of a maturity model addresses the third objective of a solution: the criteria of utility and consistency with existing theory. Each of the bundles was then arranged in one of five positions, corresponding to each of the five levels in the Collaboration Maturity Model: Ad hoc; Aware; Defined; Managed; Continuous. The allocation was driven by the underlying description of culture embodied in these level descriptors. For example, if a bundle of vignettes described a situation that was evidence of policies and processes to try to ensure the aspirations and rationalisations of the group culture, it was placed under 'Managed'. In the example in Table 5.3, the bundle was placed under 'Ad hoc'.

Collaboration by groups and organisations do not form accidentally or spontaneously. They are usually created because someone highlighted how the concerted action of several people could accomplish something that would be impossible through individual action alone. Therefore, some of the sub-categories required evidence beyond that gained from interviews. Documents analysed included: vision and values statements; strategic and operational statements; policies; procedures; guidelines; manuals; newsletters; annual reports; and any other documentation provided by the case study universities. Such evidence was used for three purposes: a) to determine what the actual situation was. For example, if individual staff members were spotlighted for praise and / or thanks in the internal staff newsletter; b) to determine what the policy was, to compare what occurred in practice. For example, the annual plan details specific projects that will be undertaken that year, however, the plan is not revisited, so there is no monitoring of whether the projects are completed; and c) when there were conflicting views held by interviewees, to determine which, if any, were an accurate reflection of reality. For example, three interviewees believed there was no culture of research collaboration, three believed that there was, however that this only applied to certain institutions, and three knew that there was, yet believed it applied to every willing institution. An example of documentary evidence included in the card sort is presented in Table 5.6.

Table 5.6: Example of Using Evidence from Documentary Provision Training

Ad-hoc	There are no policies, documented practices or procedures relating to training of staff. [INST8]
Aware	There is atraining programme developed by 'the staff development group' (a small group of staff) consisting of core training sessions such as manual handling, disability awareness, customer service skills, and sessions in response to requests from groups of staff. [INST5]
Defined	We do have a generous amount of funds in the [training] budget which we try to protect as much as possible ... And we parcel that out to the teams so ... everyone gets a fair cut. ... Then it is up to the team leader to agree with their staff what they go on. Within reason and if it is work related, we will let them go on anything." [INST2]
Managed	There is a training programme comprising training needs assessment, provision, and an assessment of the effectiveness of the training. Training is provided in the tools, techniques, and skills for improvement. Data gathering and reflection are encouraged. [INST3]
Continuous	There is a training programme comprising training needs assessment, provision, and an assessment of the effectiveness of the training. Training is related to future necessary research skills. Training takes account of succession planning and developing skills required for the future. Training is provided on 'learning how to learn'. Time is built in to work for critical reflection. [INST6]

All the sub-categories are consistent with what constitutes a collaborative culture, due to the deliberate incorporation of evidence from literature into Iteration One. As indicated in Chapter Two, the deficiency in the existing literature is not a failure to describe the elements of collaboration culture in having research partnership with technology firms, nor a failure to describe the characteristics of a research group or an organisation culture (the failure is in not recognising or describing the intervening stages between failing and excellent). Therefore, these descriptions from the literature of the group or organisation relationship to its environmental level attributes were included in the card sort. An example of this is illustrated in Table 5.7.

Table 5.7: Example Where the Descriptors Drawn from the Literature Learning

Ad-hoc	"We don't formally require that people who have gone to conferences formally report back to us. There is an assumption that if someone comes back with a bright idea, they will make us aware of it." [INST9]
Aware	"The subject government sponsorship recently did a staff development session where they reported back what [courses] they had been on and that was very good as it cascaded down, but that doesn't happen very often." [INST2]
Defined	"… you have been to that conference come and discuss it with me, come and talk to me about it and then I would say 'alright, let's bring this to a team meeting" [INST3]
Managed	If [staff members] collaborate to publish a high impact research or go out to a training event or conference, they have to publish a report in [the internal staff newsletter]" [INST6]
Continuous	There is shared learning, information, and knowledge throughout the levels of the organisation. (Swieringa and Wierdsma, 1992)

When the card sort was completed, the evidence for each level of each sub-category was synthesised to produce a rubric for the Collaboration Maturity Model consistent with both theory and practice. In accordance with the principles of Charmaz (2006) Grounded Theory, the natural language of interviewees was preserved when it served as a symbolic marker of their views. Such in vivo codes fall into one of three groups: (i) general terms that everyone knows, which highlight condensed but significant meanings; (ii) an innovative term that vividly captures meaning of experience; and (iii) insider shorthand that reflects a particular group's perspective. An example of using thematic coding to segment, categorise, summarise, and reconstruct in a way that captures the important themes within the data set is presented in Table 5.8.

Table 5.8: Example of Preserving the Natural Language of Interviewees

Attitude to Change	
Ad-hoc	"If it ain't broke, don't fix it" [INST1]
Aware	"Not for the sake of it" [INST2]
Defined	"Change is good if done well" [INST9]
Managed	"Change is good if it is done to improve things" [INST10]
Continuous	"To stand still is to regress" [INST6]

There were some sub-categories where it was not possible to discriminate between the Ad hoc and Aware categories. These sub-categories have properties of collaboration culture, by their nature, only appeared positively in organisations with higher research maturity. The descriptors at the lower levels of maturity were simply the absence of that property. An example of this is presented in Table 5.9.

Table 5.9: Example Where Levels One and Two Could Not Be Discriminated by stakeholder's recognition of where they fit into the overall scheme

Ad-hoc	"… depending how exposed they are or wrong culture"
Aware	
Defined	"Change is good if done well" [INST9]
Managed	"Change is good if it is done to improve things" [INST10]
Continuous	"To stand still is to regress" [INST6]

5.7. Demonstration and Evaluation

This section presents Iteration Two with full consideration of the impact of culture on the interactions of the group. The output of the increment is populated with the Collaboration Maturity Model rubric as a solution to the problem of static directional collaboration developed from the static Research Collaboration (defined in Iteration One); i.e., in order to area that lack dynamic practitioner engagement between UK universities and technology firms on the concept of research collaboration. Following this demonstration, the solution is evaluated, both in terms of utility of the artefact and the learning that has occurred about the problem space. Artefact produced for Iteration Two is to be referred to as Culture Research Collaboration is presented in Figure 5.2 while, the populated output with the Collaboration Maturity Model rubric in the management process is presented in the evaluation section.

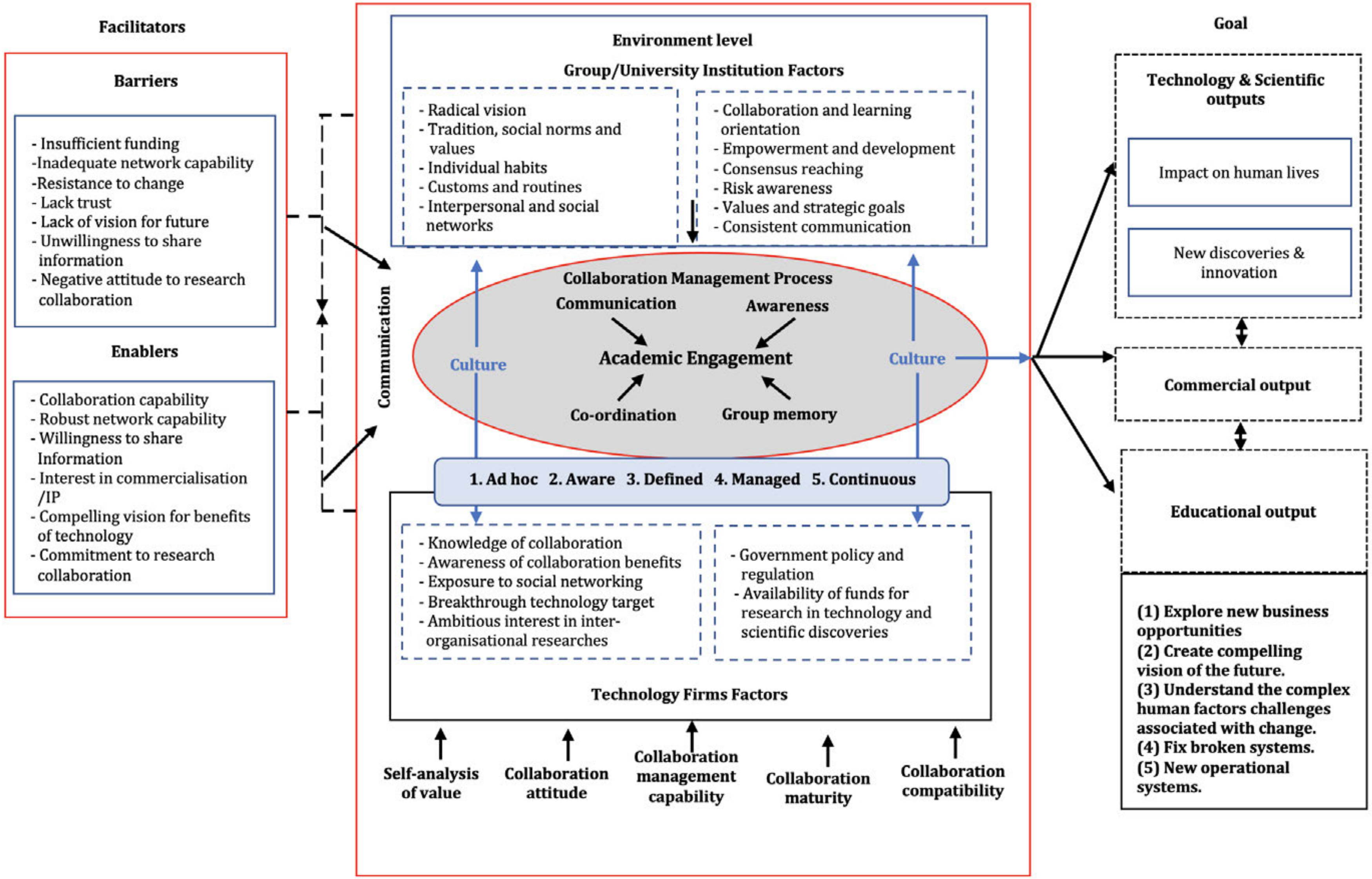


Figure 5.2: Research Collaboration Culture

5.7.1. The Demonstration

The demonstration of the Research Collaboration Culture artefact as a solution to the problem of static directional academic engagement collaboration between researchers in the UK universities and technology companies was twofold. Firstly, the potential Static Research Collaboration artefact – identified from literature (see figure 4.3) - was used to developed semi-structured questions that was presented to mainly selected researchers and practitioners interested in issues of research projects assessment. This was achieved by contacts with individual researchers in UK universities and practitioners in technology firms with their responses to decipher the interactions in the collaboration management process. This process gave the understanding of the significance of research collaborative cultural preconceptions, assumptions, and the nature that directs the "pushes" or "pulls" of research groups or organisations towards the direction of having dynamic research collaboration.

Secondly, the output of Research Collaboration Culture artefact (Iteration Two) was used in conjunction with the Collaboration Maturity Model as assessment instrument, tool to assess the collaboration culture of two UK universities and a technology company. In practical application, research groups will be able to use the Collaboration Maturity Model independently. In the responses related to the cultural nature, assumptions, and preconceptions, researchers and a director of the technology company were asked to comment on research cultural maturity.

The university researchers' comments on how they conceived the importance of maturity of the individuals in the in group of 'research collaboration' is summed up as:

"I guess, whilst we have always obviously had our minds on making assumptions that helps the relationship with external stakeholders, there are elements in here that we have probably thought-of-less than some others. Everybody thinks about the collaboration activities, everybody is looking at how long it takes to do things, everybody is looking at improving processes, but there are bits in here about [e.g.] how interpersonal structures relate to each other, the impact of passing that on through the service, that maybe we hadn't really thought of."

Comments by individuals involved in research collaboration in the technology company is summed up with:

"By breaking down the maturity of the culture of researchers into different levels and elements, it then gives you a lot of direction into the areas you should focus on. Which might not be the areas you thought of, or you would originally focus on when thinking in the abstract of the project. That's where it is particularly useful."

This evidence from the Research Collaboration Culture artefact demonstrates the CMM assessments as an efficient tool that will help researchers and practitioners re-conceive thereby, engage with issues, according to Lee et al. (2012), on research on 'dynamic collaboration' in co-creation of value in the engagement between UK universities and technology firms.

5.7.2. Iteration Two CMM Assessment

The demonstration of Research Collaboration Culture artefact with the Collaboration Maturity Model is for researchers, research groups, and organisations to be able to self-assess using the freely available tools. This contrasts with performance of other digital assessment frameworks or benchmarks for academic research engagements.

The standard for the assessment with the CMM produces a score from 0 to 5 (0 if the descriptors for level 1 are not met) for each of the 40 factors to produce a profile of research collaboration culture. A technology company or research groups in a university environment with a strong and ubiquitous technology bias collaboration culture will score the maximum 5 for all factors for the level 5 on the model. Other factors at other levels have different scores for the three Cases (see Table 5.7, 5.8, and 5.9).

Case Study 1 – Knowledge Transfer Centre (KTC)

The first case study is the scoring from Researchers (Senior/Principal Researchers) in a UK university Knowledge Transfer Centre. This environment is underpinned by a culture of collaboration that is based on good governance, best practice, and support for the development of creative innovations through research collaboration. The organisational environment usually has clear policies, procedures, and practices on the support for researchers and partners. The management of these types of knowledge transfer centres that includes Research Networks, Research Clusters, Enterprise Gateway Hubs for business start-up, and Research Groups, place emphasis on the creation of research impact with suitable learning, training, and mentoring opportunities to support a dynamic research collaboration (Ajjawi et al., 2018). The maturity level of such an organisation presented in Table 5.10.

Table 5.10: Assessment of Culture in Research Collaboration with CMM for Case 1 -KTC

Factors	2019 score	2022 score
...		
4.0 Attitude to change		
4.1 Attitude to change	5	?
4.2Perception of drivers for change	4	?
5.0 Attitude to research collaboration and innovation		
5.1 Definition of collaboration (including locus control)	4	?
5.2 Attitude to research collaboration improvement	4	?
5.3 Perception of responsibility for research collaboration improvement	4	?
5.4 Types of collaboration improvement initiatives	4	?
6.0 Leadership		

From the above assessment of the collaboration factors, research collaboration maturity levels are mostly in Managed (level 4) with only one factor, Attitude to change, is in the Continuous (level 5). Studying the research environment of the Knowledge Transfer Centre can yield understanding in concrete progress on research capacity building. The understanding is useful for faculty staff but also for research managers, international donors, and policymakers to understand the way researchers work and the challenges they face in their activities. The research-intensive environment is underpinned by heavy matured collaboration culture with integrity based on good governance, best practice, and support for the development of researchers. Similarly, there is access to grants, world-class infrastructure, and equipment. There is available suitable learning, training, and mentoring opportunities to support researchers.

These scores are improvements from the Static Research Collaboration artefact which were mostly between Ad hoc and Defined (levels 1 and 2) with just only one factor in the Defined stage (level 3).

Case Study 2 - Academic Health Science Networks (AHSN)

The second case study is the scoring from the NHS England – Academic Health Science Networks (AHSN). AHSN, setup by the UK government, is to align clinical research, informatics, education, innovation, training, and healthcare delivery with knowledge transfer networks through collaboration with internal and external partners. It is to deliver changes in the way the NHS identifies, develops, and adopts new technologies that are predicated on the collaboration between the NHS, academia, the private sector, and other external partners. AHSN places emphasis on a culture of research collaboration and agile in the adoption of innovation into practices that improves clinical outcomes as well as patient experience. The leadership and the investment in its numerous staff will be of significant interest in areas such as co-development, testing, evaluation, early adoption as well as the spread of innovative products and services (Barber et al., 2007; Barr, 2009).

Table 5.11: Assessment of Culture in Research Collaboration with CMM for Case 2 - AHSN

Factors	2019 score	2022 score
...		
6.0 Leadership		
6.1 Vision and value setting	2	?
6.2 Trust	3	?
6.3 Inspiration and motivation	2	?
7.0 Investment in training		
7.1 Attitude of researchers and staff	3	?
7.2 Training provision	3	?
7.3 Development of staff	2	?
7.4 Recognition of staff	2	?
8.0 Alignment		

From the above assessment of the collaboration factors, research collaboration maturity level is almost all at the Aware (level 2) and Defined (level 3). Collaborative leadership should create communities of people and organisations that unites around a common vision and value by encouraging working collaboratively to accomplish a shared vision that makes a powerful and positive impact. A leader's job is to champion the vision, provide resources and remove roadblocks (Lawrence, 2017).

Theoretical underpinnings of collaborative leadership suggests that for the realisation of effective clinical leadership, there is a link to a wide range of functions that includes transformative and experiential learnings. The key skill to be developed for collaborative leadership is knowing how to encourage collaborate and build influential partnerships in their organisation [*ibid.*]. It's also an increasingly important capability in leading the modern workforce. Collaboration combines the knowledge, experience and creativity of others and creates shared accountability. This meets the requirement of healthcare to include system performance, achievement of health reform objectives, timely care delivery, system integrity and efficiency, and is an integral component of the healthcare system.

There is the need for collaborative tools that are inexpensive and efficient. The tool being developed in this research will give exploitable pieces of information that can be updated regularly so that the whole organisation as well as research teams can follow their overall maturity progress.

Case Study 3 – Research Funding and Support Body

The third case study is the scoring from the professional research funding and support bodies in the UK. According to Research Councils (2014), there are various research funding and support bodies in the UK. There is a broad split between commercial and non-commercial (including internal funding). For example, there are the Research Charities that provides vital stream of research funding that compliments the objectives and visions of the Research Councils and Government departments. There are hundreds of research funding charities covering a wide range of aims. The Research Charities are regulated by charity law and are required to observe certain obligations and restrictions on the use of charitable funds for research, such as the requirement to publish research findings and a prohibition on funding research for the purpose of commercial or private gain. Others are the Association of Medical Research Charities (AMRC), UK Research and Innovation (UKRI), Department of Environment, Food and Rural Affairs (DEFRA), QinetiO, Defence Science and Technology Laboratory, Royal Society, and Royal Academy of Engineers.

There are several industry and private companies (national and multi-national) that fund a wide variety of activities for commercial gains. It is critical for researchers and research groups to understand the market context as well as the collaboration culture maturity of technology firms when negotiating with the industry. For example, it is significant to understand technology firms position within the wider market context (e.g., retaining or gaining market share), gaining sufficient knowledge of competitors, taking advantage of opportunities (e.g., gaps in the market), understanding the funders' willingness and ability to pay, minimising risks and threats, and relating supply with demand (e.g., reacting to funders' priorities, where appropriate).

Table 5.12: Assessment of Culture Research Collaboration with CMM for Case 3 - Funding

Factors	2019 score	2022 score
1.0 Management of the organisation		
1.1 Strategic plan	4	?
1.2 Management of alignment (achieve strategic plan)	4	?
1.3 Progress monitoring	3	?
1.4 Performance measurement	4	?
1.5 Research project management process	4	?
2.0 Environmental sensing		
2.1 Partners (bottom up)		
2.1.1 Partners - Gathering feedback	4	?
2.1.2 Partners - Collation of feedback	4	?
2.1.3 Partners - Action because of feedback	5	?
2.2 Partners (top down)		
2.2.1 Organisation – Gathering feedback	3	?
2.2.2 Organisation – Influencing organisation decision	5	?
2.3 Wider context (inside out)		
2.3.1 Wider context – Involvement of staff in profession	3	?
2.3.2 Wider context – Gathering feedback	3	?
2.3.3 Wider context – Contribution to profession	4	?
3.0 Learning organisation		

From the above assessment of the collaboration factors, research collaboration culture maturity levels are all between the Defined (level 3) and with several factors in Managed (level 4) and two in the Continuous (level 5). These are improvements from the Static Research Collaboration artefact which were mostly between Ad hoc and Defined (levels 1 and 2) with just only one factor in the Defined stage (level 3). Clear policies, practices, procedures to support researchers. There is high maturity in the culture of research and integrity governance to support universities as well as researchers to ensure they meet the legal, ethical, and scientific requirements and obligations.

5.7.3. CMM with Levels descriptor

To demonstrate the relevance of the descriptor to common situations found in literature such as Schein (2017), two of the factors from the full detailed Collaboration Maturity Model with their maturity levels descriptor are presented below in Table 5.13.

Table 5.13: Extract from the CMM showing maturity descriptors

1.2 Management alignment	
Ad hoc Level 1	Actions are solely reactive to events.
Aware Level 2	Strategic plan includes breakthrough improvement processes. Many actions are unrelated to the strategic plan and are reactive to events.
Defined Level 3	Strategic plan includes breakthrough improvement processes. Some actions are unrelated to the strategic plan.
Managed Level 4	Strategic plan includes breakthrough improvement processes.
Continuous Level 5	All improvement processes, both incremental and breakthrough, flow from the strategic plan, and it is updated to reflect new developments.

4.2 Attitude to collaboration improvement	
Ad hoc Level 1	Culture is the responsibility of everyone to do their best to adhere to procedures.
Aware Level 2	Culture is the responsibility of people serving customers face-to-face to be ‘nice’.
Defined Level 3	Culture achievement is the responsibility of the management of the service (or the quality officer if there is one), thought it may be explicitly devolved down for specific areas.
Managed Level 4	Culture for a particular area is the responsibility of the people in that area.
Continuous Level 5	Culture for the whole research group is everyone’s responsibility.

It emerges that meaningful collaboration requires researchers to devote more time to develop collaboration capacity building by managing a culture of networking with others in trust, fairness, empowering, and inspiring (Freitas et al., 2013). If a balance is not achieved in these areas before and during academic engagements, the time and human resources invested often may not produce tangible value co-creation (Lee et al., 2012). As an example, the researcher’s direct involvement with a research project, may indeed discourage technology firms to collaborate in information intensive research. The environment partner–researcher relationships domain suggests that the development of social and professional relationships between technology firm representatives and academic researchers is a foundational element of collaborative research. This condition can be easily understood considering the history of the nature of interpersonal attribute and relationships (Schein, 2017). Solid professional relationships may tip the imbalance of power between researchers and technology organisations and communities, so that trust around major issues such as information is proprietary or subject to trade secrets or post-research academic publications especially studies that address intractable and social problems or social change. Some of the concerns for technology companies are the protection of their intellectual property and financial interests and that commonly requires keeping information away from their competitors. Problems can arise between universities and companies, and the researchers at each, over whether and when to publish because of proprietary concerns and/or the ownership of intellectual property.

The characteristics of the collaborative research group domain reflects the poignant data on values previously described in the collaboration participatory literature (Minkler and Wallerstein, 2011). Collaborative research that involves impactful social change and solution to problems is more likely to engender technology firm's involvement. It is preferred and ought to have clear purposes defined in partnership, ought to involve university researchers and research participants staff in decision making, ought to allow for technology firm staff and academic research learners to expand their knowledge base, and ought to improve the collaborative research culture that assist the improvement of the services provided by technology companies. These priorities, expressed in the voices of researchers and technology staff, add credibility to a developing body of knowledge about factors that influence collaborative research (Calvert and Patel, 2003). Dynamic collaborative research can be strengthened through embedding sound collaboration cultural values and by upholding as well as supporting these values.

Consequently, the potential of Research Collaboration Culture as a solution for a high-reward dynamic research collaboration is adequate as demonstrated through review of the categorisation within the five maturity levels between universities and technology firms. However, the possible adoption of the artefact by all stakeholders as expressed by academic researchers was in the nature of the reality in embedding the culture of collaborative research ideas in the environment of researchers and practitioners. Following this demonstration, the solution (as evaluated) requires further iterations in terms of utility of the artefact and the learning that has occurred about the problem space requires further iterations.

5.8. Utility of Artefact

This new increment, Research Collaboration Culture, received positive feedback from researchers and technology firm practitioners as it highlights in practice the underlying assumptions taken-for-granted, espoused group beliefs and values, as well as observed behaviour part of culture often during academic engagement. Five senior researchers' responses summed up as pointed out to the author:

"… this is typical of a recipe that will improve the reduction of the divide to tech companies in the digital transformation age".

These included three researchers in the UK universities that regularly get published in several international peer-reviewed journals. Two researchers in the Centre for Digital Business and practitioner in a digital agency for the education sector that supports university research particularly indicated interest to be 'early adopters' in new research initiatives and assist with the statistical development of the next iterations. One expressed to the author:

"You probably need to hear this, and you will all the time, but your research is truly, truly exciting. I'd easily describe it as inspiring and courageous. Just like you, I believe research collaboration with technology companies is our future, but we agree there is a need for our people to understand the culture to bring about a good change to research collaborative groups and organisations."

This evidence demonstrates that the solution has relevance because it deals with real concerns, captures attention, and is not only of academic interest.

The solution has fit, because the analysis shows that the concepts fit with the incidents they are representing to the point of saturation, at least to the limits of the available data. The solution also has workability, because it explains the heterogeneous research area of collaboration culture both i.e., in terms of different constructs and different levels and encompasses all first-order factors present in the literature or the grounded data.

5.9. Learning About the Problem

The basic process of embedding the cultural element, a given belief or assumption, is a "teaching" process, but not necessarily an explicit one. The basic model of culture formation, it will be remembered, is that someone must propose a solution to a problem the group faces. Only if the group shares the perception that the solution is working will that element be adopted, and only if it continues to work will it come to be taken for granted and taught to newcomers. It goes without saying, therefore, that only elements that solve group problems will survive, but the issue of "embedding" is how a research group or senior researchers gets the group to do things in a certain way in the first place, so that the question of whether it will work can be settled. In other words, embedding a cultural element in this context is important and means that it has ways of getting the group to try out certain responses. There is no guarantee that those responses will, in fact succeed in solving the group's ultimate problem since there are several mechanisms: from very explicit teaching to very implicit messages of which even long-established researcher may be unaware. These mechanisms are to ascertain the ubiquity of the output of increment against distinctive real-world examples.

Research Collaboration Culture artefact has established three areas of learning about the problem space. Firstly, researchers and practitioners do want to engage with issues of research collaboration being more dynamic and collaboration culture and are keen to do so if such issues are brought to them in an accessible and meaningful way.

Secondly, a maturity rubric format rich in detail is supportive way of making the abstract concepts of dynamic research collaboration nature of reality, therefore understandable to practitioners.

Finally, a model of collaboration maturity levels is not sufficient to enable researchers in the universities and technology firms' practitioners to self-assess the cultural maturity of their research groups or organisations. The community in the environment need for academic engagement, off-the- shelf tools to enable them to undertake such assessment and embed the cultural elements in the collaboration process.

5.10. Summary

This chapter presented the Research Collaboration Culture artefact, where the outline of the culture of the individuals in a research group influences the values and strategic goals, learning orientation, consensus reaching, awareness as well as empowerment and development of dynamic collaboration in the environment. Collaboration Maturity Model for the culture assessment instrument was produced as the output of the Static Research Collaboration artefact to enable to enable academic research groups or practitioners in technology organisation interested in research collaboration with UK universities to be located on the Collaboration Maturity Model 'road map' without the need for external consultant input and plan improvement in their collaboration process.

The grounded theory methodology used in the previous Iteration was used to developed interview questions, and axial coding and synthesis of the interview data, documentary evidence and literature was used to determine the dimensions of the properties of collaboration culture. The natural language of interviewees was preserved in the rubric when it vividly captured experience or reflected a particular perspective. The output of this Iteration was a fully characterised culture of research collaboration and Collaboration Maturity Model.

This improvement of culture of groups and the organisations in the environment of research collaboration was demonstrated to solve the problem of lack of practitioner understanding of the amorphous concept of research partnerships by universities with digital technology firms and the collaboration culture. How the improvement of the culture of collaboration met the evaluation criteria of fit and workability was described, and evidence presented that demonstrated the relevance of collaboration maturity. Finally, the learning that occurred about the problem space led to amended definitions for a solution going into Iteration Three.

CHAPTER SIX

ITERATION THREE – DYNAMIC RESEARCH COLLABORATION

6.1. Introduction

In this chapter, the adoption of research culture to empower, develop, and encourage a dynamic research collaboration environment is introduced, while the evaluation of the adoption is described.

The purpose of Iteration Three is to develop an efficient and affordable self-assessment instrument to enable research groups, UK universities, and technology organisations to adapt and embed a collaborative culture into their environment. This Iteration uses standard survey design methodology to create and test an instrument ready to be used by research groups and organisations for data collection, analysis, and reporting of an embedding collaborative culture. The questionnaire consists of predominately closed questions addressing the attitudes and knowledge of respondents. The questionnaire was conducted as an online survey as it is easily available and easy to administer the data without resolve to a big cost to the researcher. The questionnaire was tested informally, and then formally with two UK academic researchers in UK universities and organisations, and amendments are made to the survey in response to feedback from participants. The artefacts produced in Iteration Three are the Research Collaboration Culture Assessment Instrument, RCCAI instructions for use, the rubric for mapping the RCCAI results onto the CMM, and instructions for reporting the RCCAI results.

Section 6.1 describes the research design used in this iteration. Section 6.2 details the development process, covering the application of the research design, the development of the instrument, the informal and formal testing of it, and the artefacts produced. Section 6.3 presents the demonstration and evaluation of the output of Iteration Three, including an evaluation of the artefact produced from this iteration and the artefact produced from Research Collaboration Culture artefact in Iteration Two. Section 6.4 describes the communication of the research. Finally, section 6.5 summarises the chapter.

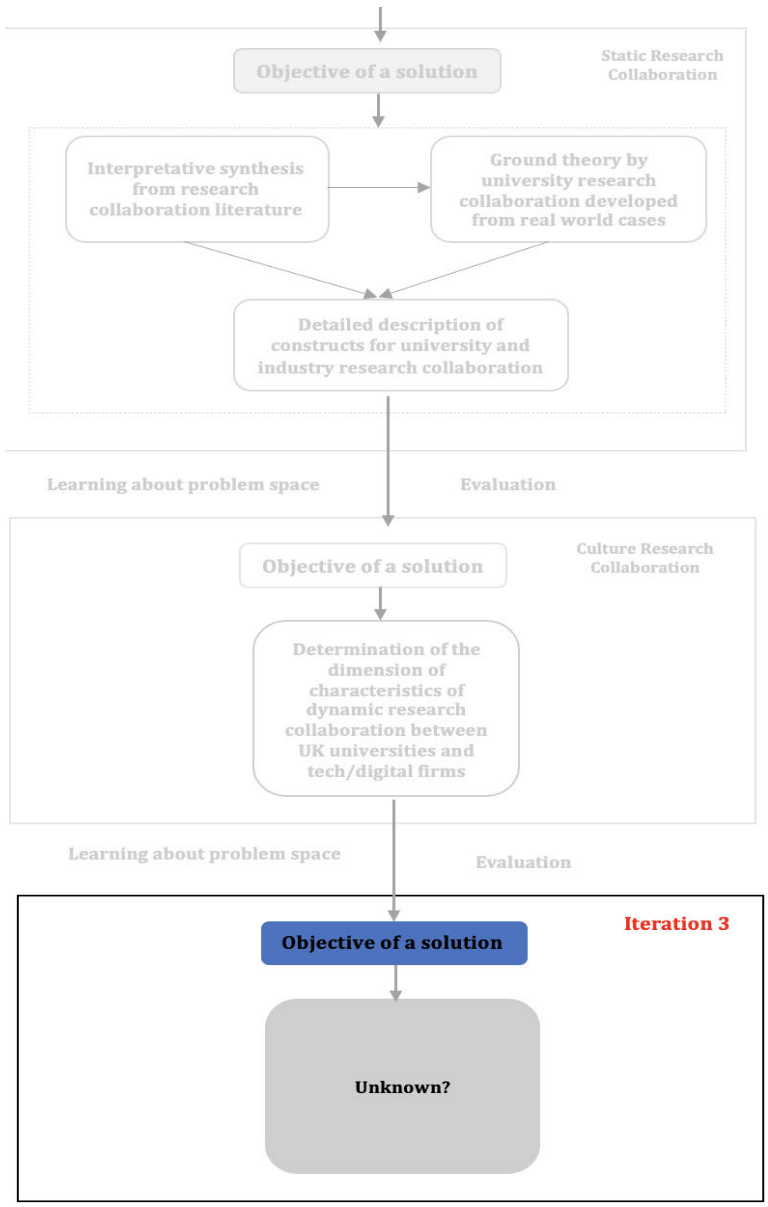


Figure 6.1: Research Iteration Three

6.2. Applied Research Method

The purpose of this iteration is to develop an assessment instrument for the adoption of culture maturity that encourages a dynamic research collaboration. To fulfil the aim of this research, to facilitate researchers and practitioner engagement with issues of dynamic academic engagement, this instrument must be able to:

1. be easily and affordably administered by researchers, research groups, and partitioners.

2. be easily analysed by a research group and partitioners, without specialist statistical knowledge; and

3. locate the dynamic research collaboration on the Culture Maturity Model.

For the development of this iteration, a quantitative approach with survey questionnaire was used. Several studies such as Foddy (1993) suggested that surveys are a keystone of contemporary social science and are an appropriate instrument to assess the maturity of an organisation; and invariably their collaboration culture maturity. A survey is within a positivist methodological framework. A stimulus-response model is usually used where each stimulus is standardised for each to be a forced choice for example, each respondent is compelled to give a single response to each of the stimulus (Foddy, 1993; de Vaus, 2002). Forced choice (or 'closed') questions ensures respondents must choose a response from a pre-set range (Oppenheim, 2000; Bradburn, Sudman and Wansink, 2004). The assumption is that the combination of the responses from the range can be meaningfully compared.

Use of survey questionnaires is at the opposite end of the data capture landscape to methods used so far to underpin the research in this thesis, since previous work has used subjectivist approach of qualitative field research. Qualitative interviews focused on the interpretation of people's experience of their world, so data collection is sensitive to actors' views. Accordingly, a subjectivist approach best addressed the aims of Iterations one and two (Chapters 4 and 5), however subjectivist approaches take a long to administer, and requires specialist skills in data collection, analysis, and reporting. Therefore, the use of a subjectivist approach is not an appropriate approach that addresses the aims of the third iteration in this research.

A mixed of both open and forced-choice positivist research design is a method that is the best fit for the aims of this iteration; it is quick both to understand and easy to administer with some accuracies and does not require extensive specialist skills to administer. However, studies such as Bryman (2012) warns of the discrepancy between theoretical research framework and methodology as one of the most fundamental errors in the design of research. However, the purpose of the Research Collaboration Culture Assessment Instrument (RCCAI) is not to determine the position of the collaborative research culture on the Culture Maturity Model (an absolute statement of the real world), but to position the collaborative research culture on the Culture Maturity Model as determined by the attitudes of researchers and staff in responding to the RCCAI survey. This distinction is important as it enables the conflict, if subtle, between theoretical research framework and methodology to be sufficiently resolved to address the research aims of this iteration which are to develop an efficient and affordable self-assessment instrument to enable research groups, UK universities, and technology organisations to adapt and embed a collaborative culture into their environment.

The research design as illustrated in Figure 6.2 therefore, follows a standard survey design method done in studies such as Bradburn et al. (2004); Czaja and Blair (2005); Sapsford (2007). The purpose of this iteration is to produce a survey that is ready to be used by UK universities and technology organisations for data collection, analysis, and reporting. This will not add additional layer of support or hiring of extra staff to manage the operations of the survey. This iteration thus, follows the methodology until the end of Stage 3: Final Survey Design and Planning, where the final questionnaire; analysis plan; report outline; and operations plan form the output of Iteration Three.

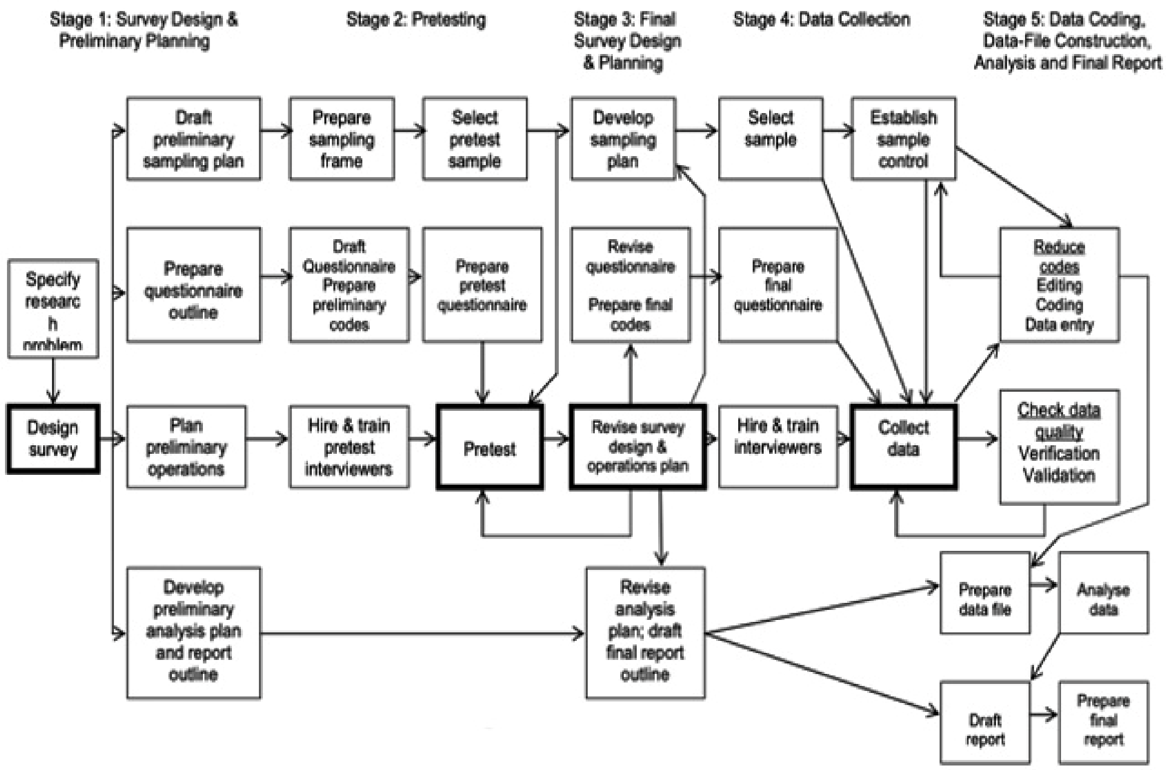


Figure 6.2: Stages of Survey development in Iteration Three: Adapted from Czaja & Blair, 2005, p. 12

6.2.1. Survey Design and Preliminary Planning

Czaja and Blair (2005) pointed out that a good questionnaire "is a valid measure of the factors of interest; it convinces respondents to cooperate; and it elicits acceptably accurate information" (p.65). Therefore, a well-designed survey is derived from a clearly defined research topic that is reasonably thought through before starting to design the questionnaire (Bradburn et al., 2004).

Following the specification of the research problem, the first stage in survey design is to design the questionnaire in general terms for open knowledge flow. Czaja and Blair (2005) pointed out that this involves deciding whether to ask open or closed questions; whether questions need to determine attitude, knowledge, trend, trait, or behaviour; and the types of demographic information required. For open questions, it produces narratives that then need to be coded and interpreted however, closed questions have two parts: the statement of the question and the response groupings. For example, when the focus of the questions is on attitude, researchers need to be aware that respondents' attitudes, beliefs, and opinions have been shown to be unstable. Similarly, care should be taken to ensure that respondents have the necessary information available to them when asking questions on knowledge; and when asking questions on behaviour, researchers should be aware that the relationship between what people say they do and what they do not is always convincing (Czaja and Blair, 2005). The type of demographic information required determines whether the questionnaire can be administered face-to-face or remotely.

The next stage is to draft a sampling plan to identify the nature of the sample required. It is, therefore, necessary to determine from the preliminary plan the availability to organisations in the digital sector to improve their collaboration with the universities, as these may have an impact on how the questionnaire is conducted as web-based surveys are faster and efficient. This is compared to face-to-face interviews that the planning takes longer and are more expensive (*ibid.*). Finally, the preliminary analysis plan and report outline should be drafted, as the nature of the data required will influence the questions asked.

These following four planning documents determine the outline design of the survey. The outline for the research design is done in the pretesting phase.

6.2.2. Pre-testing

The presentation of a draft the questionnaire is done in the first stage. This includes iteratively the writing of the questions, writing the response categories, and organising the questions in the range. Czaja and Blair (2005) suggested that a good question should be "unadorned and uncomplicated, as explicit and single-minded" (p.72). It should be clear, simple, and understandable (Sapsford, 2007). Questions should:

- be written using everyday language (Czaja and Blair, 2005)
- ask only a single question at once (Sapsford, 2007)
- contain no clauses, double negatives, negative phrasing, or instructions
- be short and in a single tense; and
- be either single or plural, not both (*ibid.*).

The question an author must watch out for are the ones with individual words having potential misunderstandings of the meaning. Respondents do their best to answer every question put to them, even questions they have difficulty understanding or relating to. They either do it with cognitive adjustment to the question to answer it or rely on some contextual clues and general attitudes to formulate appropriate answers (Czaja and Blair, 2005). Words with several syllables; low frequency of occurrence in everyday usage; context-specific nuances of meaning; lack of empirical referents; and apparently similar words with related nuances are easily misinterpreted or misunderstood (Sapsford, 2007).

Closed questions require the response categories to be written as part of the questionnaire (*ibid.*). Respondents should be able to give answer in terms of only one choice provided (Czaja and Blair, 2005). Response categories should be explicit with relative order to each other (e.g., Very Fair / Fair / Unfair / Very Unfair/ Neutral) (Bryman, 2012).

Questions should be organised into sections and grouped into:

- relevance to the topic

- ease of answering
- interest to the respondent
- available knowledge
- internal logic; and
- with a smooth progression or flow from one question to the other (Czaja and Blair, 2005).

Researchers need to take into consideration the effects of a question on the order and the format as small changes could have a major change in the way the respondent answers (*ibid.*). Bryman (2012) suggested that preceding questions have an impact on the answers given to the following ones and the best arrangement is for questions to move from the general to the specific within a section.

The questionnaire should have in its arrangement an introduction stating:

- what the study is about?
- who is conducting the study?
- who the sponsor of the study is?
- why the study is important?
- what will be done with the results of the study? (Czaja and Blair, 2005).

The arrangement and presentation of the questionnaire can also affect response rates. The ideal completion time for a self-administered questionnaire is less than 15 minutes, but respondent perception of how long it will take is more important than the actual time taken in the determination of the response rates (*ibid.*). Following the above grouping strategies, a questionnaire should appear to take the least possible time.

The second stage in pretesting is the draft questionnaire testing, which is done informally initially, then formally. The purpose of testing is to ensure that respondents understand the questions, and that the questionnaire is valid and reliable (*ibid.*).

Informal testing uses the researcher themselves, and their friends / family / colleagues to critically evaluate the questionnaire and identify problems with wording, layout, grouping and timing. Bradburn et al. (2004) suggest that the researcher can ensure all questions are necessary by asking 'Why do I want to know this?' and 'How does this link directly to addressing the research question?'; rejecting any non-essential questions and/or question that discriminate between respondents. For closed questions, response categories can provide clues to the respondents how they should interpret the question (Sapsford, 2007), so category definitions should be viewed in combination with the question when viewing the questionnaire.

Questionnaire testing should follow four steps (see below), which are repeated until the researcher is satisfied with the survey (Czaja and Blair, 2005). The four steps are:

1. prepare the pre-test questionnaire,
2. recruit the pre-test sample (about 10 respondents will be satisfactory),
3. analyse the pre-test feedback,
4. revise questions, answers, and procedures considering feedback.

When the testing is complete, the survey design can be finalised.

6.2.3. Final Survey Design and Planning

The final design for the survey comprises the questionnaire from pretesting, a sampling plan to ensure an appropriate sample is obtained, training procedures and materials for interviewers (unless self-administered), data-coding plans, plans for analysing the data, and a report outline.

6.3. Development

This section describes how the research method detailed in section 6.2 was applied to develop the Research Collaboration Culture Assessment Instrument.

6.3.1. Survey Design and Preliminary Planning

The underpinning research problem for this survey was to logically locate a dynamic collaborative research culture on the CMM through the view of researchers, research groups and staff in technology firms responding to the questionnaire. The questionnaire consisted of predominantly closed questions, with a single open question, it is not possible to produce a meaningful response set a priori for the element of the CMM corresponding to that question. The questions addressed attitudes and knowledge of respondents, with two demographic questions to enable cross-tabulation of results by team and hierarchy during research collaboration.

The sampling plan was for researchers within UK universities, research groups, and staff in organisations that are involved with the development of digital technology innovations to complete the questionnaire. This is crucial to provide a true balanced picture of the opinions of those involved in current static directional flow of research collaboration as shown in literature. Most academic research groups and staff in firms with technology collaboration orientation are small, with only a few people in such roles. A sample that is representative of the research groups and technology firms produces a representative picture; this is relevant particularly the case when cross tabulating the results by the demographic questions.

The preliminary operations plan was to conduct the questionnaire using a cloud-based enabling platform that allows internet-connected devices. Cloud-based platform surveys fits the requirements that the questionnaire is easily administered by research groups and technology firms. The pros and cons of online surveys are shown is Table 6.1.

Table 6.1: Pros and Cons of Online Web Surveys (adapted from Czaja and Blair, 2005, p.35)

Administration	
Cost	Very low
Length of data collection period	Very short / short
Geographic distribution	May be wide
Questionnaire issues	
Length of questionnaire	Short (<15 mins)
Complexity of questionnaire	May be complex
Complexity of questions	Simple / moderate
Respondent control of question order	Poor / fair
Use of open-ended questions	Fair / good
*Use of visual aids	Very good
*Use of personal records	Very good
Rapport	Poor / fair
*Ability to handle sensitive topics	Poor / fair
Non-threatening questions	Good
Data quality issues	
*Sampling frame bias	Low / high
Response rate	Poor / good

*Response bias	Medium / high (favours more educated people, who would have internet access)
Knowledge about refusals or non-contacts	Fair
Control of response situation	Poor
Quality of recorded response	Fair / good

Some of these issues (asterisked) are not applicable to this research, such as the response bias as all the respondents would have internet access. Some of these issues, particularly rapport and respondent control of the question order, have implications for the questionnaire design. To address these issues:

- humanising cues were added to the initial welcome / instructions to build rapport (Tourangeau et al., 2001).
- questions have a 'Don't know' response category, because the cloud-based platform survey tool used (Microsoft forms/Qualtrics) web-based surveys requires that all questions receive a response (Czaja and Blair, 2005); and
- all questions are presented on a single page, so that respondents can control the order in which they answer them (Czaja and Blair, 2005).

In addition, care was taken to ensure that the questionnaire is self-explanatory (as is standard practice for any self-administered questionnaire) while, data protection issues were explicitly addressed at the start of the questionnaire, because respondents usually have concerns about the security of information on the internet (Bryant, 2012).

The preliminary analysis plan has, where possible, a one-to-one correspondence between an element of the CMM and a question; and between an answer choice and the level achieved on that element. The preliminary report is the CMM, with the level achieved highlighted.

6.3.2. Pre-testing – Draft Questionnaire

The draft questionnaire, showing the questions, response categories, and organisation, is presented in Appendix I The questionnaire was built using Microsoft forms, to which University of Reading subscribes. Screenshots of the presentation of the questionnaire are shown in Appendix J.

6.3.3. Expert Pilot Study Testing

A pilot test was used cross-check the developed questions as presented in appendix L against the checklist of best practice (as described in sections 6.2). The researcher recruited six colleagues with experience of questionnaire design (one principal investigator, two research fellows, two members with faculty research group, and one NHS information technology programme delivery manager) to test the questionnaire. Each informal tester was sent a link to the pre-test questionnaire and asked to complete it as though it were being run by their own institution. They were asked to provide detailed feedback about any issues they identified while completing the online form (either in the feedback box, or via email).

The common noticeable feedback from the pilot study provided the following:

i. The wording in Q19, Q38A4, Q39 is confusing.

ii. I don't know some of the answers.

iii. I can only give my opinion and it might be different from reality.

iv. The introductory text stating that you cannot return to previous pages, combined with 40 questions on the first page, gave the impression that the questionnaire would be very long.

v. Our organisation is operating below the lowest level for some questions (Q3b, Q6, Q9, Q10, Q23).

vi. The order of the responses increasing in maturity aided understanding of the questions.

The following changes were made in response to this feedback (with numbers below corresponding to the above points raised):

i. Changed the wording to questions Q19 ("What happens if you do not trust?" to "What happens if an organisation (staff) does not trust the collaboration process?"), Q38A4 ("... go directly." to "... find a way round them."), and Q39 ("How does the structure of the communication work?" To "How does the university structure the communication with external parties?").

ii. Added a "Don't know" option to Q5, Q7, Q8, Q9, Q10, Q11, Q14, Q15.

iii. Emphasised that questions Q16 to Q39 are looking for the respondent's opinion by: Adding the following to the Welcome page (page 1) "Please answer the questions based on your opinion or how you feel. You should answer them quickly as I am looking for your 'gut feeling' reaction."; Adding the following to the introduction (before the About You section on the third page) "I am looking for your opinions and feelings. Please give your initial 'gut feeling' answer." ; Changing the wording in the questions Q23 ("Where does ..." to "Where do you think..."), Q24 ("What is the main barrier ..." to "In your opinion, what is the main barrier ..."), Q26 ("How does the research collaboration..." to "How do you feel the research collaboration ..."), and Q27 ("How does the university or organisation try to improve..." to "How do you feel the university or organisation can improve ...").

iv. Added the following to the Welcome page (page one) "The survey is anonymous, contains 40 multiple-choice questions and takes around 15 minutes to complete. There is also a question asking for your feedback on the questionnaire itself."

In addition, to improve rapport with respondents, the Welcome, Data Protection and Final aspects were personalised by writing in the first person, adding the name of the researcher, and adding the researcher's email address.

6.3.4. Industry based Pilot study

Using the test questionnaire in situ, the questionnaire was tested in a technology firm. The technology firm is a large nationally recognised multi-functional technology-delivery firm. The technology firm includes integration of innovative technologies with healthcare, general practitioner services (online, face-to-face, and remote care support), study skills support for healthcare, disability, and dyslexia welfare support. The technology firm is not based in a single building and has offices in Leeds and London. The team that is involved with collaboration has 57 FTE staff. The study skills support has recently been incorporated into the service.

The questionnaire was delivered through Qualtrics Online Survey using the output of the informal testing. This final questionnaire is presented in Appendix M Respondents were pre-selected and contacted via email (presented in Appendix K). The questionnaire ran for one working week.

To ensure the quality of the question, 23% of the contacted respondent completed the questionnaire. Some of the provided feedbacks that was a noticeable common thread in the answers was as follows:

i. I don't know the answers to some questions, but 'Don't know' was not an option.

ii. Q20A4 and Q22A1 contain emotive language.

iii. Q19A1 is confusing.

iv. I wanted to select more than one answer for some questions, or part of one answer and part of another.

v. I wanted a free text option for some of the questions, as none of the given answers was appropriate.

Some feedback could not be interpreted as respondents did not provide information about the specific questions being considered.

The following changes were made in response to this feedback (with numbers below corresponding to the above points raised)

i. Clarified the nature of the information sought by the questions by adding the following wording to the introduction (before the About You section on page three): "Questions that ask for information have a DON'T KNOW option; questions that ask about your opinions do not.".

ii. Removed the phrases "no-one will die" from Q20A4 and "If it isn't broke don't fix it" from Q22A1.

iii. Q19A1 "We try to make up for it. If they find out ..." to "We try to make up for it to ensure there is trust ...".

Points (iv) and (v) refer to the intrinsic nature of the instrument, i.e., a forced- choice set of answers to closed questions Appendix N.

6.3.5. Revised Questionnaire - pilot study

University of Westminster and University of Reading researchers were recruited for data collection. There are about 40 staff members in four teams and groups: Academic Services, Collection Services, Content services, and Customer Services. Academic services incorporate study skills support (academic writing, statistics). support and national technology delivery firm,

The questionnaire was again delivered through Qualtrics Online Survey using the adapted question, i.e., after pilots' changes had been applied. This questionnaire is presented in Appendix O. Respondents were contacted via email (presented in Appendix P.

To ensure the quality of the question, 25% of the contacted respondent completed the questionnaire. One of the provided types of feedback that was a noticeable common thread in the answers was as follows: I would have liked to be able to select more than one answer, as no single answer was an exact match, my ideal answer would have combined parts from two or more answers (Q18, Q27, Q34, Q37).

In the initial design of the response set, the wording of each answer was kept as short as possible (i.e., so it fitted on a single line in the online presentation) in order to try to keep the questionnaire as simple as possible. This meant that some repetition of earlier answers within later answers was removed. For example, instead of:

- A1. I use it.
- A2. I use it and share it with my team.
- A3. I use it and share it with my team and other teams.

The responses were presented as:

- A1. I use it.
- A2. I share it with my team.
- A3. I share it with my and other teams.

However, feedbacks from the revised questionnaire pilot study have shown indications that this change was unhelpful as it makes the possible answers not mutually exclusive. Therefore, all the response sets were reviewed to ensure that the selection of answers offered are mutually exclusive (except Q24, where this is not possible, and respondents are asked to indicate the main reason). The following question answers were changed: Q3A2, Q6, Q3, Q8, Q9A3-A5, Q11A3, Q14A4, Q18A4, Q27A2, Q34A3, Q36A5, Q37A1-A2. Q28 had an additional answer added to the response set: A4 "Dynamic collaboration is the responsibility of the Principal Investigator" which maps onto Level Three of element 5.3 of the CMM. In addition to these changes, the following wording was added to the introduction (before the About You section): "You may only select one answer for each question. If no answer exactly matches your opinion, please select the closest one."

Analysis of the results from this second pre-test revealed that in Q16 A3 professional staff who, to an outsider would be considered at the middle management level, do not consider themselves as such (because they do not actually manage people). Therefore, Q16A3 was amended to "Managers / Researchers / professional staff." And the CMM element 3.1 Level Three changed to "There is limited middle management level / professional staff decision making."

It can be argued that to ensure the perfection of a questionnaire, these changes should be taken through another test in the form of a third formal pre-test. A testing could be stretched or takes on forever. Unfortunately, ongoing research collaborative initiatives were suspended because of the Covid-19 pandemic therefore, researchers were mostly unreachable. Other potential pre-testers would take longer time to contact and were unsuitable because they were in the USA; and it was not known if the terminologies in the UK would apply. Other researchers that have provided data for the development of the Research Culture Collaboration artefact in Iteration Two while measuring different attributes to the RCCAI, is sufficiently like provide conflict. Therefore, pragmatically, the testing of the questionnaire ended after the revise questionnaire pilot test.

6.3.6. The Artefacts

The artefacts developed in Iteration Three consists of the Research Collaboration Culture Assessment Instrument (RCCAI) instructions for use, the rubric for mapping the RCCAI results onto the CMM, and instructions for reporting the RCCAI results.

The RCCAI is presented in Appendix Q It is an online questionnaire of 43 questions, three of which are sub-questions depending on the answer to the previous question. The first two questions are attribute questions; the other 41 are attitude questions. All but one of the questions requires the respondent to select an answer from a multiple-choice list. All questions are mandatory.

The questionnaire must be tailored for the university, research group, research centre, and technology firm undertaking it, to ensure the results are meaningful and the respondents are able to answer the questions. Questions that are relevant to respondents are more likely to trigger an attitude response and so are completed more easily.

The instrument must be administered using an online survey tool, such as Qualtrics, Survey Monkey, or an in-house application. Care must be taken to ensure that the data provided by respondents is held anonymously and securely, in accordance with data protection rules. Similarly, care must be taken to ensure that the number of people that have access to the raw data are minimal, as it would be possible in most research centres and technology firms with few numbers of staff (unless very large) to determine who had provided a particular response by combining the responses to the attribute questions. Data should be aggregated and analysed by the survey administrator before being reported.

The responses that are expected in the question on the instrument should be grouped. The mode average response (i.e., most frequent) is taken. The rubric for mapping answers on to the level of an element of the CMM is presented in Appendix S

Three of the elements of collaboration culture (8.1, 8.7, 8.8) do not have questions on the instrument. Instead, these are assessed by cross tabulating the answers to specific other questions by research team membership and/or individual level in the organisational hierarchy. If the responses are spread over several answers, the results should be cross tabulated across research team membership and/or level in the hierarchy, i.e., to see if this produces different responses between groups and the same responses within groups. If so, these differences should be reported. If no groupings can be determined, then the main modal responses should be reported. An example of this is presented in Table 6.2.

Table 6.2: Example of Result: Cross Tabulation and Presentation Where There Are Two Modal Answers

Aggregated responses:

Q32. Do you feel valued by the group?

Not really	4%
Not really but we receive training that we want/need	7%
Sort of. They say they are committed to the achievement of staff satisfaction / development / well-being	45%
Sort of. People are supported in developing their research capabilities	3%
Yes, l know the university / organisation sees the staff as its most valuable asset	41%

Cross tabulated by grade:

	4	5	6	7	8	9
Not really	2%	0%	0%	2%	0%	0%
Not really but we receive training that we want/need	2%	3%	2%	0%	0%	0%
Sort of. They say they are committed to the achievement of staff satisfaction / development / well-being	16%	14%	5%	10%	0%	0%
Sort of. People are supported in developing their research capabilities	0%	0%	0%	3%	0%	0%
Yes, l know the university / organisation sees the staff as its most valuable asset	0%	0%	0%	0%	27%	14%

Report:

Grades 3-7 = Level 3
Grades 8-9 = Level 5

The results should be presented as locating the maturity of culture that is enabling dynamic research collaboration between universities and technology firms on the CMM. This also enables the research centres, research groups, and staff of organisations to see both where they are on the road to a culture of collaboration and the next stage forward. An example is presented in Figure 6.3. (The rest are in Appendix U).

Table 6.3: Example of Presentation of Results (3.0 Learning organisation)

	Level 1 Ad hoc	Level 2 Aware	Level 3 Defined	Level 4 Managed	Level 4 Continuous
3.0 Learning organisation					
...					
3.4 Attitude to mistakes	Mistakes are hidden due to a blame culture.	Mistakes are fixed – they are viewed as result of the person not following procedure.	Mistakes are fixed – they are viewed as faulty processes (especially not enough training).	Mistakes are viewed as opportunities for learning	Mistakes are viewed as opportunities for learning and are accepted as inevitable if trying new things.
3.5 Attitude to risk	The research group/organisation is risk averse – it refuses to take risks.	The library is risk averse – it may occasionally take what it views as risks, but only if they are virtually guaranteed to work.	The library is risk averse – it employs checks and balances to minimise risks.	The library is risk tolerant – willing to accept risk taking behaviour ("It is OK to take risks, no-one will die!").	The library is risk seeking – encourage risk taking behaviour ("It is better to do something and fail than to wait to be certain it will work and do nothing").

Instructions for the research centres, research clusters, and technology firms wishing to use the Research Collaboration Culture Assessment Instrument are presented in Appendix U.

6.4. Demonstration and Evaluation

This section presents the potential of the artefacts produced from Research Collaboration Culture (Iterations Two) and the development of an assessment instrument presented in the Iteration Three. They are presented as a solution to the problem of lack of dynamic research collaboration academic engagement with technology firms by researchers and practitioners with the concept of collaboration culture. Following this demonstration, the solution is evaluated, both in terms of utility of the artefact and the learning that has occurred about the problem space.

6.4.1. The Demonstration

Two UK academic research groups and University of Westminster Research and Engagement Support undertook an assessment of their culture of research collaboration using the RCCAI (output from Iteration Three) and the Research Collaboration Culture (output from Iteration Two). The characteristics of these organisations and academic researchers are described in Sections 6.3. Each questionnaire was run online using the Qualtrics Online Survey platform and ran for one week which is standard for such a survey (Hamilton, 2009).

The responses were analysed by the researcher following the rubric and instructions detailed in Section 6.3.6. The results were sent online to a PI (Principal Investigator) and a Research Fellow for the university as well as a manager for digital healthcare innovation testing in a technology firm to locate the research centre or technology firm on the CMM (as in Table 6.3). As the assessment instrument for the research collaboration culture, it was not instigated by the individuals in the research centre and the organisation so were not familiar with the context behind the CMM, so the researcher talked through Skype calls the results with each of them.

Following the presentation of the results, three individuals, two university researcher and a management staff of a digital technology firm, were interviewed. The three interviewees were readily accessible despite the communication difficulties brough about by the Covid-19 pandemic. Using the semi-structured interview schedule presented in Appendix R. These interviews formed the basis of the evaluation of the artefacts and the solution.

Finally, one of the PIs, involved with the output of Research Collaboration Culture (Iteration Two) was demonstrated (see section 5.3) was keen to see all the artefacts produced from this research as soon as they were finished, and in return provided their feedback on their utility.

6.4.2. The Utility of Artefacts

This assessment instrument has no need for specialist analysis tools with no knowledge required. It will be easy and inexpensive to administer while, it was quick for participants to complete (around 15 minutes). No negative feedback was received on administering the RCCAI from participants (excluding the requested constructive criticism of individual questions), though both response rates were low. This issue was addressed by one of the PIs: "There're bound to be difficulties I guess with this as with anything one tries to do, such as engaging all staff to do it. You don't want to force people to do it because that will skew the results. However, providing a climate within an environment that with the time, with the desire to want to do it because they can see that it is going to be used, it is not just another tick box exercise."

All the individuals presented with the results felt that it was clear and liked that it located the level of research collaboration on the CMM. They appreciated the details of the 'next level up'. Observation from the Research Fellow was that the results for some facets were confusing as there are not a single or two adjacent results, however, postulated that this may change if the response rate was higher because it would be clearer whether there was an overall majority opinion or a genuine split.

The Research Fellow and the Manager in the agency pointed out that an easily available inexpensive assessment instrument that can be tailored will give them the incentive to assess the culture of their research collaboration with the Manager expressing that: "Putting this together is a good step. […] really adaptable". "It is useful to have an instrument in whole or in part that can be easily understood."

There were positive observations from the research professionals on the RCCAI and CMM as tools to assess the culture of their organisations or centre research collaboration on partnering for technology innovations: "I consider it was useful, and I can see it being useful going forward. ... it will help us to do the things we are looking to do ... I can see that there are different things that are coming together [in the CMM] that will assist the UK to be much better in doing stuff about having competitive advantage with technology innovations ... there are some areas where we have already started to put things in place to move it on, and what I would quite like to do is to do it again, to demonstrate that we have done something that moves it on."

Similarly, two research practitioners that have spent many years working on several collaborations with several sectors of the economy, in their candid observations pointed out that the results challenged their assumptions and perceptions of how culture will instigate the removal of barriers to dynamic research collaboration. For example, one of the researchers pointed out that: "Amongst other good potentials, it has highlighted the difference between my perception of how researchers in universities in the UK and managers of technology firms think on the intricacies of interactions in collaboration and how staff really feel. To me that's one of the most interesting things because I like to think I am a reasonable judge of how people think, and in some respects, I was reasonably right and, in some aspect, it was quite different. I think that has been the best part. It's useful. ... There are some areas where the staff perception of the informal communications was better than I would have expected it to be." "There are times where I have gone 'really?!?' because that is a bit more troubling for me, why that is still the way they feel and is there anything we can do about it".

Related to this was the insight it gave into the internal variations in culture across the organisations and the research centres. A stakeholder in a university KTC pointed out: "[it is valuable] when you start to get different results from different teams. That indicates that perhaps there is something which is not necessarily in the culture generally but is specific to the teams."

A particular area of interest was inconsistencies in answers. Another participant who has been a Principal Investigator in several millions British Pounds research collaborations pointed out that: "how they have answered the question in one place as opposed to how they have answered the question in another place gets me thinking about ... does the one influence the other, is there a matched pair, or is there something contradictory going on that needed to be looked into more closely." "What was interesting was often the inconsistency with some of the responses. This may have several explanations. It could be that the questions were not properly interpreted as they should be. Not sure about that. It could simply be that sometimes we would have to accommodate contradictory views."

All the individuals, the PI and the Research Fellow (both from UK universities) as well as the Manager from the technology firms, responded that they had positive experiences from the exercise as well as the areas of focus: "I guess there is a lot of pressure to maintain some of these good results." "It gives me reassurance in some areas of informal interactions towards research collaboration that what we are doing seems to be working so we keep doing it to scale up our collaboration levels."

Finally, seen from captured evidence, simply by administering the RCCAI, the research collaboration culture was improved, through the Hawthorn effect whereby individuals react by modifying aspects of their behaviour in response to their awareness: Test respondent A7 “This questionnaire makes me realise that some certain things needed to be in place in how we do things that has to do with collaborating with technology firms between universities and external partners.” Test respondent A12 “makes you think about what you're doing”. Test respondent B5 “the questions themselves start a thought process”.

This evidence has demonstrated the utility of the RCCAI and CMM as tools to address the problem of the lack of practitioner engagement with the concept of the culture of research collaboration that increases the quality of the partnerships within the environment.

6.4.3. Learning About the Artefacts

Through the process of demonstration of the utility of the artefacts, the PI, Research Fellow, and the Manager in the technology firm provided feedback on the Collaboration Maturity Model as a roadmap for documenting and improving the culture for dynamic research collaboration between UK universities and technology firms. As a result, some of the terminology in the rubric was changed. The final Collaboration Maturity Model is presented in Appendix U.

6.4.4. Learning About the Problem

The development of the artefacts in Iteration Three have illuminated two things about the problem space. Firstly, assessment of research collaboration culture does not need the input of an ‘expert’ - it can be assessed using the opinions of individual researchers of research centres, groups, and staff in the technology organisation. Secondly, the lack of availability of funds is a barrier to research collaboration by research practitioners wishing to implement research collaboration culture assessment tools.

This solution however does not indicate the stages on the developmental road towards a matured continuous improvement research collaboration culture that is focussed on the innovations that transforms a business resources and competitive advantage. It does not indicate whether the concept of dynamic research collaboration deviates into 40 facets, nor if the most efficient way to describe research collaboration culture is through the eight facets described in the CMM. It does not infer that the definitions of research collaboration developed through this research cannot be generalised beyond UK Higher Education to other countries, other economic sectors, or other service sectors.

In summary, the Collaboration Maturity Model and associated Research Collaboration Culture Assessment Instrument are useful tools, however, may not automatically be definitive roadmap to help practitioners engage with the concept of dynamic research collaboration culture if the barriers are still encouraged.

6.5. Communication

Communication is the final stage in the Design Science Research Methodology, which occurs when the researcher decides, based on the evaluation of the final iteration, that any further iterations will not improve the effectiveness of the solution. The purpose of its inclusion is to 'close the loop' – to ensure that the learning that has occurred about the problem space is shared throughout the discipline.

The communication of this research takes three forms. Firstly, this thesis forms one channel of communication of the problem, its importance, the artefacts, their utility and novelty, the rigor of the design, and their effectiveness. The thesis will be freely available to all on the internet via the University research repository. It will be indexed on the British Library open access EThOS database7 and searchable via Google etc.

Secondly, the research will be further presented as further research papers in academic journals such as presenting evidence from knowledge transfer collaboration in academic engagement as knowledge co-production partners; rigorous orientation toward theory development, testing, and application on culture as a concept in dynamic collaboration; and presenting university and business environment actors on the implication of culture in their academic engagement in knowledge transfer.

Finally, the artefacts and the background to their use will be publicly and freely available on the internet via the SCONUL Performance Portal. This will be advertised to the discipline communities internationally via relevant mailing lists and publications.

6.6. Summary

This chapter presented Iteration Three of the research on the development of an instrument to assess research collaboration culture to enable the UK universities, knowledge transfer centres, technology hubs or clusters, research groups, individual researchers, and policy makers for the government to collect data, analyse it and use it to locate themselves on the CMM 'roadmap' without the need for external expensive support.

The standard method for constructing surveys was detailed, and its application to this research was described. The questionnaire consisted of predominately both open and closed questions to address the attitudes and knowledge of respondents to improving collaborating in their environment and was conducted as an online web survey because this is easy to administer with quick undertakable assessment feedbacks. It is also easy way to administer a survey.

The survey was formally tested on academic researchers in one UK and a technology agency that is involved in nationwide healthcare initiatives. Efforts were made to improve the instrument in response to feedbacks from the respondents. In addition to the Research Collaboration Culture Assessment Instrument (presented in Appendix U) the other artefacts that comprise the survey are instructions for using the RCCAI, including instructions for reporting the RCCAI results (Appendix S); and the rubric for mapping the RCCAI results onto the CMM (Appendix U), there is the Guidance for Deployment in Appendix T.

The use of these artefacts to address the research problem was demonstrated and tested on academic researchers in one UK and a technology agency involved in nationwide healthcare initiatives. This demonstration produced feedback on the CMM and an evaluation of the CMM and RCCAI for continuous improvement. The final CMM was presented in Appendix U.

The development of the RCCAI gave clarifications in two main areas on the problem space: research collaboration culture can be self-assessed using the views of members of research groups and officials in technology firms that wished to engage in research collaboration culture assessment were not aware of such an instrument and will find the cost of existing tools as prohibitive.

Finally, the routes to communicating the research and its results were detailed.

CHAPTER SEVEN

RESEARCH CONCLUSIONS

7.1. Introduction

This chapter provides a panorama of the artefacts presented in this thesis in the form of summation and conclusions. This chapter also includes reflections on meeting the initial objectives stated that it would achieve in this research; the limitations of the research and how they may be addressed; and the effectiveness of the research methodology used. The Chapter concludes with some reflections on the author's personal research journey.

Section 7.2 provides a summary overview of the research. Section 7.3 presents the conclusions of the research, both for the solution space and for the problem space. Section 7.4 reflects on the research overall, and whether it has achieved the objectives. Section 7.5 explores the limitations of the research and sets some themes for further research. Finally, Section 7.6 concludes the chapter with some personal reflections on the doctoral research process.

7.2. Research Summary

This thesis mirrored the research paradigm, design science research, that was used to structure the presentation of this thesis.

Chapter Two presented the problem identification and motivation through a review of the relevant literature as it stood at the start of the research. Three bodies of literature were presented: outline of research collaboration by universities; the need for research collaboration maturity; barriers to research collaboration for development of technology innovations with potentials to transform the UK economy. This chapter demonstrated that views of UK universities, research and development centres, research campuses, business clusters and incubator clusters of collaborations have been sclerotic for decades that thrived on comparing performance with that of others but find it difficult to use research collaboration assessment measures. This is a problem because barriers to a dynamic research collaboration with technology firms which accelerates innovation and growth of the UK economy would continue to thrive. However, the research collaboration assessment techniques have the potential to change the need for the culture of physical clusters which the hub model has become a victim of its own success due to steep rise in prices, to a culture of researchers in an organisation and research centres to one of collaboration-focussed learning organisation. The chapter concluded that a model that convert measures of research collaboration into a format like existing performance measurement techniques is needed, which may enable the sector to come to terms with measures of research collaboration that draw international investments, rather than just the enthusiastic few or restricted to North America and Tech Mahindra.

Chapter Three detailed the design science research methodology and its application in the research being undertaken. The aim of this chapter was to provide a mental model to enable the reader to assess the rigor of the research. The chapter presented the design science research paradigm as a novel framework for conducting research collaboration with technology firms and Information Science research to close the research-practice gap. It stated with the principles of the paradigm and summarised the debate in the literature concerning the purpose of design science research. The author stated the research perception regarding these issues. The Design Science Research Methodology developed by Peffers *et al.* (2008) was presented as the preferred framework to plan, undertake, evaluate, and refine the research.

The chapter defined the objectives of a solution to the problem detailed in chapter two by identifying three constraining criteria. The solution must:

1. Tease out the individual first-order factors of dynamic research collaboration;
2. Act as a roadmap; and
3. Be useful to practitioners and be consistent with existing theory.

A review of maturity models as a reference model and a preliminary study demonstrated that a Collaboration Maturity Model has the potential to fulfil all three of these criteria, therefore, provide a solution to the problem of knowledge transfer practitioner can transform the academic engagement with the issues to change the culture to research collaboration for technological innovations.

Chapter Four presented the first design iteration, where the individual elements of research collaboration culture that is steeped in increasing the partnerships between academics were explicated from both existing literature and current practice in the UK academic research collaboration engagement in to impose a framework on the amorphous concept of dynamic research collaboration culture. The first iteration, developed in this chapter, was incrementally developed using the systematic literature review approach to analyse literature, then used the grounded theory method to do an interpretative synthesis analyse interviews with staff from three case studies. Finally, the grounded theory method was used to integrate the outputs from the increments to the artefacts of Ambit Design of solutions, Facilitation of Collaboration Dynamism, and Dynamic Collaboration with the application of the reference Collaboration Maturity model. The output of Static Research Collaboration (Iteration One) with an outline of the Collaboration Maturity Model, was presented and evaluation of the demonstration of this artefact confirms the utility and effectiveness of the outline CMM and provides additional objectives for a solution going into Iteration Two.

Chapter Five presented the second iteration designed with the grounded theory method of Charmaz (2006) to populate the output of Iteration One with responses from twenty researchers in UK universities and practitioners in technology firms with their responses to decipher the interactions in the collaboration management process in order to produce a 'roadmap' to enable practitioners to plan improvement in the research collaboration culture for their organisations, research centres, and groups. The development of the Grounded Theory methodology into axial coding was explained, and its use to synthesise the interview data, documentary evidence and literature from which the dimensions of the properties of dynamic research collaboration culture was determine and described. Evaluation of the demonstration of the resulting artefact confirmed the utility and effectiveness of the CMM and provided additional objectives for a solution, leading to amended definitions for a solution going into Iteration Three and more iterations with same end results.

Chapter Six presented the third designed iteration, an assessment instrument to enable academic researchers, research groups, research centres, and technology firms to self-assess their location on the CMM. The survey design method with both open and closed was detailed, and its application to this research described. The three iterations of testing the instrument (pretesting, informal testing, and formal testing) were documented and the CMM and RCCAI were applied to two UK universities and technology firm. The evaluation of these demonstrations indicated that the solution developed through this research is successful in achieving the research aims. Finally, the artefacts were communicated to the practitioner and research communities.

7.3. Research Conclusions

The outputs of this research are the learning that occurred as part of the Design Science research process – learning about the solution space and learning about the problem space. The learning about the solution space is demonstrated in the two artefacts: The Collaboration Maturity Model (CMM); and the Research Collaboration Culture Assessment Instrument (RCCAI) - and associated instructions for use.

This research provided initial indications that the CMM has fit, relevance, and workability while, it is meaningful, useful, and attractive to academic research practitioners and its use helps them re-conceive, and so engage with, the issues of 'research collaboration'. The 40 practice areas detailed in the outline Collaboration Maturity Model are in the face of the data collected, sufficient and necessary to describe research collaboration culture at an appropriate level of granularity to be useful to practitioners. This data set consisted of 15 UK HE Research Knowledge Transfer Centres, researchers, and technical firms (ten from iterations 1 and 2; two from iteration 3) that were (it turned out) heterogeneous in research collaboration culture. This is support for the applicability of the CMM, however, neither design science nor grounded theory are intended to produce a result with generalisability. The evaluation of the modifiability of the theory comes from how well it can be altered when relevant new data is compared to existing data. This is an area for further research. The preliminary findings of this research suggest that the RCCAI is easy use, understand, and to manage with no expert evaluation tools or knowledge required while, it is easy for all various grades of participants to complete (about 20 minutes) following the Guidance for Deploying it. The presentation of the results in locating an organisation, a research centre, a research group on the CMM was clear to the three researchers interviewed.

This learning and these outputs, though useful, are not the means to an end. They are part of the solution space and as such they have been developed to illuminate the problem space, which in this research is the lack of engagement by researchers and practitioners in UK universities with technology firms with issues of technology innovations.

The learning about the problem space that has occurred throughout the research process enable several sketches to be drawn and proffer solutions to the problem space. Firstly, research collaboration appears to be a complex, multi-faceted concept consisting of intertwined and inter-related strands that goes beyond the focus of research collaboration restricted only to research collaboration between academic researchers or between practitioners in research groups. However, it is not necessarily an amorphous concept, but one that can be explicated. This is not to state that the elements of research collaboration are as described in the CMM, merely that it is possible to be specific in response to the question 'what is dynamic research collaboration?'. Not only that, but it appears helpful to practitioners to do so – research collaboration is one area where the most elegant solution is not optimal in terms of utility.

Secondly, research collaboration culture can be 'measured' – not in an absolute way (the researcher does not propose there are units of 'dynamic research collaboration culture' but designed an assessment tool with guidance for use to aid the support and stimulate practitioner academic engagement. The development of a culture of dynamic research collaboration can be split into an arbitrary number of useful discrete stages so that it looks and feels like the performance measures that researchers and practitioners are familiar with. The research does not indicate that the number of levels in the CMM is correct, merely that it is both possible and useful to have staging posts on the road to a culture of dynamic research culture.

Thirdly, if practitioners in technology firms, research knowledge transfer centres, and research groups are presented with an appropriate inexpensive and easy-to-use off-the-shelf set of tools to assess the dynamic research collaboration culture on engagement of knowledge transfer on technological innovations then they are keen to do so. The failure to engage with concepts of dynamic academic engagement on research collaboration on technology innovations that is only currently done by an enthusiastic few, seems not due to something fundamental in the nature of the concept nor in research practitioners in general, but due to the lack of utility of the previous representation of a dynamic research collaboration and its assessment tools.

This research has not concluded that the Collaboration Maturity Model is the panacea to the problem rather, merely a solution. Similarly, the research has not surmised that the

RCCAI is the only tool that can be used to evaluate dynamic research collaboration culture of a the UK university, technology firms, research knowledge centres, research groups, and start-up companies that are engaged in businesses that are involved in innovation, development, deployment, or commercialisation of new products, processes or services driven by technology or intellectual property rather, merely a potential tool that may be the beginning of others.

The CMM and RCCAI are solutions designed for a problem where previously there were no tools with clarifications existed. They are a starting point on the exploration of the development of a dynamic research collaboration culture in academic engagements. The design science research process takes a 'wicked problem' and by developing a solution, improves the scoping of the problem through the options of theory development or testing in the quantitative or qualitative paradigms. The outcomes developed with Design Science are appropriate to change the representation of concepts and make evident what was previously ambiguous, while assisting to stimulate new ways of thinking. Follow-up studies can be done on the performance of such representations. It corresponds to the difficulties felt when faced with a blank sheet of paper in the creation of contents for a document; it will be easier to be presented with a draft and correct it with a red pen. The development of the artefacts in this research, has made the previously unknown and unexplored environment called 'research collaboration culture' to have documented specified features and described paths. If some of the features in the artefacts turn out to be like a starting point 'Here be Treasure' on the map for future explorers on the concept of dynamic research collaboration for the rapid development of technological and digital innovations in the UK.

7.4. Reflections on the Research

The aim of this research was to produce an easily applicable, easy to understand, operate, inexpensive and reliable assessment tool for dynamic research collaboration culture that facilitate increased academic engagement with digital technological firms. The new tool representation would: enable researchers and entrepreneurs of any UK to assess their location on a roadmap to a culture of research collaboration; guide them as to the next step forwards; enable them to measure their progress over time; and enable them to compare themselves to others thereby, learn from each other as well as from others. This research has from the above therefore, achieved these aims through the fulfilment of the objectives.

The objectives of this research are to:

1. Develop and describe a model of the evolution of a culture of dynamic research collaboration.

2. Produce an instrument that can easily be used by practitioners, researchers, and Culture entrepreneurs in the academic engagements that will assist in self-assessing their research collaboration maturity level.

3. Evaluate the research and demonstrate that the artefacts produced have helped practitioners, researchers, and entrepreneurs in research collaboration academic engagement with the idea of developing a research collaboration culture.

The first of these objectives has been achieved through the production of the Research Collaboration artefact, that characterises a research collaboration culture as comprising eight facets made up of 41 practice areas and evolving through five levels of maturity of the CMM. The CMM comprise of five maturity levels and a rubric for each of the practice areas at each of the maturity level.

The second objective has been achieved through developing the Research Collaboration Culture Assessment Instrument (RCCAI) as well as associated instructions and guidance. The RCCAI is a self-assessment tool that is inexpensive and available to universities research knowledge transfer centres, practitioners, researchers, and entrepreneurs in technology firms interested in academic engagement and can be implemented using any online survey tool. It uses an aggregation of responses from staff to determine their location on the CMM without the need for 'expert' intervention.

The third objective has been partially achieved. Interviews with a university PI, Research Fellow, and the Manager in the technology firm was done with the demonstration of both the CMM and RCCAI. This exercise provided evidence that these artefacts helped them to engage with the idea of dynamic research collaboration culture. The viewing of research collaboration culture through CMM perspective changed how they conceived a dynamic research collaboration with the introduction of the idea that elements such as individual researchers' mindset on improving research collaboration have an impact on the culture of the organisational structure towards an enthusiastic research collaboration for the development of technological innovations. The existence of the RCCAI as an inexpensive and free off-the-shelf yet scalable tool meant that they were now planning to undertake an assessment of their research collaboration culture that had been dismissed because of unjustifiably not scalable and expensive. Undertaking the assessment challenged the assumption and perceptions of the university PI, Research Fellow, and the Manager in the technology firm about how individual researchers and staff feel on research collaboration between the UK universities and technology firms. It also brought insight into the internal variations in culture such as how dynamic organisations are across the environment. Undertaking the assessment also had an impact on the respondents' engagement with the idea of increased dynamic research collaboration culture "the questions themselves start a thought process".

There is also unsolicited evidence from others involved in academic engagements that wished to use the CMM and RCCAI to assess their research collaboration culture beyond the sclerotic collaborations between individual academic faculty researchers.

However, such an evaluation is neither comprehensive nor robust in demonstrating that the CMM and RCCAI help the Manager in the technology firm engage with research collaboration culture concepts. To demonstrate this is it would be necessary to determine an entrepreneur and top management's level of engagement with research collaboration culture before they interact with the CMM, and then again after they had undertaken an assessment of their engagement with the UK universities. However, this requires a method of assessing the level of engagement with research collaboration issues; such a method does not exist. It is a similar 'wheel within a wheel' that instigated the current research in the first place – trying to determine whether benchmarking has improved the research collaboration culture of an improved academic engagement between UK universities and technology firms required a method of assessing the research collaboration culture, and there was no such method. There is now.

To demonstrate the same effect on the whole of collaborations with UK universities by all sector communities there should have been a 'before and after' assessment of the level of engagement with issues of research collaboration culture. However, this is not possible as it would necessitate going back in time to the very start of this PhD research to make the 'before' assessment.

7.5. Limitations and Further Research

As would be expected at the beginning of exploration in a research area, there are various areas for further research on this topic.

As described in the informal testing of the RCCAI (see section 6.3.3), some organisations may be operating below the base level (Level 1) on the CMM. This is consistent with anecdotal evidence from several researchers in the field of performance measurement and assessment in collaborations and partnerships that there are gaps in the awareness of the state of an organisation until there is an instrument used to present its true situation.

Further research is needed into the application of the CMM and RCCAI to large multi-functional organisations and newly start-ups incorporating more than the traditional firms that are within a particular environment such as business hubs with proximity to a UK university. Although the 'case study' included a converged technology firm that is research collaboration with UK universities for its transformation healthcare products and services, incorporating, the artefacts were only tested on a digital technology service that has awareness. In addition, between the initial data collection at case study and the testing of the artefacts, over two years have elapsed. During this time the landscape of the decisions by universities and technology firms might have changed, with a significant number not broadening their partnerships as a fallout from the economic downturn because of the pandemic that have recently ravaged businesses and HE in the UK. It is not known if the CMM and RCCAI will broadly apply to such new start-ups, however, at the very least the language and concepts used can be scaled to suit any purpose.

As the RCCAI has only been demonstrated in few UK universities and technology firms, there are no data on the psychometric properties, such as reliability, construct validity and content validity. Further research is necessary to demonstrate that the instrument is robust and valid. The author does not recommend that factor analysis be undertaken, as the whole purpose of the instrument is to locate a dynamic research collaboration on the CMM where the factors of research collaboration are expanded rather than reduced.

Research is also needed into which research collaboration improvement tools assists a technology firm or a research group to make the leap from one level to the next in a particular practice area. The study for this research suggested that some tools were suited to measure the performance of an organisation at a particular maturity stage, but not those below. Such a menu of improvement tools is very high up the wish list from practitioners who have been exposed to the CMM. Related to this, although this research has demonstrated that the CMM, in conjunction with the RCCAI, functions as a roadmap to enable practitioners to assess where they are, it has not been demonstrated that it helps practitioners to identify where they should be heading.

Finally, the ultimate output of this research would be an increase in the number of LIS directors who are actively engaging with issues of the quality of their service and how they can improve it. Further research is necessary to demonstrate this has occurred and so prove the CMM and RCCAI have provided a solution to the research problem. As indicated in Section 7.3, such research is non-trivial as it requires the creation of an assessment tool to measure levels of engagement. As such is outside the scope of this PhD and it is left to future researchers.

7.6. Final Thoughts

Undertaking a PhD is a journey, a learning process about what it means to be a researcher in your chosen field. Much of my learning is documented in this thesis, both directly as learning about the research area, and indirectly, as evidenced by appropriate application of research tools and techniques.

I have also learnt a great many things during this PhD that are not documented in this thesis. In no order, I have learnt that researchers are ready to assist another researcher however, it was not easy to schedule most meetings while, transcribing interviews takes a long time; that working at the university you are studying at means that work always eats into research time; that working fulltime while undertaking a PhD is difficult; and that working fulltime whilst undertaking a PhD can impact on health.

I have learnt that the research community especially, the knowledge transfer centres and groups are extremely generous with their time, interest, and enthusiasm; that the increase in research collaboration for the development of technological innovations is not only of interest to the UK government but to a large number industry; and that sometimes it really is the case that no-one has done it before.

I have learnt that the epistemology and ontology of research methods are fascinating, and that to be conversant with qualitative, quantitative and design research paradigms is unusual.

Finally, the enthusiastic pursuit of various solutions to the lack of research collaboration by UK universities with fledging digital technology firms have broaden my knowledge on getting solutions for phenomena that have no quick-fix solutions due to complexities. The guidelines provided in this thesis is worth it.

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APPENDIXES

APPENDIX A
Examples of search strategy for Interpretive Synthesis – Iteration 1: Increment 1

Database	Web of Knowledge
Access via	University of Reading Library
Date searched	17 June 2018
Search string	(Collaboration OR "University collaboration") = Topic AND (Culture) = Topic
Date range	All years
Output	46,130 matches
Refined by	Research Domains = Business Social Sciences
Output	3,634 matches
Refined by	Research Areas = Business Economics; Behavioural Sciences; Computer Science; Higher Education Research; University Collaboration Projects; Information Science Library Science; Social Sciences Other Topics; Operations and Management Research; Engineering Collaboration Research
Output	2,783 matches
Refined by	Reviewing the title and journal of each reference and excluding those that were irrelevant (1)
Output	253
Results input into RefWorks, where de-duplicated with output of other searches.	

(1) Examples of exclusions:
- Bower, J. L. and Christensen, C. M. (1995). Disruptive Technologies: Catching the Wave. *Harvard Business School*, vol. 73(1), pp. 43-53.
- Giannakis, M. and Bullivant, N. (2016). The Massification of Higher Education in the UK: Aspects of Service Quality. *Journal of Further and Higher Education*, vol. 40(5), pp. 630-648.
- Hjørland, B. (2002). Domain Analysis in Information Science: Eleven Approaches- Traditional as well as Innovative. *Journal of Documentation*, vol. 58(4), pp. 422-462.
- Istance, D. and Kools, M. (2013). OECD Work on Technology and Education: Innovative learning environments as an integrating framework. *European Journal of Education*, vol. 48(1), pp. 43-57.

Database	Web of Knowledge
Access via	University of Reading Library
Date searched	25 July 2018
Search string	("Learning organisation" OR "Business collaboration") = Topic AND (Culture) = Topic
Date range	All years
Output	101 matches
Refined by	Reviewing the title and journal of each reference and excluding those that were irrelevant (2)
Output	20 matches
Results input into RefWorks, where de-duplicated with output of other searches.	

(2) Examples of exclusions:

- Laredo, P. (2007). Revisiting the third mission of universities: Toward a Renewed Categorisation of University Activities? *Higher Education Policy*, vol. 20(4), pp. 441-456.
- Li, L. (2012). Effects of enterprise technology on supply chain collaboration: analysis of China-linked supply chain. Enterprise Information Systems, vol. 6(1), pp. 55-77.
- Palacios-Marqués, D., Merigó, J. M. and Soto-Acosta, P. (2015). Online social networks as an enabler of innovation in organizations. *Management Decision*, vol. 53(9), pp.1906-1920.

RefWorks

Number unique references identified	423
Refined by	Reading abstract or whole paper or skimming through books and excluding those that did not make a statement about what constitutes a 'collaboration culture'. (3,4)
Output	116

(3) Examples of exclusions:

- Reich, B. H. and Benbasat, I. (2000). Factors that influence the social dimension of alignment between business and information technology objectives. *MIS Quarterly*, vol. 24(1), pp. 81-113.
- Salmi, J. (2002). Facing the Challenges of the Twenty-First Century. *Perspectives: Policy and Practice in Higher Education*, vol. 6(1), pp. 8-12.
- Scott, W. R. (2008). Approaching Adulthood: The Maturing of Institutional Theory.

  Theory and Society, vol. 37(5), pp. 427-442.

(4) Examples of exclusions:

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Books

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- Christensen, C.M. (1997). *The Innovator's Dilemma*. New York: Harper Collins.
- Cook, M., Noyes, J. and Masakowski, Y. (2007). *Decision-making in complex environments*. Ashgate Publishing.
- Ragin, C. C. (1992). Casing and the process of social inquiry. In: Ragin C. C. and H. S. Becker (Ed.) *What is a case? Exploring the foundations of social inquiry*, pp. 217-226. Cambridge, UK: Cambridge University Press.
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- Sheninger, E. (2014). Digital leadership: Changing Paradigms for Changing Times. Thousand Oak, CA: Corwin.
- Tapscott, D. (2015). *The Digital Economy: Promise and Peril in the Age of the Networked Intelligence*. New York: McGraw-Hill.
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- Zusman, A. (2005). Challenges facing higher education in the twenty-first century. In: P. G. Altbach, R. O., Berdahl, and P. J. Gumport (Eds.), *American higher education in the twenty-first century* (2nd Ed.), pp. 115–160. MD: The Johns Hopkins University Press.

APPENDIX B
Examples of the list of literature included in Interpretive Synthesis (Iteration 1, Increment 1)

Books

- Arthur, W. B. (2009). *The Nature of Technology: What it is and how it evolves*. New York, NY: Simon and Schuster.
- Berglund, D. and Coburn, C. (1995). *Partnerships: A Compendium of State and Federal Cooperative Technology Programs.* Columbus, Ohio: Batelle.
- Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P. and Trow. M. (1994). *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*, London: Sage.
- Nelson, R. R. (1993). *National Innovation Systems: A Comparative Study*. New York: Oxford University Press.
- Zupic, I. (2014). The knowledge base of technology entrepreneurship. In Therin, F. (Ed.), *Handbook of Research on Techno-entrepreneurship* (2nd Ed., pp.1–16). Northampton, MA: Edward Elgar.

Journal Articles

- Awan, U., Kraslawski, A. and Huiskonen, J. (2018). Governing interfirm relationships for social sustainability: the relationship between governance mechanisms, sustainable collaboration, and cultural intelligence. *Sustainability*, 10(12), pp.4473.
- Bailetti, T. (2012). Technology Entrepreneurship: Overview, Definition, and Distinctive Aspects. *Technology Innovation Management Review*, 2(2), pp.5–12.
- Beckman, C., Eisenhardt, K., Kotha, S., Meyer, A. and Rajagopalan, N. (2012). Technology Entrepreneurship. *Strategic Entrepreneurship Journal*, 6, pp.89–93.
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- Fernández-Olmos, M. and Ramírez-Alesón, M. (2017). How internal and external factors influence the dynamics of SME technology collaboration networks over time. *Technovation*, 64, pp.16-27.
- Gibson, E., Daim, T. U. and Dabic, M. (2019). Evaluating University Industry Collaborative Research Centres. *Technological Forecasting and Social Change*, 146, pp.181-202.
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- Haddara, M. and Elragal, A. (2015). The Readiness of ERP Systems for the Factory of the Future. *Computer Science*, 64, pp.721–728.
- Hong, A. J. and Kim, H. J. (2018). College Students' Digital Readiness for Academic Engagement (DRAE) Scale: Scale Development and Validation. *Asia-Pacific Education Researcher*, 27(4), pp.303–312.
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- Nambisan, S. (2017). Digital Entrepreneurship: Toward a Digital Technology Perspective of Entrepreneurship. *Entrepreneurship Theory and Practice*, 41(6), pp.1029–1055.
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- Walker, D. H., Davis, P. R. and Stevenson, A. (2017). Coping with Uncertainty and Ambiguity through Team Collaboration in infrastructure Projects. *International Journal of Project Management*, 35(2), pp.180-190.

Practice Research Documents

- JISC TechWatch Report (2009). *EA Unleashed: Institutional Architectures and the value of joined up thinking*. Retrieved November 2018 from [Online]: http://www.jisc.ac.uk
- UNESCO (1998). World Declaration on Higher Education for the Twenty-First Century: Vision and Action. Retrieved November 2018 [Online]: http://www.unesco.org/education/educprog/wche/declaration_eng.htm
- World Bank (2007). *Building Knowledge Economies: Advance Strategies for Development*. Available on International Bank for Reconstruction and Development/ The World Bank Institute September 2018 http://siteresources.worldbank.org/KFDLP/Resources/461197-1199907090464/BuildingKEbook.pdf.

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- Baldridge National Quality Program (2007). Criteria for Performance Excellence. Gaithersburg, MD: Baldridge National Quality Program.
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EFQM

- EFQM (2003). Assessing for Excellence: A Practical Guide for Successfully Developing, Executing and Reviewing a Self-Assessment Strategy for Your Organisation. Brussels: European Foundation for Quality Excellence.
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- EFQM (2003). Introducing Excellence. Brussels: European Foundation for Quality Excellence.
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- The Quality Assurance Agency for Higher Education (2005). The Partnership Quality Assurance Framework for Healthcare Education in England: Approval of Healthcare Education in England. The Quality Assurance Agency for Higher Education.

Investors in People

- Investors In People (2004). The Investors in People Profile. version 19 Ed. London: TSO.
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Tricordant

- Tricordant (2006) - last update, The Tricordant Approach. Available: http://www.tricordant.com/emb02.htm [July 2018].
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APPENDIX C
Examples of information derived from sources of Interpretive Synthesis

Author	Aggestam, L.
Title	Towards a Maturity Model for Learning Organizations – the Role of Knowledge Management
Reference	(2006). 17th International Conference on Database and Expert Systems Applications.
Concepts	• Environment promotes a community of collaboration learners. • Culture begins with leader who inspires the vision. • Must be linked to organisational aims.

Author	Altbach, P.
Title	The Complex Roles of Universities in the Period of Globalisation
Reference	(2009). In: Higher Education at a Time of Transformation. (GUNI. 35 Ed.). Hampshire, UK: Palmgrave.
Concepts	• Social responsibility. • Focus on the future. • Social responsibility. • Sense of mission. • React positively to change. • Systems. • Learn about learning.

Author	Baldridge
Title	Criteria for Performance Excellence
Reference	(2007). Gaithersburg, MD: Baldridge National Quality Program.
Concepts	• Visionary leadership. • Customer driven excellence. • Organisational and personal learning. • Valuing employees and stakeholders. • Agility. • Focus on the future. • Managing innovation. • Management of performance level. • Social responsibility. • Focus on results and creating value. • Systems perspective

Author	Barr, H.
Title	New NHS, New Collaboration, New Agenda for Education.
Reference	(2009). Journal of Interprofessional Care, 14(1), pp.81-86.
Concepts	• Projects aligned to strategy and policy. • KPIs • Effective cross-silo collaboration working. • Important elements at start, always in place, and need continuous improvement.

Author	Dahlstrand, A. L.
Title	Large Firms Acquisitions, Spin-offs and Links in the Development of Regional Clusters of Technology-Intensive SMEs.
Reference	(2017). In: Keeble, D. and Wilkinson, F (Ed.). High-technology Clusters, Networking and Collective Learning in Europe. London, UK: Routledge.
Concepts	• Employee empowerment. • Sense of mission. • React positively to change. • Strong leadership commitment. • Policies, procedures, and processes emphasise collaboration. • Everyone knows importance of partnerships with stakeholders. • Customer focus – employees, planning, performance measures. • Communication.

Author	Deeming, W. E.
Title	Out of the Crisis
Reference	(2018). Cambridge, MA: MIT Press.
Concepts	• Consistency of purpose towards improvement. • Philosophy to meet challenges and collaborate for change. • Prevention is better than cure. • Strive to continuously improve. • Leadership. • Drive out fear of collaboration. • Breakdown barriers between departments. • Empower staff. • Education and self-improvement of staff. • It's everybody's job.

Author	D'Este, P. and Patel, P.
Title	University–industry Linkages in the UK: What are the Factors Underlying the Variety of Interactions with Industry?
Reference	(2007). Research Policy, 36, pp.1295–1313.
Concepts	• Structures. • Systems. • Staff – utilisation of human capital. • Skills (providing people with). • Style (leadership). • Shared values. • Strategy.

Author	D'Este, P. and Patel, P.
Title	Why do Academics Engage with Industry? The Entrepreneurial University and Individual Motivations.
Reference	(2011). The Journal of Technology Transfer, 36, pp.316–339.
Concepts	• Consistent direction & leadership from top. • Learning – personal, team, organisation. • External scanning.

	• Cross internal boundaries. • Trusting, open, and curious environment.

Author	Swieringa, J. and Wierdsma, A.
Title	Becoming A Learning Organisation: Beyond the Learning Curve.
Reference	(1992). Wokingham: Addison-Wesley.
Concepts	• Strategy. • Structure. • Culture. • Systems. • Learn about learning.

Author	Tricordant
Title	The Tricordant Approach
Reference	www.tricordant.com.
Concepts	• Clear structure, targets, responsibility, ownership. • Quality embedded into processes. • Continuous improvement. • Vision, values, practices. • Personal development training. • Purpose, aims, plan, strategy, ethics, values. • Process, syntax, technology, communication, people structure, roles, measurement. • Spirit, plan, motivation, ethos, leadership, evaluation, teamworking.

APPENDIX D

The Collaboration Maturity Model

Environment sensing - external stakeholders

		Level 1: Ad hoc	Level 2: Aware	Level 3: Defined	Level 4: Managed	Level 5: Continuous
2.1.	Gathering of feedback.	Feedback from stakeholders is gathered ad hoc and reactively.	Feedback is gathered from stakeholders proactively to assess satisfaction. Feedback is sought from a sub-set of stakeholder groups only. A limited number of methods are used.	Feedback is gathered proactively via a range of methods.	Feedback is gathered proactively via a wide range of methods to access views of all customers.	Feedback is gathered proactively via a wide range of methods to access views of all customers and non-customers. Feedback is proactively sought to assess impact of changes on customer satisfaction.
2.2.	Collation of feedback	Feedback is not collated.	Feedback may be collated.	Feedback is collated separately for each source.	Feedback is collated across all feedback methods and analysed for consistency.	Feedback is collated across all feedback methods and analysed for consistency. Collated feedback is analysed over time to identify trends.
2.3.	Respond to feedback	Feedback is responded to with excuses, or discounted as due to customers "not understanding the other team's way"	Feedback is responded to with explanation, excuses, or discounted as due to customers "not understanding the other team's way" Changes are not reported.	Feedback is responded to with details of changes, or explanation of why changes cannot be made. The locus of control is presented as the service ("we decided to do ...").	Feedback is responded to with details of changes, including timescales for longer-term changes. The locus of control is presented as if we are a team ("you said ... we did ...").	Feedback is advertised, and responded to with details of changes, including timescales. Changes are pro-actively communicated as based on feedback (locus of control is presented as a team working together).
2.4.	Act on feedback	No changes are made in response to feedback.	A small number of changes are made based on feedback. Changes are made only if small and/or	Most feedback results in changes. However, changes are limited to	All feedback results in change (though some may be long-term), including	All feedback results in change (though some may be long-term), including

			agree with service's point of view ("sensible" "possible").	those "within the service's control"	changes to other services and big changes requiring institutional funding and support.	changes to other services and big changes requiring institutional funding and support. Analysis of trends leads to anticipatory changes, with both long- and short-term future focus. Feedback leads to changes in overall goals and strategy.

Environment sensing - organisation

		Level 1: Ad hoc	Level 2: Aware	Level 3: Defined	Level 4: Managed	Level 5: Continuous
2.5.	Feedback gathering	Instructions from the digital parent organisation are obtained ad hoc.	Instructions are proactively obtained from the digital parent firm.	Indicators of desired direction are obtained proactively from the digital parent firm.	Indicators of desired direction are obtained proactively from the parent organisation, and other sibling departments. Feedback is proactively sought from the parent digital firm and other stakeholders.	Knowledge of wider organisational context is obtained. Indicators of possible future directions of the parent organisation are monitored. Indicators of desired direction are obtained proactively from the digital parent firm, and other stakeholders. Feedback is proactively sought from the digital parent other stakeholders.
2.6.	Influencing organisation	Change is responded to ad hoc as instructions from the digital parent firm.	Change is imposed top down as instructions from the digital parent firm.	Changes are determined top down in response to desired direction from the digital parent firm.	The service negotiates with digital parent firm and stakeholders for change implementation (both to achieve change desired by the service, and to mitigate	The service influences digital parent organisation and stakeholders in determination of organisational change.

					change, if contradictory to other feedback, desired by parent and siblings).	

Environment sensing - wider context

		Level 1: Ad hoc	Level 2: Aware	Level 3: Defined	Level 4: Managed	Level 5: Continuous
2.7.	Feedback gathering	The collaborating team members are unaware of position, policies, and practices in each other organisations. There is no awareness of possible future developments.	The collaborating team members seeks out specific information relating to potential changes ("We want to do X – how did others do it?"). Specific staff may attend conferences ad hoc.	Indicators of a wide range of best practice (research and practice) are obtained ad hoc ("What are the issues around X?"). A range of staff attend conferences ad hoc.	Indicators of best practice (research and practice) are proactively and comprehensively obtained ("What is going on?"). All staff are encouraged to read professional literature and attend conferences.	Knowledge of the wider professional context is obtained. Indicators of possible short- and long-term future directions of orgnisations are monitored (including current best practice, research and 'cutting edge' ("What might be going on in the future?").
2.8.	Involvement & contribution of staff in profession	The service does not like to engage with 'the profession'.	The service does not like contribute to wider professional knowledge but does occasional like to listen but not engage with the profession.	Staff of the service may contribute to wider professional knowledge ad hoc.	Staff of the service can contribute to wider professional knowledge through publications, experience sharing and conferences. Limited projects may be undertaken if do not 'interfere' with the service's business.	The service actively contributes to wider professional knowledge through projects, publications, experience sharing, and conference papers. All staff are encouraged to contribute. The service operates at the cutting edge in at least some areas.

Learning organisation

		Level 1: Ad hoc	Level 2: Aware	Level 3: Defined	Level 4: Managed	Level 5: Continuous
3.1.	Staff empowerment	Decisions are not taken or are taken ad hoc.	Decision making is controlled by the top.	There is limited middle management level / professional staff decision making	Staff are empowered to make decisions about their own job (with support of the management structure).	Staff are empowered to make decisions about anything (with consultation and 'permission'), with the lowest possible locus of control.
3.2.	Staff involvement in change	Staff try to prevent change.	Staff are passive in the change process.	Staff are informed of change and sometimes participate in the change process.	Staff are included in the change process and the implementation of change.	Staff are the drivers of change, and of the implementation of change.
3.3.	Learning	Learning is personal.	There is some shared learning within work units.	There is some shared learning between co-ordinated work units.	There is some shared learning throughout the service.	There is shared learning, information, and knowledge throughout the service.
3.4.	Attitude to mistakes	Mistakes are hidden due to a blame culture.	Mistakes are fixed – they are viewed as the result of the person not following procedure.	Mistakes are fixed – they are viewed as indicative of faulty processes (especially not enough training).	Mistakes are viewed as opportunities for learning.	Mistakes are viewed as opportunities for learning and are accepted as inevitable if trying new things.
3.5.	Attitude to risk	The service is risk averse – refuses to take risks.	The service is risk averse – may occasionally take what it views as risks, but only if they are virtually guaranteed to work.	The service is risk averse – employs checks and balances to minimise risks.	The service is risk tolerant – willing to accept risk-taking behaviour ("It is OK to take risks, no-one will die!").	The service is risk seeking – encourage risk taking behaviour ("It is better to do something and fail than to wait to be certain it will work and do nothing").
3.6.	Staff encouragement to innovate	Innovation is discouraged.	'Innovation' from senior staff is tolerated (inspiration is taken from elsewhere).	Middle management, professional staff, and specific specialist staff are encouraged to innovate (innovations are taken from elsewhere).	Most staff are encouraged to innovate, but this does not include the most junior levels.	All staff at all levels are encouraged to innovate.

Attitude to change

		Level 1: Ad hoc	Level 2: Aware	Level 3: Defined	Level 4: Managed	Level 5: Continuous
4.1.	Attitude to change	The service is change averse – change is avoided and prevented. Change is perceived as disruptive to the 'day job'. "If it ain't broke, don't fix it".	The service is change resistant – it prefers stability and permanence. Staff list reasons why change is bad and will fail. "Whether change is good or bad depends on what the change is".	The service is change managing – stability and permanence are preferred, but change accepted as inevitable. "Change is good if done well".	The service is change friendly – there are systems and processes in place to make implementation of change easy. "Change is good if it is done to improve things".	The service is change seeking – constantly seeking to change. "To stand still is to regress".
4.2	Perception of drivers for change	Change is viewed as imposed top down.	Change is viewed as imposed top down – though the influence of external factors on the service management is acknowledged.	Change viewed as driven by customers and/or parent organisation and/or external environment.	Change viewed as driven by customers and parent organisation and external environment.	Change viewed as driven by everyone, with focus on serving and anticipating changing needs of customers and environment.
4.3	Identification of barriers to change	Barriers are the structure / hierarchy / bureaucracy / competency of middle management.	Barriers are the attitudes of staff.	Barriers to change are resources (money / space / time / staff). These barriers are insurmountable.	Barriers to change are other parts of the parent organisation.	There are no barriers that cannot be overcome.
4.4.	4.4 "Vanilla" vs. "sexy"	Changes are implemented to ensure that existing policies / procedures / practices are properly adhered to by everyone. 'Get the vanilla right'.	Changes are implemented to produce incremental improvements to the what the service is already doing (the 'vanilla').	Changes are implemented in terms of breakthrough new projects, to offer new products / services.	Changes are implemented to produce both incremental and breakthrough improvements.	Changes are implemented to produce both incremental and breakthrough improvements. Staff are aware of why both necessary, and both are included in targets.

Attitude to research collaboration and innovation

		Level 1: Ad hoc	Level 2: Aware	Level 3: Defined	Level 4: Managed	Level 5: Continuous
5.1.	Definition of collaboration	Collaboration is defined by the service	Collaboration is defined as happy face-to-	Collaboration is defined as stakeholders'	Collaboration is defined as stakeholders'	Collaboration is defined by stakeholders.

		(e.g., "We provide a perfect team system, it is their fault if they can't work with us. It is bad working with others and never trust other except they look like you")	face with others for improvements.	satisfaction with collaboration on products and services. Locus of control is the service (e.g., service level agreement levels are determined by the service staff). Targets for quality are implicit or secret.	satisfaction with products and services. Locus of control is the service (e.g., service level agreement levels are determined by the service staff). Targets for quality are explicitly advertised.	Locus of stakeholders working together (e.g., agreement levels are determined by stakeholders). Targets for quality are explicitly communicated.
5.2.	Collaboration improvement	Collaboration is not absolute, rather relative, not an option.	Collaboration is achieved by luck / accident.	Collaboration improvement focuses on improving the team working together. Collaboration improvement is written in the strategy of the firm.	Collaboration improvement focuses on improving processes by which products and services are achieved. Collaboration and improvement measures are written into documented work processes.	Collaboration improvement is viewed as a continuous process. All staff are encouraged to continually improve themselves and their work.
5.3.	Perception of responsibility for collaboration.	Collaboration is the responsibility of everyone to do their best to adhere to procedures.	Collaboration is the responsibility of people serving customers face-to- face to be 'nice'.	Collaboration achievement is the responsibility of the management of the service (or the collaboration officer if there is one), though it may be explicitly devolved down for specific areas.	Collaboration for a particular area is the responsibility of the people in that area.	Collaboration for the whole service is everyone's responsibility.

Leadership

		Level 1: Ad hoc	Level 2: Aware	Level 3: Defined	Level 4: Managed	Level 5: Continuous
6.1.	Vision and value setting	The leader has not set their vision and values.	The leader has clearly articulated their vision and values.	The leader has articulated their vision and values and communicated it to all staff through a variety of mediums, including	The leader has articulated and communicated their vision and values, which underpin policies, practices, targets, KPIs, staff	The leader has articulated, communicated, and aligned their vision and values. All staff 'walk the talk' i.e., behaviour in accordance

				dialogue sessions. They embody it by 'walking the talk'. It is covered in new staff induction.	development, and behaviour. They and other key people 'walk the talk'.	with the vision and values is second nature. There are initiatives in place to ensure this behaviour is sustained.
6.2	Trust	The leader engenders distrust and a lack of openness.	There is distrust in the leader, attributed to lack of understanding on their part. There is no feeling of openness.	There is a lack of distrust in the leader. There is a feeling of openness.	There is trust in the leader and a feeling of openness.	The leader engenders trust and a feeling of openness. They have the 'hearts and minds' of staff.
6.3	Inspiration and motivation	Staff are generally demotivated.	New staff are generally motivated to perform, but over time staff become demotivated by the service culture.	Staff are personally motivated to perform.	Specific teams are motivated and inspired to perform.	Leader inspires, motivates, encourages, organises and directs staff to ensure that all the other aspects of achieving a mature quality culture happen.

Investment in staff

		Level 1: Ad hoc	Level 2: Aware	Level 3: Defined	Level 4: Managed	Level 5: Continuous
7.1.	Staff as an asset	There is no specific commitment to staff development.	There is a commitment to the achievement of staff development, where staff development is equated with training.	There is a commitment to the achievement of staff satisfaction, development, and well-being.	Systems, structure, and processes are in place to achieve staff satisfaction, development, and well-being.	People are viewed as the LIS's most critical asset. Staff feel the commitment of the LIS to them.
7.2	Training provision	Training is ad hoc and related to the inability to perform specific work task.	There is a reactive training programme, related to work tasks and ad hoc requests.	There is a training programme related to training needs assessment, and provision is related to this.	There is a training programme comprising training needs assessment, provision, and an assessment of the effectiveness of the training. Training is provided in the tools, techniques, and skills for improvement.	There is a training programme comprising training needs assessment, provision, and an assessment of the effectiveness of the training. Training is related to future necessary skills and account is

					Data gathering and reflection are encouraged.	taken of succession planning and developing skills required for the future. Training is provided on 'learning how to learn'. Time is built in to work for critical reflection.
7.3	Development of staff.	There is no development of staff.	Staff are supported in their professional development ad hoc.	Staff are supported in their professional development. There is a clear progression path for some staff.	Staff are supported in their professional and personal development. There is an appreciation that happy and fulfilled staff are more engaged and so produce better work. There is a clear progression path for all staff.	Staff are supported in their professional and personal development. Future leaders are identified and coached. All staff are encouraged to develop their career and their talents, and there is a clear progression path (which may involve leaving the organisation to progress). Staff feel valued as a whole person.
7.4.	Recognition of staff.	Staff do not feel their work makes a difference.	Staff may feel recognition for their work, dependent on the characteristics of their line manager.	There is a commitment to the recognition of staff, though there are no specific systems in place.	There are systems, structures, and processes in place for recognition and/or reward and/or progression of staff.	Staff "feel the love" due to recognition and/or reward and/or progression systems, structures, and processes.

Alignment

		Level 1: Ad hoc	Level 2: Aware	Level 3: Defined	Level 4: Managed	Level 5: Continuous
8.1.	Vertical alignment	There is no alignment of cultures between the top, middle and bottom of the service.	There is no alignment of cultures between the top, middle and bottom of the service.	The service is aiming for alignment of cultures between the top, middle and bottom of the service.	There is some alignment of cultures between the top, middle and bottom of the service, with some areas of 'blockage'.	The service is fully aligned at all levels of the service in vision, values, attitudes, policies, and practices.

8.2.	Horizontal alignment	There is no co-ordination between work units.	There is some ad hoc co-ordination between work units.	There is planned co-ordination between work units.	The concept of the internal customer is applied between work units.	A systems approach is taken – “managing the whole elephant”.
8.3.	Consistency	Work processes are dependent on the person undertaking them.	Basic work processes are documented and consistently applied.	Consistency is ensured by documented processes, practices and policies, or job description (as appropriate).	Consistency is ensured by documented processes, practices and policies or job description. Training is provided regularly to emphasise these.	Consistency is ensured by documented processes, practices and policies or job description, which are regularly reviewed for improvement. Training is regularly provided.
8.4.	Communi-cation flow	Limited information flows top down.	Limited information flows top down and bottom up. Messages are mediated before being passed down, and limited bottom-up communication is sought.	Communication flows top down and bottom up. Not all staff feel confident in the free flow of communication.	Communication flows top down and bottom up. Channels exist for circumventing any blockages to communication.	Multiple methods exist for top down, bottom up and lateral communication. Communication is unambiguous and consistent, with a clear purpose.
8.5.	Staff recognition of where they fit into the overall scheme	Staff member’s approach to the purpose of the service is dependent on their specific work.	Staff member’s approach to the purpose of the service is dependent on their work unit or area.	All staff understand the overall aims and purpose of the service. Most understand their contribution to achieving them.	All staff understand the overall aims of the service and their contribution to achieving them. Leaders understand how all staff contribute to the achievement of service aims.	All staff understand how the overall aims of the service contribute to the achievement of the aims of the parent organisation, and how they contribute to achieving them. Leaders of the parent organisation understand how the service contributes to the overall aims of the organisation.
8.6.	Structure	The structure of the service creates silos - it is a barrier to integration and communication.	Some parts of the operational structure are barriers to integration and communication	The structure of the operation process is not a barrier to integration and communication.	The structure of the process facilitates alignment, integration, and communication.	The structure of the process facilitates alignment, integration, and communication as well as flexible so as not to be a

						barrier to change.
8.7.	Alignment of attitude to collaboration	There is no collaboration culture.	There is no collaboration culture.	Collaboration culture is weak	Collaboration culture is strong	Collaboration culture is ubiquitous.
8.8.	Alignment of attitude to change.	The attitude to change is inconsistent.	The attitude to change is varied.	The attitude to change is split along specific lines (team, location, grade).	The attitude to change is widespread, with some known non-aligned areas.	The attitude to change is universal.

APPENDIX E

Checklist for Data Gathering Visit

University/Digital Technology Firm

Date:

Address:

Phone:

Time Management for Meeting:

Contact Name:

Interview Mode:

Checklist

Interview Schedule for Researchers	
Interview Schedule for Research Principal Investigators	
Interview Schedule for university entrepreneurial group staff	
Interview Schedule for digital firm staff	
Interview Schedule for university Knowledge Transfer Centres	
Consent Forms	
Vision statement	
Mission statement	
Strategic plan	
Operational plan	
Staff development policy	
Relationship policy	
Collaboration management policy	
Partnership policy	
List of internal committees	
Minutes of internal committees	
Procedural manuals	
University / Digital Technology Firm interaction	
Appraisal / performance management system	
Induction programme	

APPENDIX F

Participant Informed Consent Interview (Information Sheet)

I will appreciate for you to volunteer to participate in this research. My name is Ben Gold, I am a PhD student at University of Reading. This study forms part of my PhD.

For my PhD I have developed a framework for measuring an organisation's attitude to research collaboration. The aim of this study is to test this framework by investigating the attitude to research collaboration between UK universities and digital technology firms.

I am investigating these stakeholders' attitude to research collaboration through analysis of documents and interviews with a few academic researchers and staff in the digital technology firms. You have been selected as a representative of your job role.

You do not have to have any knowledge about "collaboration" to take part in this study, and there are no right or wrong answers to the questions.

I will tape record this interview. I will be analysing your answers for my study, but all data will be kept and analysed anonymously. I may use quotes of what you have said in my PhD thesis, but any quotes will be anonymous.

You have the right to withdraw from this study at any time.

My framework scores an organisation from 1 to 5 in several areas. I will report back the scores this study to your organisation, but the report will consist only of the score. It will not include what anyone has said and will not include any quotes. Your organisation will not be able to tell what you say in this interview.

I have read and understood the above information I agree to participate in this study

Signed:

Date:

APPENDIX G

Interview Questionnaire

ID:	*Date/Time:*
---Researcher input here ---	---Researcher input here ---

Background questions

Role	*Position*
---Answer here ---	---Answer here ---
Type of organisation	*Years in current organisation*
---Answer here ---	---Answer here ---
Type of research collaboration	*Name of membership of an academic network?*
---Answer here ---	---Answer here ---

Interview questions

Q1: Thinking about the research collaboration projects your firm/university have done in the few previous years, please describe how it was organised and implemented?
---Answer here ---

Q2: If any, are there challenges faced in the collaborative projects?
---Answer here ---

Q3: Examining collaborations projects done by your organisation, how was the process of the collaboration projects initiated, introduced, defined, and organised or implemented in your organisation?
---Answer here ---

Q4: On introducing the research collaborative projects, describe who or which party drove the initiatives?
---Answer here ---

Q5: How important were these to the success of the initiatives and why?
---Answer here ---

Q6: Kindly talk me through the basis that the collaborative projects were given resources?
---Answer here ---

Q7: On the communication with external partners, how was this usually organised?
---Answer here ---

Q8: What was the usual communication process with external partners?
---Answer here ---

Q9: On the research collaborative projects, tell me what were your organisation's expectations for the research projects?
---Answer here ---

Q10: Are these expectation(s) related to pre-conceived strategies?
---Answer here ---

*Q11: What are your expectations or what d***o you*** *hope to achieve in research collaboration?*
---Answer here ---

Q12: And in your view, what are the issues that comes to mind that are blocking the potentials or the dynamic movement of research collaboration productive value?
---Answer here ---

Q13: What are your suggestions to bypass or overcome these blocks or barriers?
---Answer here ---

Q14: In explaining the relationships between UK universities and tech firms research collaborative projects, what are the power relationships in such collaborations?
---Answer here ---

Q15: What are your suggestions on what could make the relationships to be dynamic and productive?
---Answer here ---

Q16: Was there an approach or a framework used to co-ordinate the research collaboration projects or the partnerships with external parties that you have been involved with?
---Answer here ---

Q17: Does the approach or framework require any modifications to suit a purpose?
---Answer here ---

Q18: What possible paths forward to assist in making UK universities and tech-firms research collaboration to have more research productive value (publications or policy changes)?
---Answer here ---

Q19: In order of their priority or importance to you, what research collaboration projects do you or your organisation prefer to engage in?
---Answer here ---

Q20: Which area of the research collaboration, if any do you think you or your organisation have challenges?
---Answer here ---

Q21: What are the actions taken to encourage research collaboration potentials and productivity values?
---Answer here ---

Q22: Have you used the productivity value from the research collaboration to publish academic articles or for other value incentives?
---Answer here ---

Q23: Are the productivity values from research collaboration a good incentive for the trouble taken to do such research?
---Answer here ---

Any comments / suggestions?
---Answer here ---

APPENDIX H

Examples of Initial Coding - Line-by-Line

INST1LA2

How does your team members organise communicate of their ideas to staff?	
Away day Communicate ideas at away day Staff asked for feedback Senior staff visit university campus to communicate (one way) 'latest developments and schemes'	We have our away day, and I'm sure they transmit some of the ideas through that. As well as asking for feedback from us. We have regular *********** and ******** come round to the campuses and tell us the latest developments and schemes.

So do you feel you know what is going on?	
Lack of trust of university researcher Conspiracy Secret issues Confidential issues Digital Firm decide what to pass on Some info does not cascade downwards Trust university researchers Pass on what needs to know Don't need to know everything that is going on	[pause] I'm sure I know what they want me to know is going on. There may well be issues that are secret – especially things that affect staff working conditions and practices. I am not sure secret is the right word – they feel that certain information doesn't need to cascade downwards. When you have a management team you must trust that they do cascade what we do need to know and what they don't tell us we don't need to know.

Do you follow a manual in your work?	
Operational actions derived from policies	Yes, there are policies behind our actions.

Not all work circumstances covered by manuals	Yes, largely. There are circumstances which are

INST6SMT

Where does the impetus for change come from?	
Impetus for change from individual collaboration member Not 'change for change's sake' Change a tool Efficiency of resource use Looking to future 'Not stagnating' continuing to exist 'Keeping a weather eye' Exploiting technologies Efficient use of systems. Future planning of staffing requirements Impetus for change in team top down from manager Changing a culture Change is viewed as acceptable Specific issue Post cut Specific post not in structure Difficulty with lack of post Strategic management of work Discuss within team operational problems	Very much from me, as you can probably guess from the things I say, but it is not change for change's sake, it is very much making sure we are exploiting the systems that we have got to the full. That we have got an eye to the future that we are not stagnating, that we are looking to keep the service going. So, it is about keeping a weather eye and making sure we are exploiting the technologies, the systems that we have got, and for staff to take that forward. So, anyone who works in information resources, they would probably say from me. But I hope that I am bringing in the culture where change is acceptable, where people can go away and ... I think we have a particular issue with a post that has been cut, though actually we have never had it. We never had a post of serials librarian, I put one together, it was never filled while I was away, and now I find out it has been cut, which is very annoying but now I have a serious issue about dealing with it because it can't keep limping along. So, we started a discussion

INST4PLA2

How do you work with other teams?	
Variable workflow Work varies thru year Training only in non-busy time Offer to help adjacent team Share workload of other team, but still their work Appreciation of workload of others Lead culture of inter-team support From ad hoc to established part of culture Own work has priority Ad hoc arrangement Variable workload Individual assigned tasks 'Secondary job' Response to staff feedback about their job Develop staff Assigned jobs by manager Staff satisfaction – keep them busy Not all staff will enjoy all parts of the job Share workload of other team, but still their work Unimportant task to keep busy	Err…mmm…. Document supply the workflow comes and goes. October to January is our busy time, so we have more scope to do training, and we would also offer our services to cataloguing acquisitions, we always help with acquisitions with reading list there are piles and piles. I have always tried to instil in my team that we should offer help. On a goodwill basis in the last couple of years, but more recently it is more of an acceptance of the nature of the role. If we have enough work, we will carry on with that, so it is an ad hoc arrangement. So, we do have times when there aren't as many requests as possible, so each of the information assistant in my team have got a secondary job. It is something we set up from appraisal to give them variety, so they are not just doing a banal task. I am very pro; I would hate to think they are sat at the desk with nothing to do. I want them to come to work and enjoy the work that they do. Easier said than done sometimes, but I do try. We will help with communicating tasks, or we have got a little task now to weed out the ….

APPENDIX I

Focused coding for analysis of interviews for iteration 1, increment 2

Generation of the strategic plan

Strategic plan determines development work Scope of strategic plan

Good management practices

Walk the talk

Leadership

Hearts and minds

Staff development

Staff training strategically managed

Be on same hymn sheet

Consistency

Alignment

Integration

Little mechanisms

Structure

Managing the whole Communication Process

Attitude to change

Attitude to barriers to change

Flashy vs vanilla

Bottom up gather

Bottom up act

Close loop

Top down gather

Top down act

Influence organisation

Operate within wider profession

Awareness of professional issues

Culture of quality

Customer focus

Responsibility for quality

Management of projects

Decision making

‘Business as usual’

Inclusion – empowerment

Performance measurements collected

Use of performance measures

Monitoring of progress

APPENDIX J

Examples of focused coding of interviews for iteration 1, increment 2.

INST3PLA1

How does your teamwork with the other teams?	
Integration Communication Communication Structure Communication	Umm, they do work fairly separate, but they do overlap when there are tasks, such as lots of things with the desks involve us and acquisitions ordering books and things and there are talk sessions with all the staff when they got together. I think quite separate but there is overlap and communication when there needs to be. And a lot of the staff from acquisitions and customer services work on the service points together so there is a mixture and contact there so you can just informally mention things there.
	Who has responsibility for quality?
	Within the team or?
	Anything you like!
Customer service Culture of quality	Um, I think lots of persons have good customer care, the quality of the service being provided, lots of people have pride in the service being provided so you can measure the quality of the work that way [pause]
	So how does the organisation try to improve its innovation improvement?

INST8SMT

So how do you communicate with your staff?	
Communication	I run contact pact of the process, but in the office there about 3 or 4 people – the people who work at the issue desk are all junior staff.
	When they are on the ID are you their line manager when they are on there?
Good management practices Hearts and minds Lead Managing the whole elephant	There is a senior assistant who is in the service, and she deals with any day to day, though since <PI> came she has reorganised it, to her credit, and she is making us take more managerial role. <PI> has got us out of our comfort zones, which is a good thing. But it is very difficult to quantify – so when you are filling out an appraisal form, as I am going to have to do the rest of today and tomorrow, you think 'how can I justify spending 2 1/2 hours reading a document that is in the end irrelevant to us, or an afternoon at a meeting when we don't even offer that service. I find that very difficult, I always have. But that may just be me.

Environmental sensing top-down gather Staff valued	Appraisals here […] assistants have in the past misunderstood what they were for, some way of getting a bonus or getting a promotion. There are some people who do not like to work with others […].

INST9DOL

From what you have said, it seems the hierarchy flows upwards?	
Generation of strategic plan Environmental sensing top-down act Generation of strategic plan Environmental sensing top-down gather Environmental sensing top-down act Scope of strategic plan	It is fair to say that the actions are inserted into the bottom and go up to the appropriate level, however the plans themselves are top down, in that there is no point us writing an organisational plan that is out of step with information services overall plan and likewise that has to be in step with the university overall plan. So, … um, the full structure of the strategy is in many ways top down, we are setting out to deliver services that are in line with what the university wants and requires. And to do that within the context of the university's overall strategies. There is no point for example in us saying we are going to build a research library here if the university's main priorities are teaching. And vice versa. So, in many ways the strategy is top down, but the implementation of the strategy, the actions, is bottom up.
So how do you go on with that and achieve your key objectives? Do you have individual team plans within the firm?	

INST5LA1

Who has responsibility for collaboration quality?	
Attitude to collaboration quality Responsibility for collaboration quality Culture of quality Responsibility for quality Responsibility for quality Decision making	Quality of service? Well, I suppose the quality of our work is checked, spot checked, so that would be my line manager. We all take individual pride for all that we do. And we are not trained researchers, though we are doing now quite a lot of what the researchers do, and the checking side of things, so we are the last point of contact now, so we are pretty much responsible for our own. Obviously, it is spot check to pick up. And I presume, I don't know I presume the librarians wander round and look for themselves how the shelf- ready is going. I presume they would because researchers like to keep an eye on things don't, they, to make sure it is all how they want it. I don't know if it is, whether that is our fault I don't know. It may not be shelved exactly where they want it to be, but we follow what they say, because we are not trained, we wouldn't know

Attitude to risk Empowerment	what they are saying was meant to be at anyway. So, the collaboration quality is not in my view good.

APPENDIX K

Text for testing of questionnaire (at Reading)

Welcome to the Collaboration Culture Test Survey.

This survey includes a first draft version of the Collaboration Maturity Assessment Questionnaire, which I have created. When it is fully developed, it is intended that the questionnaire will position a UK university collaboration with Digital Technology Firms on the Collaboration Maturity Model (which I have also developed). This will enable management to determine the areas to focus on for improvement.

This survey aims to gather feedback on the questionnaire and on the assessment process. It forms part of the data gathering for my PhD.

The survey is anonymous, contains 40 multiple-choice questions and takes around 15 minutes to complete. There is also a question asking for your feedback on the questionnaire itself.

Please answer the questions based on your opinion or how you feel. You should answer them quickly as I am looking for your 'gut feeling' reaction

Thank you for helping me,
Ben Gold

<new page>

Data Protection Statement

All data collected in this survey will be held anonymously and securely. No personal data is requested.

Cookies (personal data stored by your Web browser) are not used in this survey.

All the results will be based on aggregated data. The results will be split by question, section, grade, or team of respondent to undertake the necessary analysis.

The results will be fed back to a UK university PI Researcher to evaluate the whole process and give me feedback. I will not use the results, only the feedback. The PI Researcher will not use the results. Participating is solely to support my academic studies.

The free text comments you provide in the final section (feedback about this questionnaire) may be used in my thesis. Any quotations used will be anonymous.

Ben Gold

<new page>

< Collaboration Culture Assessment Questionnaire> <new page>
Your feedback about the questionnaire

This questionnaire is in the very early stages of development. If you have any feedback about it, positive or negative, please comment below. I will use your comments to improve it.

41. Please leave your comments/feedback about the questionnaire. (Optional)

<new page>

[Final Page]

Thank you very much for completing this questionnaire.

The results will be shared with a PI Researcher to provide feedback to me about the process. This feedback, and any feedback you gave in the last section, will be used in my research. The results of the questionnaire will not be used in my research, or by the PI Researcher.

Thank you for helping in my PhD research.

Best regards,

Ben Gold, benk.g.2020@gmail.com.

APPENDIX L

Text for testing of questionnaire (at Westminster)

Welcome to the Collaboration Culture Test Survey.

This survey includes a first draft version of the Collaboration Maturity Assessment Questionnaire, which I have created. When it is fully developed, it is intended that the questionnaire will position a UK university collaboration with Digital Technology Firms on the Collaboration Maturity Model (which I have also developed). This will enable management to determine the areas to focus on for improvement.

This survey aims to gather feedback on the questionnaire and on the assessment process. It forms part of the data gathering for my PhD.

The survey is anonymous, contains 40 multiple-choice questions and takes around 15 minutes to complete. There is also a question asking for your feedback on the questionnaire itself.

Please answer the questions based on your opinion or how you feel. You should answer them quickly as I am looking for your 'gut feeling' reaction

Thank you for helping me,
Ben Gold

<new page>

<u>Data Protection Statement</u>

Data Protection Statement

All data collected in this survey will be held anonymously and securely. No personal data is requested.

Cookies (personal data stored by your Web browser) are not used in this survey.

All the results will be based on aggregated data. The results will be split by question, section, grade, or team of respondent to undertake the necessary analysis.

The results will be fed back to a PI Researcher in the Centre for Digital Business to evaluate the whole process and give me feedback. I will not use the results, only the feedback. The Centre for Digital Business PI Researcher will not use the results. Participating is solely to support my academic studies.

The free text comments you provide in the final section (feedback about this questionnaire) may be used in my thesis. Any quotations used will be anonymous.

Ben Gold

<new page>

<Collaboration Culture Assessment Questionnaire>

<new page>

Your feedback about the questionnaire

This questionnaire is in the very early stages of development. If you have any feedback about it, positive or negative, please comment below. I will use your comments to improve it.

41. Please leave your comments/feedback about the questionnaire. (Optional)

<new page>

[Final Page]

Thank you for completing this questionnaire.

The results will be shared with PI Researcher in the Centre for Digital Business to provide feedback to me about the process. This feedback, and any feedback you gave in the last section, will be used in my research. The results of the questionnaire will not be used in my research, or by the PI Researcher.

Thank you for helping in my PhD research.

Best regards,

Ben Gold,

APPENDIX M

Draft RCCAI Questionnaire before Pretesting

Welcome to the Collaboration Culture Test Survey.

This survey includes a first draft version of the Collaboration Maturity Questionnaire. When it is fully developed, it is intended that the Collaboration Maturity Questionnaire will assist to position a Research Collaboration between UK Universities and Digital Technology Firms on the Collaboration Maturity Model. This will enable the management of a Digital Technology Firm to determine the areas to focus on for improvement.

This survey aims to gather feedback on the Collaboration Maturity Questionnaire, and on the Collaboration Maturity assessment process.

The survey is completed anonymously and takes around 15 minutes to complete.

Note that once you have clicked on the CONTINUE button at the bottom of each page you cannot return to review or amend that page

[new page]

Data protection statement

All data collected in this survey will be held anonymously and securely. No personal data is requested.

Cookies (personal data stored by your Web browser) are not used in this survey.

All the results will be based on aggregated data. The results will be split by question, section, grade, or team of respondent to undertake the necessary analysis.

The results will be fed back to the Director so s/he can evaluate the whole process. The researcher will not use the results.

The free text comments you provide in the final section, feedback about this questionnaire, may be used in the thesis of the researcher. Any such used quotes will be anonymous.

[new page]

Please select the statement that best describes how you see the situation at <Position Held name>.

Questions are mandatory unless marked otherwise.

Note that when you have clicked on the CONTINUE button your answers are submitted, and you cannot return to review or amend that page.

About you

Part of this survey looks at whether there are any differences in the answers from different types of firms.

To do this, we need to know your team and your sector.

The answers will be averaged across each team or level/grade. e.g., "The innovation team have an average score of ..." or "Staff who is a founder have an average score of ..."

You answers will not be used to individually identify you. Individual responses will not be communicated to your board members or management.

Q1. What team are you in?

A1. Academic support.
A2. Administration.
A3. Customer services.
A4. Helpdesk.
A5. IT support.
A6. Senior management team.

Q2. What grade are you?

A1. 3.
A2. 4.
A3. 5.
A4. 6.
A5. 7.
A6. 8.
A7. 9.
A8. Senior staff.

<u>Management of the organisation</u>

Q3. Are you involved in the strategic planning or action / operational planning process?

A1. Yes [-> Q3a and Q3b are displayed].
A2. No [-> Q3a and Q3b are not displayed].

Q3a. How is the strategic plan generated?

A1. There is no strategic plan.
A2. There is a limited strategic plan.
A3. The strategic plan is derived from reasonable/achievable feedback from the environment.
A4. The strategic plan is derived directly from user feedback OR from the University's strategic plan OR from awareness of developments at other universities.
A5. The strategic plan is derived from feedback from users, the University's strategic plan, and awareness of new developments at other universities.

Q3b. How are actions related to the strategic plan?

A1. Actions are solely reactive to events.
A2. The strategic plan includes 'big project' improvements, but many actions are unrelated to the strategic plan and are reactive to events.
A3. The strategic plan includes 'big project' improvements, although some actions are still unrelated to the strategic plan.
A4. The strategic plan includes 'big project' improvements.
A5. All improvement processes, both incremental and 'big project', flow from the strategic plan, and it is updated to reflect new developments.

Q4. Do you have any goals or targets for the work you do with external parties such as universities?

A1. No.
A2. Yes, but I am not sure what they are.
A3. Yes.
A4. Yes, there are team goals that come down through the management structure from the strategic plan.
A5. Yes, there are team goals that come from the strategic plan, and I have individual goals too.

Q5. In your experience, how is progress towards achieving innovation targets or goals monitored?

A1. There is no monitoring of progress.
A2. There is some monitoring of progress.
A3. There is monitoring of progress, and corrective action is sometimes taken.
A4. Progress is closely monitored, and corrective action taken where necessary.

Q6. How is the digital technology innovation performance measured?

A1. We use statistical measures, e.g., end per current technology development, number of new technologies, number of journals subscribed to, number of transactions.
A2. We use statistical measures and user feedback.
A3. We use user feedback and measures of internal processes relating to user expectations, e.g., time taken to re-shelve books.
A4. We use a range of performance indicators and have some KPIs (key performance indicators).
A5. We use a range of balanced performance measures and the KPIs closely relate to the strategic aims. The measures are regularly evaluated.
A6. I don't know.

Q7. How are changes to services/processes/procedures managed?

A1. Changes are just implemented.
A2. It depends on what the change is and who is leading it.
A3. Changes are implemented through project management processes developed for that

project.
A4. 'Big project' changes are implemented through standard project management processes, including planning, monitoring and impact assessment.
A5. All changes (incremental and 'big project') are implemented through standard project management processes.

Environmental sensing

Q8. How does the organisation gather feedback from its users?

A1. There are feedback/complaints forms, and users tell us/email us if they are not happy.
A2. We ask customers on our sites/conferences or via a survey. There are also feedback forms.
A3. We ask customers using a range of methods, e.g., conferences, surveys, focus groups, feedback boards.
A4. We use a range of methods to get feedback from all users (staff, academic staff, researchers).
A5. We use a range of methods to get feedback from all users. We specifically gather feedback on the impact of any changes we make.

Q9. What happens to user feedback?

A1. We respond to it.
A2. We respond to it. Some of it is collated and reported.
A3. We respond to it. The feedback from course committees is collated, and the survey results are collated, but separately.
A4. We respond to it. It is collated across all feedback methods.
A5. We respond to it. It is collated across all feedback methods and analysed over time for trends.

Q10. How is user feedback responded to?

A1. We explain the reasons behind the problem, or how the user should be doing things.
A2. We explain the reasons behind the problem, or how the user should be doing things. Sometimes we decide to change things.
A3. We respond with details of the changes we have made, or an explanation of why changes cannot be made.
A4. We respond with details of changes, including timescales for longer term changes. We make it clear that these changes are a result of feedback.
A5. We respond with details of changes, including timescales. We advertise the feedback we received, and the changes made to address it.

Q11. What changes are made in response to user feedback?

A1. No changes are made in response to feedback.
A2. Some changes are made based on feedback if they are sensible and possible.
A3. Most feedback results in changes if we can do so.
A4. All feedback results in change (though some may be long term), including big changes requiring institutional funding and support.

A5. All feedback results in change. We also analyse trends and make changes in anticipation of what users will want.

Q12. How does the organisation know what the University wants?

A1. They tell the Director what to do.
A2. The Director asks them what to do.
A3. The Director finds out from the University strategic plan.
A4. The Director finds out from the University strategic plan and the plans of other service departments.
A5. The Director knows what is going on in the University and monitors possible future directions. S/He proactively seeks their feedback on organisational plans.
A6. I don't know.

Q13. How does the organisation during collaboration influence the changes the University wants to make?

A1. The University tells us what to change, not the other way round!
A2. The University sets the organisation plan for the collaboration, and we agree to it.
A3. The organisation management decide what changes to make in response to the University strategic plan.
A4. The Director negotiates with the University and other departments about what changes to implement and how to do so. It is a two-way process.
A5. The organisation contributes to the wider University strategic planning process, not just those relating to the organisation.
A6. I don't know.

Q14. How does the organisation know what is going on in the same areas in other Universities?

A1. It doesn't.
A2. If we want to do something, we find out how others did the same thing. Some staff go to conferences.
A3. We find out the best practice relating to our work area. A range of staff go to conferences.
A4. The organisation gathers best practice information in all areas. We are all encouraged to read professional literature and attend conferences.
A5. The organisation gathers best practice information and we read professional literature and attend conferences. It looks at possible future directions.

Q15. How do organisation staff interact with the wider profession?

A1. We don't.
A2. Most are on mailing lists.
A3. We can go to conferences or special interest groups if we want to. Some people have presented at conference or written articles.
A4. We contribute through publications, experience sharing and conferences. We can do research projects if it does not interfere with normal work.
A5. We are all encouraged to take part in research projects, publications, experience sharing, and conferences. The organisation is cutting edge in some areas.

Organisational learning

Q16. Who do you feel is allowed to make decisions?

A1. People don't really make decisions.
A2. Senior management.
A3. Managers.
A4. Anyone can make decisions about their own job.
A5. We can all make decisions about anything if we get permission to make that decision and consult with people.

Q17. Are you involved in changes during research collaboration?

A1. Only to point out the problems that they haven't thought of.
A2. Not really.
A3. I know about what the changes during research collaboration are. If it was relevant to my job, I would change what I do.
A4. Yes. If it is in my area or I am on a project group I help to plan the changes during research collaboration.
A5. Yes, we come up with improvement ideas, and if they are approved, we implement them.

Q18. If you go on a course, what do you do with what you have learned?

A1. I use it in my work.
A2. I share what I have learned with the others in my team.
A3. I share what I have learned with others in my team, and other teams where it is relevant.
A4. I do a report that any collaboration member can read/attend.
A5. I share it with the rest of the collaboration members. We try to share learning, information, and knowledge.

Q19. What happens if you make a mistake?

A1. I try to make up for it. If they find out, then you get the blame.
A2. We fix it and make sure that whoever made the mistake knows what the correct procedure is.
A3. We fix it and make sure that whoever made the mistake has more training, or knows they can ask someone for help if they are unsure about something.
A4. We fix it, and use it as an opportunity for learning.
A5. We fix it, and use it as an opportunity for learning. These things are going to happen if you are trying out new things.

Q20. Are you encouraged to take risks and try out new things?

A1. No - The organisation doesn't take risks.
A2. Not really. The organisation occasionally takes risks, but only if they are virtually guaranteed to work.
A3. Not really. If we are doing something new, we try to minimise the possible risks.
A4. Yes, it is OK to take risks, no-one will die.

A5. Yes, it is better to do something and fail than to wait to be certain it will work and do nothing.

Q21. Are you supported in trying to improve the service you provide in your job?

A1. No.
A2. Yes, if it has been tried successfully somewhere else first.
A3 Yes.

<u>Attitude to change</u>

Q22. Is research collaboration change a good thing?

A1. No, it is disruptive. If it ain't broke, don't fix it.
A2. It depends on what the change is. It can be good or bad.
A3. It is inevitable. It is good if it is done well.
A4. Yes, if it is done to improve things.
A5. Yes, it is essential.

Q23. Where does the impetus for collaboration change come from?

A1. From the organisation management team.
A2. From the organisation management team, though they are under pressure from the University.
A3. From users / the University / digital technology firm.
A4. From users and the University and digital technology.
A5. From everyone. The world is constantly changing, and we try to anticipate what our users will want before they ask for it.

Q24. What is the main barrier to making changes?

A1. The structure/hierarchy/bureaucracy of the organisation.
A2. The attitudes of some members of staff.
A3. Resources (money, space, time, staff).
A4. Other parts of the University.
A5. None - there is always a way to overcome barriers.

Q25. What sort of changes should the organisation make?

A1. None.
A2. To make sure we are doing things right.
A3. To improve the things, we are doing.
A4. To implement new products or services.
A5. Both to improve things we are doing and to implement new products or services.

<u>Attitude to collaboration quality</u>

Q26. How does the organisation try to provide a matured research collaboration service?

A1. We make sure all our systems are as good as they can possibly be, and that everyone follows procedures properly.
A2. We try to provide excellent customer service.
A3. We try to make sure our users are happy with what we do.
A4. We try to make sure our users are happy with what we do. We have service level agreements written by research collaboration team.
A5. We try to make sure our users are happy with what we do and anticipate what they want before they ask for it. We have partnership level agreements written by our collaborators in the university knowledge transfer.

Q27. How does the organisation try to improve collaboration quality?

A1. We make sure that everything is done properly.
A2. We have constraints on what we can do (resources / building etc.), so it can be down to luck and if we have the money or space to make improvements.
A3. We try to improve the products and services we offer. Collaboration is part of our strategic plan.
A4. We try to improve the processes we use to assist us to develop products and services. Collaboration quality and performance measures are part of our strategic plan.
A5. It is a continuous process. We are all encouraged to continually improve our work, and to develop ourselves. Collaboration and performance measures are part of our strategic plan.

Q28. Who has responsibility for collaboration quality?

A1 Collaboration quality is the responsibility of everyone to do their best to follow procedures.
A2 Collaboration quality is the responsibility of people directly in the team to give excellent service.
A3 Collaboration quality is the responsibility of the organisation management team, though it may be devolved down to managers for specific projects.
A4 Collaboration quality for a particular project is the responsibility of the people in the project.
A5 Collaboration quality for the whole organisation, it is everyone's responsibility.

<u>Leadership</u>

Q29. Do you know what the vision and values are that the Director has set out for research collaboration?

A1. Yes. [-> Q29a is displayed]
A2. No. [-> Q29a is not displayed]

Q29a. How do you know?

A1. I have seen them written down somewhere.
A2. We had a briefing document/presentation/workshop where we were told about them.
A3. They were talked about during my induction.
A4. They are part of what we do (policies, targets, development).
A5. They are who we are. It is how everyone behaves.

Q30. Do you trust management?

A1. No.
A2. I'm sure they are doing their best, but they don't really understand.
A3. I don't distrust them.
A4. Yes, you must trust them to do their job.
A5. Yes, it is clear from what they have done in the past that they know what to do for the best of the organisation.

Q31. Do you feel motivated to do the best you can?

A1. Not really.
A2. I do personally, but it is difficult. You lose enthusiasm.
A3. Yes, I do.
A4. Yes, as a team we always do our best.
A5. Yes, we all do. The Director is inspirational, and everything is in place to support you in doing so.

<u>Investment in staff</u>

Q32. Do you feel valued by the organisation?

A1. Not really.
A2. Not really, but we receive training that we want/need.
A3. Sort of, they say they are committed to the achievement of staff satisfaction/development/well-being.
A4. Sort of, people are supported in developing themselves.
A5. Yes, I know that the organisation sees the staff as assets that are valuable.

Q33. What training do you receive?

A1. Training is provided when we need it on how to perform specific work tasks.
A2. There is a training programme related to specific work tasks, and we can request to go to specific training events if we want to.
A3. There is a training programme related to needs assessment (e.g., through appraisals or performance reviews), and provision is related to this.
A4. There is a training programme based on needs assessment and training is assessed for effectiveness. Training is provided on how to learn, and reflection is encouraged.
A5. There is a needs-based training programme that is assessed for effectiveness. Training is provided on the skills required for the future. Critical reflection is encouraged in work time.

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A1. No.
A2. I am supported if I ask for training related to my job.
A3. I feel supported in my professional development. There is a clear progression path for me.
A4. Yes, we are encouraged to develop ourselves professionally and personally. There is a clear

progression path for everyone. The organisation tries to ensure we are happy.
A5. Yes, professionally, and personally. The 'next generation' and 'highflyers' are actively encouraged. Progression is mapped for everyone, though it may involve leaving to progress.

Q35. Do you get recognition for doing a good job?

A1. No, what I do isn't noticed.
A2. No, but that is because of my line manager.
A3. Yes, but that is because of my line manager.
A4. The organisation tries to recognise when staff have done a good job, but there are no specific systems in place.
A5. There are systems, structures, and processes in place for the recognition/reward/progression of staff.
A6. Yes, the organisation does this well. There are recognition/reward/progression systems in place to ensure everyone who does a good job is recognised.

Alignment

Q36. How do you work with other teams?

A1. We all get on, but we don't really work together on things.
A2. We work with people from other teams on specific projects. Sometimes certain people from other teams will work with us.
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Q37. If a new member of staff joined your team, how would they know what to do?

A1. They would learn from other people doing the job.
A2. There is a manual that documents the standard work processes. Not everything is in it though.
A3. Everything is in the manual/practices and policies/job description.
A4. Everything is in the manual/practices and policies/job description. There is regular training to remind everyone.
A5. Everything is in the manual/practices and policies/job description, which are reviewed to ensure they are current. Training is regularly provided.

Q38. How does communication work in the organisation during collaboration?

A1. Limited information flows top down, from senior managers, to managers, to their staff.
A2. Information flows top down and goes up via the same route. Not everything is passed on by my manager/the managers in my team.
A3. Information flows top down and goes up via the same route.
A4. Information flows top down and bottom up. We are asked for our opinions. If my manager/the manager in my team is not good at passing things on, I can go directly.

A5. There are lots of ways of communicating, e.g., through the management structure, via meetings, through the newsletter, email people, or pop in for a chat.

Q39. How does the structure of the staff in organisation that is involve in research collaboration work?

A1. The structure makes it difficult to work and communicate with other teams.
A2. The structure doesn't really make much difference.
A3. The structure makes it easy to work and communicate with other teams, and to see how the work we do fits with the overall strategy.
A4. The structure makes it easy to work and communicate with other teams and see where we fit. It is flexible so it can adapt to changing circumstances.

Q40. What is the purpose of research collaboration by the organisation and how do you contribute to it?

Free text answers.

[new page]

Your feedback about the questionnaire

This questionnaire is in the very early stages of development. If you have any feedback about it, positive or negative, please comment below. Your comments will inform the next stage of its development.

Feedback on this questionnaire

Q41. Please leave your comments/feedback about the questionnaire. (Optional)

[new page]

Thank you for completing this questionnaire.

The results will be shared with the Library Director so s/he can provide feedback to me about the process. This feedback, and any feedback you gave in the last section, will be used in my research. The results of the questionnaire will not be used in my research.

Thank you for helping in my PhD research.
Best regards,
Ben Gold

APPENDIX N

Pretesting questionnaire for formal testing 1 (KTC)

Please select the statement that best describes how you see the situation at the university knowledge transfer centre.

I am looking for your opinions and feelings. Please give your initial ‘gut feeling’ answer.

Questions are mandatory unless marked otherwise.

Note that when you have clicked on the CONTINUE button your answers are submitted, and you cannot return to review or amend that page.

About you

Part of this survey looks at whether there are any differences in the answers from different parts of knowledge transfer centres.

To do this, we need to know your team and your collaboration with external parties.

The answers will be averaged across each team or level e.g., "The first contact team have an average score of ..." or "Staff at grade 6 have an average score of ..."

You answers will not be used to individually identify you. Individual responses will not be communicated to the University.

Q1. What team are you in?

A1. Administration (inc. Communication)
A2. IT Support
A3. Research services
A4. Collaboration Operations Team
A5. Teaching & Research Support
A6. Organisation Executive
A7. Help Team

Q2. What grade are you?

A1. 2
A2. 3
A3. 4
A4. 5
A5. 6
A6. 7
A7. 8
A8. 9
A9. ‘Senior Manager’

Management of Collaboration Support

Q3. Are you involved in the strategic planning or action / operational planning process?

A1. Yes [-> Q3a and Q3b are displayed]
A2. No [-> Q3a and Q3b are not displayed]

Q3a How is the strategic plan generated?

A1. There is no strategic plan
A2. There is a limited strategic plan
A3. The strategic plan is derived from reasonable/achievable feedback from users.
A4. The strategic plan is derived directly from user feedback OR from the University's strategic plan OR from awareness of developments at other universities.
A5. The strategic plan is derived from feedback from users, the University's strategic plan, and awareness of new developments at other universities.

Q3b. How are actions related to the strategic plan?

A1 Actions are solely reactive to events.
A2 The strategic plan includes 'big project' improvements, but many actions are unrelated to the strategic plan and are reactive to events.
A3 The strategic plan includes 'big project' improvements, although some actions are still unrelated to the strategic plan.
A4 The strategic plan includes 'big project' improvements.
A5 All improvement processes, both incremental and 'big project', flow from the strategic plan, and it is updated to reflect new developments.

Q4. Do you have any goals or targets for the work you do?

A1. No.
A2. Yes, but I am not sure what they are.
A3. Yes.
A4. Yes, there are team goals that come down through the management structure from the strategic plan.
A5. Yes, there are team goals that come from the strategic plan, and I have individual goals too.

Q5. In your experience, how is progress towards achieving targets or goals monitored?

A1. There is no monitoring of progress.
A2. There is some monitoring of progress.
A3. There is monitoring of progress, and corrective action is sometimes taken.
A4. Progress is closely monitored, and corrective action taken where necessary.

Q6. How is Collaboration research performance measured?

A1. We use statistical measures, e.g., spend per FTE, number of PCs, number of journals subscribed to, number of collaborative transactions.
A2. We use statistical measures and user feedback.

A3. We use user feedback and measures of internal processes relating to user expectations, e.g., time taken to complete projects.
A4. We use a range of performance indicators and have some KPIs (Key Performance Indicators).
A5. We use a range of balanced performance measures and the KPIs closely relate to the strategic aims. The measures are regularly evaluated.
A6. I don't know.

Q7. How are changes to services/processes/procedures managed?

A1. Changes are just implemented.
A2. It depends on what the change is and who is leading it.
A3. Changes are implemented through project management processes developed for that project.
A4. 'Big project' changes are implemented through standard project management processes, including planning, monitoring and impact assessment.
A5. All changes (incremental and 'big project') are implemented through standard project management processes.
A6. I don’t know.

Environmental sensing

Q8. How does the knowledge transfer centre gather feedback from its users?

A1. There are feedback/complaints forms, and users tell us/email us if they are not happy.
A2. We ask collaborating organisations boards, collaborating committees or via a survey. There are also feedback forms.
A3. We ask organisations using a range of methods, e.g., reflection meetings, surveys, focus groups, feedback boards.
A4. We use a range of methods to get feedback from all users (innovators, academic staff, researchers).
A5. We use a range of methods to get feedback from all users. We specifically gather feedback on the impact of any changes we make.
A6. I don’t know.

Q9. What happens to user feedback?

A1. We respond to it.
A2. We respond to it. Some of it is collated and reported.
A3. We respond to it. The feedback from course committees is collated, and the survey results are collated, but separately.
A4. We respond to it. It is collated across all feedback methods.
A5. We respond to it. It is collated across all feedback methods and analysed over time for trends.
A6. I don’t know.

Q10. How is user feedback responded to?

A1. We explain the reasons behind the problem, or how the user should be doing things.
A2. We explain the reasons behind the problem, or how the user should be doing things. Sometimes we decide to change things.
A3. We respond with details of the changes we have made or an explanation of why changes cannot be made.
A4. We respond with details of changes, including timescales for longer term changes. We make it clear that these changes are a result of feedback.
A5. We respond with details of changes, including timescales. We advertise the feedback we receive, and the changes made to address it.
A6. I don’t know.

Q11. What changes are made in response to user feedback?

A1. No changes are made in response to feedback.
A2. Some changes are made based on feedback if they are sensible and possible.
A3. Most feedback results in changes if we are able to do so.
A4. All feedback results in change (though some may be long term), including big changes requiring institutional funding and support.
A5. All feedback results in change. We also analyse trends and make changes in anticipation of what users will want.
A6. I don’t know.

Q12. How does collaborating organisations know what the knowledge transfer centre wants?

A1. They tell the Director what to do.
A2. The Director asks them what to do.
A3. The Director finds out from the University strategic plan.
A4. The Director finds out from the University strategic plan and the plans of other service departments.
A5. The Director knows what is going on in the University environments and monitors possible future directions. S/He proactively seeks their feedback on plans.
A6. I don't know.

Q13. How does knowledge transfer centre influence the changes the University wants to make?

A1. The University tells us what to change, not the other way round!
A2. The University sets the knowledge transfer plan for the year, and we agree to it.
A3. The knowledge transfer management decide what changes to make in response to the University strategic plan.
A4. The Director negotiates with the University and other departments about what changes to implement and how to do so. It is a two-way process.
A5. Knowledge transfer contributes to the wider University strategic planning process, not just those relating to collaborating organisations.
A6. I don't know.

Q14. How does knowledge transfercentres know what is going on in the same areas in other Universities?

A1. It doesn't.
A2. If we want to do something, we find out how others did the same thing. Some staff go to conferences.
A3. We find out the best practice relating to our work area. A range of staff go to conferences.
A4. Knowledge transfer centre gathers best practice information in all areas. We are all encouraged to read professional literature and attend conferences.
A5. Knowledge transfer centre gathers best practice information and we read professional literature and attend conferences. It looks at possible future directions.
A6. I don’t know.

Q15. How do Knowledge transfer centre staff interact with the wider profession?

A1. We don't.
A2. Most are on mailing lists.
A3. We can go to conferences or special interest groups if we want to. Some people have presented at conference or written articles.
A4. We contribute through publications, experience sharing and conferences. We can do research projects if it does not interfere with normal work.
A5. We are all encouraged to take part in research projects, publications, experience sharing, and conferences. Knowledge transfer centre is cutting edge in some areas.
A6. I don’t know.

<u>Organisational learning</u>

Q16. Who do you feel is allowed to make decisions?

A1. People don't really make decisions.
A2. Senior management.
A3. Managers.
A4. Anyone can make decisions about their own job.
A5. We can all make decisions about anything if we get permission to make that decision and consult with people.

Q17. Are you involved in changes?

A1. Only to point out the problems that they haven't thought of.
A2. Not really.
A3. I know about what the changes are. If it was relevant to my job, I would change what I do.
A4. Yes. If it is in my area or I am on a project group, I help to plan the changes.
A5. Yes, we come up with improvement ideas, and if they are approved, we implement them.

Q18. If you go on a course, what do you do with what you have learned?

A1. I use it in my work.
A2. I share what I have learned with the others in my team.
A3. I share what I have learned with others in my team, and other teams where it is relevant.
A4. I do a report that any research member can read/attend.

A5. I share it with the rest of the Knowledge transfer centre staff. We try to share learning, information, and knowledge. We all know who to go to for more information about a topic.

Q19. What happens if someone Knowledge transfer centre staff makes a mistake?

A1. We try to make up for it. If they find out, then you get the blame.
A2. We fix it and make sure that whoever made the mistake knows what the correct procedure is.
A3. We fix it and make sure that whoever made the mistake has more training or knows they can ask someone for help if they are unsure about something.
A4. We fix it and use it as an opportunity for learning
A5. We fix it and use it as an opportunity for learning. These things are going to happen if you are trying out new things.

Q20. Are you encouraged to take risks and try out new things?

A1. No - Knowledge transfer centre staff doesn't take risks.
A2. Not really. Knowledge transfer centre staff occasionally takes risks, but only if they are virtually guaranteed to work.
A3. Not really. If we are doing something new, we try to minimise the possible risks.
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Q21. Are you supported in trying to improve the service you provide in your job?

A1. No.
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<u>Attitude to change during collaboration projects</u>

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Q23. Where do you think the impetus to change comes from?

A1. From the Knowledge transfer centre staff.
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A4. From users and the University and technology.
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Q24. In your opinion, what is the main barrier to making changes?

A1. The structure/hierarchy/bureaucracy of Knowledge transfer centre.
A2. The attitudes of some organisation members of staff.
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A4. Other parts of the University.
A5. None - there is always a way to overcome barriers.

Q25. What sort of changes should Knowledge transfer centre staff make?

A1. None.
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<u>Attitude to collaboration quality</u>

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A3. We try to make sure our users are happy with what we do.
A4. We try to make sure our users are happy with what we do. We have service level agreements written by Knowledge transfer centre staff.
A5. We try to make sure our users are happy with what we do and anticipate what they want before they ask for it. We have service level agreements written by our customers.

Q27. How do you feel Knowledge transfer centre staff tries to improve quality?

A1. We make sure that everything is done properly.
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A2. Information flows top down and goes up via the same route. Not everything is passed on by my manager/the managers in my team.
A3. Information flows top down and goes up via the same route.
A4. Information flows top down and bottom up. We are asked for our opinions. If my manager/the manager in my team is not good at passing things on, I can go directly.
A5. There are lots of ways of communicating, e.g., through the management structure, via meetings, through the newsletter, email people, or pop in for a chat.

Q39. How does the staffing structure Knowledge transfer centre?

A1. The structure makes it difficult to work and communicate with other teams.
A2 The structure doesn't really make much difference.
A3. The structure makes it easy to work and communicate with other teams, and to see how the work we do fits with the overall strategy.
A4. The structure makes it easy to work and communicate with other teams and see where we fit. It is flexible so it can adapt to changing circumstances.

Q40. What is the purpose of Knowledge transfer centre and how do you contribute to it?

Free text answers.

APPENDIX O

Email recruiting respondents for formal testing 1 (Centre for Digital Business)

Dear sir / madam,

I hope you are all well. I have been working on my PhD, but I am glad to say that it is very nearly finished. However, I need to collect some feedback on a questionnaire I have developed.

I need feedback from a few universities and the Principal Investigator (PI) for Digital Business has kindly agreed to be one of them.

There are 40 multiple-choice questions, which should take 10-15 minutes to answer.

There is also a free-text question asking for your feedback about the questionnaire.

I realise that you are all busy, but I really hope that you can find 15 minutes to help me. The survey is open Monday 25th Feb - Friday 1st March. It is only open for 5 days as I have a lot of testing (and writing) to do before my hand-in deadline (typical student - leaving things to the last minute!).

The PI and the other members of Westminster will not be using the results of the questionnaire. It is purely to support me in my PhD. The PI will see the overall results, but only so that he can give me feedback on whether they would potentially be useful or not.

Thank you very much for your time,
You are welcome to contact me if you have any questions,

Best regards,

Ben

Ben Gold,

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APPENDIX P

Pretesting questionnaire for formal testing 2 (Centre for Digital Business)

Please select the statement that best describes how you see the situation at Brunel Library.

I am looking for your opinions and feelings. Please give your initial 'gut feeling' answer. Questions that ask for information have a DON'T KNOW option; questions that ask about your opinions do not.

Questions are mandatory unless marked otherwise.

Note that when you have clicked on the CONTINUE button your answers are submitted, and you cannot return to review or amend that page.

<u>About you</u>

Part of this survey looks at whether there are any differences in the answers from different parts of the Centre for Digital Business.

To do this, we need to know your team and your level/role.

The answers will be averaged across each team or level/role e.g., "Member's role have an average score of ..."

Your answers will not be used to individually identify you. Individual responses will not be communicated to the Centre for Digital Business.

Q1. What team are you in?

A1. Academic Services
A2. Publication Services
A3. Research Services
A4. Members Services
A5. Centre for Digital Business Team

Q2. What grade are you?

A1. S1
A2. S4
A3. S5
A4. S6
A5. H2
A6. H3
A7. H5

Management of the Library

Q3. Are you involved in the strategic planning or action / operational planning process?

A1. Yes [-> Q3a and Q3b are displayed]
A2. No [-> Q3a and Q3b are not displayed]

Q3a. How is the strategic plan generated?

A1. There is no strategic plan
A2. There is a limited strategic plan
A3. The strategic plan is derived from reasonable/achievable feedback from users.
A4. The strategic plan is derived directly from user feedback OR from the University's strategic plan OR from awareness of developments at other universities.
A5. The strategic plan is derived from feedback from users, the University's strategic plan, and awareness of new developments at other universities.

Q3b. How are actions related to the strategic plan?

A1. Actions are solely reactive to events.
A2. The strategic plan includes 'big project' improvements, but many actions are unrelated to the strategic plan and are reactive to events.
A3. The strategic plan includes 'big project' improvements, although some actions are still unrelated to the strategic plan.
A4. The strategic plan includes 'big project' improvements.
A5. All improvement processes, both incremental and 'big project', flow from the strategic plan, and it is updated to reflect new developments.

Q4. Do you have any goals or targets for the work you do?

A1. No.
A2. Yes, but I am not sure what they are.
A3. Yes.
A4. Yes, there are team goals that come down through the management structure from the strategic plan.
A5. Yes, there are team goals that come from the strategic plan, and I have individual goals too.

Q5. In your experience, how is progress towards achieving targets or goals monitored?

A1. There is no monitoring of progress.
A2. There is some monitoring of progress.
A3. There is monitoring of progress, and corrective action is sometimes taken.
A4. Progress is closely monitored, and corrective action taken where necessary.
A5. I don’t know because I have no targets.

Q6. How is the Centre for Digital Business performance measured?

A1. We use statistical measures, e.g., spend per FTE, number of PCs, number of journals subscribed to, number of transactions.

A2. We use statistical measures and user feedback.
A3. We use user feedback and measures of internal processes relating to user expectations.
A4. We use a range of performance indicators and have some KPIs (key performance indicators).
A5. We use a range of balanced performance measures and the KPIs closely relate to the strategic aims. The measures are regularly evaluated.
A6. I don't know.

Q7. How are changes to services/processes/procedures managed?

A1. Changes are just implemented.
A2. It depends on what the change is and who is leading it.
A3. Changes are implemented through project management processes developed for that project.
A4. 'Big project' changes are implemented through standard project management processes, including planning, monitoring and impact assessment.
A5. All changes (incremental and 'big project') are implemented through standard project management processes.
A6. I don't know.

Environmental sensing

Q8. How does the Centre for Digital Business gather feedback from its members?

A1. There are feedback/complaints forms, and users tell us/email us if they are not happy.
A2. We ask members at boards of study/course committees or via a survey. There are also feedback forms.
A3. We ask members using a range of methods, e.g., course committees, surveys, focus groups, feedback boards.
A4. We use a range of methods to get feedback from all members (students, academic staff, researchers).
A5. We use a range of methods to get feedback from all members. We specifically gather feedback on the impact of any changes we make.
A6. I don't know.

Q9. What happens to user feedback?

A1. We respond to it.
A2. We respond to it. Some of it is collated and reported.
A3. We respond to it. The feedback from committees is collated, and the survey results are collated, but separately.
A4. We respond to it. It is collated across all feedback methods.
A5. We respond to it. It is collated across all feedback methods and analysed over time for trends.
A6. I don't know.

Q10. How is user feedback responded to?

A1. We explain the reasons behind the problem or how members should be doing things.
A2. We explain the reasons behind the problem, or how members should be doing things. Sometimes we decide to change things.
A3. We respond with details of the changes we have made, or an explanation of why changes cannot be made.
A4. We respond with details of changes, including timescales for longer term changes. We make it clear that these changes are a result of feedback.
A5. We respond with details of changes, including timescales. We advertise the feedback we received, and the changes made to address it.
A6. I don't know.

Q11. What changes are made in response to members feedback?

A1. No changes are made in response to feedback.
A2. Some changes are made based on feedback if they are sensible and possible.
A3. Most feedback results in changes if we are able to do so.
A4. All feedback results in change (though some may be long term), including big changes requiring institutional funding and support.
A5. All feedback results in change. We also analyse trends and make changes in anticipation of what users will want.
A6. I don't know.

Q12. How does the Centre for Digital Business know what the University wants?

A1. They tell the PI what to do.
A2. The PI asks them what to do.
A3. The PI finds out from the University strategic plan.
A4. The PI finds out from the University strategic plan and the plans of other service departments.
A5. The PI knows what is going on in the University and monitors possible future directions. S/He proactively seeks their feedback on Centre for Digital Business plans.
A6. I don't know.

Q13. How does the Centre for Digital Business influence the changes the University wants to make?

A1. The University tells us what to change, not the other way round!
A2. The University sets the Centre for Digital Business plan for the year, and we agree to it.
A3. The Centre for Digital Business management decide what changes to make in response to the University strategic plan.
A4. The PI negotiates with the University and other departments about what changes to implement and how to do so. It is a two-way process.
A5. The Centre for Digital Business contributes to the wider University strategic planning process, not just those relating to the Centre for Digital Business.
A6. I don't know.

Q14. How does the Centre for Digital Business know what is going on in the same areas in other University Centre for Digital Business?

A1. It doesn't.
A2. If we want to do something, we find out how others did the same thing. Some members go to conferences.
A3. We find out the best practice relating to our work area. A range of members go to conferences.
A4. The Centre for Digital Business gathers best practice information in all areas. We are all encouraged to read professional literature and attend conferences.
A5. The Centre for Digital Business gathers best practice information and we read professional literature and attend conferences. It looks at possible future directions.
A6. I don’t know.

Q15. How do Centre for Digital Business members interact with the wider profession?

A1. We don't.
A2. Most are on mailing lists.
A3. We can go to conferences or special interest groups if we want to. Some people have presented at conference or written articles.
A4. We contribute through publications, experience sharing and conferences. We can do research projects if it does not interfere with normal work.
A5. We are all encouraged to take part in research projects, publications, experience sharing, and conferences. The Centre for Digital Business is cutting edge in some areas.
A6. I don’t know.

<u>Organisational learning</u>

Q16. Who do you feel is allowed to make decisions?

A1. People don't really make decisions.
A2. Senior management.
A3. Researchers.
A4. Anyone can make decisions about their own job.
A5. We can all make decisions about anything, if we get permission to make that decision and consult with members.

Q17. Are you involved in changes?

A1. Only to point out the problems that they haven't thought of.
A2. Not really.
A3. I know about what the changes are. If it was relevant to my job, I would change what I do.
A4. Yes. If it is in my area or I am on a project group I help to plan the changes.
A5. Yes, we come up with improvement ideas, and if they are approved, we implement them.

Q18. If you go on a course, what do you do with what you have learned?

A1. I use it in my work.
A2. I share what I have learned with the others in my team.
A3. I share what I have learned with others in my team, and other teams where it is relevant.
A4. I do a report that any Centre for Digital Business member can read/attend.
A5. I share it with the rest of the Centre for Digital Business members. We try to share learning, information, and knowledge. We all know who to go to for more information about a topic.

Q19. What happens if someone (members) makes a mistake?

A1. We try to make up for it. If management find out, then you get the blame.
A2. We fix it and make sure that whoever made the mistake knows what the correct procedure is.
A3. We fix it and make sure that whoever made the mistake has more training or knows they can ask someone for help if they are unsure about something.
A4. We fix it and use it as an opportunity for learning
A5. We fix it, and use it as an opportunity for learning. These things are going to happen if you are trying out new things.

Q20. Are you encouraged to take risks and try out new things?

A1. No - The Library doesn't take risks.
A2. Not really. The Centre for Digital Business occasionally takes risks, but only if they are virtually guaranteed to work.
A3. Not really. If we are doing something new, we try to minimise the possible risks.
A4. Yes, it is OK to take risks.
A5. Yes, it is better to do something and fail than to wait to be certain it will work and do nothing.

Q21. Are you supported in trying to improve the service you provide in your job?

A1. No.
A2. Yes, if it has been tried successfully somewhere else first.
A3. Yes.

<u>Attitude to change</u>

Q22. Is change a good thing?

A1. No, it is disruptive.
A2. It depends on what the change is. It can be good or bad.
A3 It is inevitable. It is good if it is done well.
A4. Yes, if it is done to improve things.
A5. Yes, it is essential.

Q23. Where do you feel the impetus to change comes from?

A1. From the Centre for Digital Business management team.
A2. From the Centre for Digital Business management team, though they are under pressure from the University.
A3. From users / the University / technology.
A4. From users and the University and technology.
A5. From everyone. The world is constantly changing, and we try to anticipate what our users will want before they ask for it.

Q24. In your opinion, what is the main barrier to making changes?

A1. The structure/hierarchy/bureaucracy of the university and Centre for Digital Business.
A2 The attitudes of some members of staff.
A3. Resources (money, space, time, staff).
A4. Other parts of the University.
A5. None - there is always a way to overcome barriers.

Q25. What sort of changes should the Centre for Digital Business make?

A1. None.
A2. To make sure we are doing things right.
A3. To improve the things, we are doing.
A4. To implement new products or services.
A5. Both to improve things we are doing and to implement new products or services.

<u>Attitude to quality</u>

Q26. How do you feel the Centre for Digital Business tries to provide a quality service?

A1. We make sure all our systems are as good as they can possibly be, and that everyone follows procedures properly.
A2. We try to provide excellent member's service.
A3. We try to make sure our members are happy with what we do.
A4. We try to make sure our users are happy with what we do. We have service level agreements written by Centre for Digital Business members.
A5. We try to make sure our users are happy with what we do and anticipate what they want before they ask for it. We have service level agreements written by our members.

Q2.7 How do you feel the Centre for Digital Business tries to improve research quality?

A1. We make sure that everything is done properly.
A2. We have constraints on what we can do (money / building etc.), so it can be down to luck and if we have the money or space to make improvements.
A3. We try to improve the products and services we offer. Collaboration quality is part of our strategic plan.
A4. We try to improve the processes we use to develop products and services. Collaboration quality and performance measures are part of our strategic plan.
A5. It is a continuous process. We are all encouraged to continually improve our work, and to

develop ourselves. Collaboration quality and performance measures are part of our strategic plan.

Q28. Who has responsibility for research quality?

A1. Collaboration quality is the responsibility of everyone to do their best to follow procedures.
A2. Collaboration quality is the responsibility of people front of house to give excellent customer service.
A3. Collaboration quality is the responsibility of the Centre for Digital Business, though it may be devolved down to managers for specific areas.
A4. Collaboration quality for a particular area is the responsibility of the people in that area.
A5. Collaboration quality for the whole Centre for Digital Business is everyone's responsibility.

<u>Leadership</u>

Q29. Do you know what the vision and values are that PI has set out for the Centre for Digital Business?

A1. Yes. [-> Q29a is displayed]
A2. No. [-> Q29a is not displayed]

Q29a. How do you know?

A1. I have seen them written down somewhere.
A2. We had a briefing document/presentation/workshop where we were told about them.
A3. They were talked about during my induction.
A4. They are part of what we do (policies, targets, development).
A5. They are who we are. It is how everyone behaves.

Q30. Do you trust management?

A1. No.
A2. I'm sure they are doing their best, but they don't really understand.
A3. I don't distrust them.
A4. Yes, you must trust them to do their job.
A5. Yes, it is clear from what they have done in the past that they know what to do for the best of the Centre for Digital Business.

Q31. Do you feel motivated to do the best you can?

A1. Not really.
A2. I do personally, but it is difficult. You lose enthusiasm.
A3. Yes, I do.
A4. Yes, as a team we always do our best.
A5. Yes, we all do. The PI is inspirational, and everything is in place to support you in doing so.

<u>Investment in staff</u>

Q32. Do you feel valued by the Centre for Digital Business?

A1. Not really.
A2. Not really, but we receive training that we want/need.
A3. Sort of, they say they are committed to the achievement of staff satisfaction/development/well-being.
A4. Sort of, people are supported in developing themselves.
A5. Yes, I know that the Centre for Digital Business sees members as its most assets.

Q33. What training do you receive?

A1. Training is provided when we need it on how to perform specific work tasks.
A2. There is a training programme related to specific work tasks, and we can request to go to specific training events if we want to.
A3. There is a training programme related to needs assessment (e.g., through appraisals or performance reviews), and provision is related to this.
A4. There is a training programme based on needs assessment and training is assessed for effectiveness. Training is provided on how to learn, and reflection is encouraged.
A5. There is a needs-based training programme that is assessed for effectiveness. Training is provided on the skills required for the future. Critical reflection is encouraged in work time.

Q34. Do you feel supported in your development?

A1. No.
A2. I am supported if I ask for training related to my job.
A3. I feel supported in my professional development. There is a clear progression path for me.
A4. Yes, we are encouraged to develop ourselves professionally and personally. There is a clear progression path for everyone. The Centre for Digital Business tries to ensure we are happy.
A5. Yes, professionally and personally. The 'next generation' and 'highflyers' are actively encouraged. Progression is mapped for everyone, though it may involve leaving to progress.

Q35. Do you get recognition for doing a good job?

A1. No, what I do isn't noticed.
A2. No, but that is because of my line manager.
A3. Yes, but that is because of my line manager.
A4. The Centre for Digital Business tries to recognise when staff have done a good job, but there are no specific systems in place.
A5. There are systems, structures, and processes in place for the recognition/reward/progression of staff.
A6. Yes, the Centre for Digital Business does this well. There are recognition / reward / progression systems in place to ensure everyone who does a good job is recognised.

<u>Alignment</u>

Q36. How do you work with other teams?

A1. We all get on, but we don't really work together on things.
A2. We work with people from other teams on specific projects. Sometimes certain people from other teams will work with us.

A3. We work regularly with a specific other team.
A4. We have a system of 'internal customer' between teams.
A5. We all work together. If one part of the system is not working well, then the whole system might break.

Q37. If a new member joined your team, how would they know what to do?

A1. They would learn from other people doing the job.
A2. There is a manual that documents the standard work processes. Not everything is in it though.
A3. Everything is in the manual/practices and policies/job description.
A4. Everything is in the manual/practices and policies/job description. There is regular training to remind everyone.
A5. Everything is in the manual/practices and policies/job description, which are reviewed to ensure they are current. Training is regularly provided.

Q38. How does communication work in the Centre for Digital Business?

A1. Limited information flows top down, from senior managers, to managers, to their staff.
A2. Information flows top down and goes up via the same route. Not everything is passed on by my manager/the managers in my team.
A3. Information flows top down and goes up via the same route.
A4. Information flows top down and bottom up. We are asked for our opinions. If my manager/the manager in my team is not good at passing things on, I can go directly.
A5. There are lots of ways of communicating, e.g., through the management structure, via meetings, through the newsletter, email people, or pop in for a chat.

Q39. How does the staffing structure of the Centre for Digital Business work?

A1. The structure makes it difficult to work and communicate with other teams.
A2. The structure doesn't really make much difference.
A3. The structure makes it easy to work and communicate with other teams, and to see how the work we do fits with the overall strategy.
A4. The structure makes it easy to work and communicate with other teams and see where we fit. It is flexible so it can adapt to changing circumstances.

Q40. What is the purpose of the Centre for Digital Business, and how do you contribute to it?

Free text answers.

APPENDIX Q

Email recruiting respondents for formal testing 2 (NHS Digital Trust)

Dear sir / madam,
I hope you are all well. L will appreciate your assistance in finishing my PhD is very nearly. I need to collect some feedback on a questionnaire I have developed. I need feedback from a few digital technology firms and as Olaniyi, has kindly informed you and agreed for NHS Trust department to be one of them. The questionnaire is online here:
https://surveys.reading.ac.uk/qmmreading

There are 40 multiple-choice questions, which should take 10-15 minutes to answer. There is also a free-text question asking for your feedback about the questionnaire.

I realise that you are all busy, but I really hope that you can find 15 minutes to help me. The survey is open Monday 11th March - Friday 15th March. It is only open for 5 days as I have a lot of testing (and writing) to do before my hand-in deadline (typical student - leaving things to the last minute!).

The department might use the results of the questionnaire depending on if it reveals anything interesting. However, the reason for your participating is to support me in my PhD.

Thank you very much for your time, You are welcome to contact me if you have any questions,

Best regards,
Ben

Ben Gold

APPENDIX R

The Quality Culture Assessment Instrument

Please select the statement that best describes how you see the situation at <DT name>. You may only select one answer for each question. If no answer exactly matches your opinion, please select the closest one.

I am looking for your opinions and feelings. Please give your initial 'gut feeling' answer.

Questions that ask for information have a Don't Know option; questions that ask about your opinions do not.

Questions are mandatory unless marked otherwise.

About you

Part of this survey looks at whether there are any differences in the answers from different parts of the Digital Technology Firms.

To do this, we need to know your team and your grade.

The answers will be averaged across each team or level, e.g., "The research team have an average score of ...".

Your answers will not be used to individually identify you. Individual responses will not be communicated to the NHS.

Q1. What team are you in?

A1. <list team names> ...
Ax.

Q2. What grade are you?

A1. <list roles> ...
Ax .

<u>Management of the Centre for Digital Department</u>

Q3. Are you involved in the strategic planning or action / operational planning process?

A1. Yes -> complete Q3a and Q3b
A2. No

Q3a. How is the strategic plan generated?

A1. There is no strategic plan.
A2. There is a limited strategic plan that only covers some areas.

A3. The strategic plan is derived from reasonable/achievable feedback from users.
A4. The strategic plan is derived directly from user feedback OR from the University's strategic plan OR from awareness of developments at other universities.
A5. The strategic plan is derived from feedback from users, the University's strategic plan, AND awareness of new developments at other universities.

Q3b. How are actions related to the strategic plan?

A1. Actions are solely reactive to events.
A2. The strategic plan includes some 'big project' improvements, but many actions are unrelated to the strategic plan and are reactive to events.
A3. The strategic plan includes 'big project' improvements, although some actions are still unrelated to the strategic plan.
A4. The strategic plan includes 'big project' improvements.
A5. All improvement processes, both incremental and 'big project', flow from the strategic plan, and it is updated to reflect new developments.

Q4. Do you have any goals or targets for the work you do?

A1. No.
A2. Yes, but I am not sure what they are.
A3. Yes.
A4. Yes, there are team goals that come down through the management structure from the strategic plan.
A5. Yes, there are team goals that come from the strategic plan, and I have individual goals too.

Q5. In your experience, how is progress towards achieving targets or goals monitored?

A1. There is no monitoring of progress.
A2. There is some monitoring of progress.
A3. There is monitoring of progress, and corrective action is sometimes taken.
A4. Progress is closely monitored, and corrective action taken where necessary.
A5. I don't know because I have no targets.

Q6. How is the Department's performance measured?

A1. We use statistical measures, e.g., spend per FTE, number of PCs, number of journals subscribed to, number of transactions (i.e., health innovation tools).
A2. We use statistical measures and user feedback.
A3. We use statistical measures, user feedback and measures of internal processes relating to user expectations, e.g., time taken to launch innovative health tools.
A4. We use a range of performance indicators and have some key performance indicators (KPIs).
A5. We use a range of balanced performance measures, and the Key Performance Indicators closely relate to the strategic aims. The measures are regularly evaluated.
A6. I don't know.

Q7. How are changes to services/processes/procedures managed?

A1. Changes are just implemented.
A2. It depends on what the change is and who is leading it.
A3. Changes are implemented through project management processes developed for that project.
A4. 'Big project' changes are implemented through standard project management processes, including planning, monitoring, and impact assessment.
A5. All changes (incremental and 'big project') are implemented through standard project management processes.
A6. I don't know.

Environmental sensing

Q8. How does the Department gather feedback from its users?

A1. There are feedback/complaints forms, and users tell us/email us if they are not happy.
A2. There are feedback/complaints forms, and users tell us/email us if they are not happy. We ask students at boards of study/course committees or via a survey.
A3. We ask students using a range of methods, e.g., NHS committees, surveys, focus groups, feedback boards, feedback/complaints forms, encourage them to email us.
A4. We use a range of methods and get feedback from all users (NHS, academic staff, researchers).
A5. We use a range of methods to get feedback from all users (NHS, academic staff, researchers). We specifically gather feedback on the impact of any changes we make by taking a 'snapshot' before and after the change.
A6. I don't know.

Q9. What happens to user feedback?

A1. We respond to it.
A2. We respond to it. Some of it is collated and reported.
A3. We respond to it. All the feedback is collated and reported but separately for each method of obtaining it.
A4. We respond to it. All the feedback is collated, across all methods to give a 'big picture'.
A5. We respond to it. All the feedback is collated, across all methods to give a 'big picture'. It is analysed over time for trends.
A6. I don't know.

Q10. How is user feedback responded to?

A1. We explain the reasons behind the problem, or how the NHS user should be doing things.
A2. We explain the reasons behind the problem, or how the user should be doing things. Sometimes we decide to change things.
A3. We respond with details of the changes we have made, or an explanation of why changes cannot be made.
A4. We respond with details of changes, including timescales for longer term changes. We make it clear that these changes are a result of feedback.

A5. We respond with details of changes, including timescales. We advertise the feedback we received and the changes we have made to address it.
A6 I don't know.

Q11. What changes are made in response to NHS user feedback?

A1. No changes are made in response to feedback.
A2. Some changes are made based on feedback if they are sensible and possible.
A3. Most feedback results in changes if we have the resources to do so.
A4 All feedback results in change (though some may be long term), including big changes requiring institutional funding and support.
A5. All feedback results in change. We also analyse trends and make changes in anticipation of what users will want.
A6. I don't know.

Q12. How does the Department know what the NHS wants?

A1. They tell the Director what to do.
A2. The Director asks them what to do.
A3. The Director finds out from the NHS strategic plan.
A4. The Director finds out from the NHS strategic plan and the plans of other service departments.
A5. The Director knows what is going on in the NHS and monitors possible future directions. S/He proactively seeks their feedback on Department plans.
A6. I don't know.

Q13. How does the Department influence the changes the University wants to make during research collaboration?

A1. The University tells us what to change, not the other way round!
A2. The University sets the Department plan for the year, and we agree to it.
A3. The Library management decide what changes to make in response to the University strategic plan.
A4. The Director negotiates with the University and other departments about what changes to implement and how to do so. It is a two-way process.
A5. The Department contributes to the wider NHS strategic planning process, not just those relating to the collaborations with the University.
A6. I don't know.

Q14. How does the Department know what is going on in the same areas in other Universities?

A1. It doesn't.
A2. If we want to do something, we find out how others did the same thing. Some staff go to conferences.
A3. We find out the best practice relating to our work area. A range of staff go to conferences.
A4. The NHS gathers best practice information in all areas. We are all encouraged to read professional literature and attend conferences.
A5. The NHS gathers best practice information and we read professional literature and attend

conferences. It looks at possible future directions.
A6. I don't know.

Q15. How do Department staff interact with the wider profession?

A1. We don't.
A2. Most are on mailing lists.
A3. We can go to conferences or special interest groups if we want to. Some people have presented at conference or written articles.
A4 We contribute through publications, experience sharing and conferences. We can do research projects if it does not interfere with normal work.
A5. We are all encouraged to take part in research projects, publications, experience sharing, and conferences. The NHS is cutting edge in some areas.
A6. I don't know.

<u>Organisational learning</u>

Q16. Who do you feel is allowed to make decisions?

A1. People don't really make decisions.
A2. Senior management.
A3. Managers / professional staff.
A4. Anyone can make decisions about their own job.
A5. We can all make decisions about anything if we get permission to make that decision and consult with people.

Q17. Are you involved in changes?

A1. Only to point out the problems that they haven't thought of.
A2. Not really.
A3. I know about what the changes are. If it was relevant to my job, I would change what I do.
A4. Yes. If it is in my area or I am on a project group I help to plan the changes.
A5 Yes, we come up with improvement ideas, and if they are approved, we implement them.

Q18. If you go on a course, what do you do with what you have learned?

A1. I use it in my work.
A2. I share what I have learned with the others in my team.
A3. I share what I have learned with others in my team, and other teams where it is relevant.
A4. I share it with others in my team, and any other Library staff member who is interested (e.g., through circulated report or presentation).
A5. I share it with the rest of the Library staff. We try to share learning, information, and knowledge. We all know who to go to for more information about a topic.

Q19. What happens if someone (Department staff) makes a mistake?

A1. We try to make up for it. If management find out, then you get the blame.
A2 We fix it and make sure that whoever made the mistake knows what the correct procedure is.

A3. We fix it and make sure that whoever made the mistake has more training or knows they can ask someone for help if they are unsure about something.
A4. We fix it, and use it as an opportunity for learning.
A5. We fix it, and use it as an opportunity for learning. These things are going to happen if you are trying out new things.

Q20. Are you encouraged to take risks and try out new things?

A1. No - The NHS doesn't take risks.
A2. Not really. The NHS occasionally takes risks, but only if they are virtually guaranteed to work.
A3. Not really. If we are doing something new, we try to minimise the possible risks.
A4. Yes, it is OK to take risks.
A5. Yes, it is better to do something and fail than to wait to be certain it will work and do nothing.

Q21. Are you supported in trying to improve the service you provide in your job?

A1. No.
A2. Yes, if it has been tried successfully somewhere else first.
A3. Yes.

Attitude to change

Q22. Is change a good thing?

A1. No, it is disruptive.
A2. It depends on what the change is. It can be good or bad.
A3 It is inevitable. It is good if it is done well.
A4. Yes, if it is done to improve things.
A5. Yes, it is essential.

Q23. Where do you think the impetus to change come from?

A1. From the NHS Trust team.
A2. From the Department management team, though they are under pressure from the University.
A3. From NHS users / the University / technology.
A4. From NHS users and the University and technology.
A5. From everyone. The world is constantly changing, and we try to anticipate what our users will want before they ask for it.

Q24. In your opinion, what is the main barrier to making changes?

A1. The structure/hierarchy/bureaucracy of the NHS Trust.
A2. The attitudes of some members of staff.
A3. Resources (money, space, time, staff).
A4. Other parts of the University.
A5. None - there is always a way to overcome barriers.

Q25. What sort of changes should the NHS Trust make for the Department collaboration with the University?

A1. None.
A2. To make sure we are doing things right.
A3. To improve the things, we are doing.
A4. To implement new products or services.
A5. Both to improve things we are doing and to implement new products or services.

Attitude to quality

Q26. How do you feel the NHS Trust tries to provide a quality service?

A1. We make sure all our systems are as good as they can possibly be, and that everyone follows procedures properly.
A2. We try to provide excellent customer service.
A3. We try to make sure our users are happy with what we do.
A4. We try to make sure our users are happy with what we do. We have service level agreements written by Library staff.
A5. We try to make sure our users are happy with what we do and anticipate what they want before they ask for it. We have service level agreements written by our customers.

Q27. How do you feel the NHS Trust tries to improve quality?

A1. We make sure that everything is done properly.
A2. It depends whether we have the resources available at the time the suggestion for improvement is made.
A3. We try to improve the products and services we offer. Quality is part of our strategic plan.
A4. We try to improve the processes we use to develop products and services. Quality and performance measures are part of our strategic plan.
A5. It is a continuous process. We are all encouraged to continually improve our work, and to develop ourselves. Quality and performance measures are part of our strategic plan.

Q28. Who has responsibility for quality?

A1. Collaboration quality is the responsibility of everyone to do their best to follow procedures.
A2. Collaboration quality is the responsibility of people front of house to give excellent customer service.
A3. Collaboration quality is the responsibility of the NHS Trust management team, though it may be devolved down to managers for specific areas.
A4. Collaboration quality is the responsibility of the Quality Officer.
A5. Collaboration quality for a particular area is the responsibility of the people in that area.
A6. Collaboration quality for the whole NHS is everyone's responsibility.

Leadership

Q29. Do you know what the vision and values are that <director> has set out for the Department?

A1. Yes. -> complete Q29a
A2. No.

Q29a. How do you know?

A1. I have seen them written down somewhere.
A2. We had a briefing document/presentation/workshop where we were told about them.
A3. They were talked about during my induction.
A4. They are part of what we do (policies, targets, development).
A5. They are who we are. It is how everyone behaves.

Q30. Do you trust NHS Trust and Department management?

A1. No.
A2. I'm sure they are doing their best, but they don't really understand.
A3. I don't distrust them.
A4. Yes, you must trust them to do their job.
A5. Yes, it is clear from what they have done in the past that they know what to do for the best of the NHS Trust and Department management.

Q31. Do you feel motivated to do the best you can?

A1. Not really.
A2. I do personally, but it is difficult. You lose enthusiasm.
A3. Yes, I do.
A4. Yes, as a team we always do our best.
A5. Yes, we all do. The NHS Trust and Department management team is inspirational, and everything is in place to support you in doing so.

<u>Investment in staff</u>

Q32. Do you feel valued by the NHS Trust and Department management?

A1. Not really.
A2. Not really, but we receive training that we want/need.
A3. Sort of, they say they are committed to the achievement of staff satisfaction/development/well-being.
A4. Sort of, people are supported in developing themselves.
A5. Yes, I know that the NHS Trust and Department management sees the staff as its most asset.

Q33. What training do you receive?

A1. Training is provided when we need it on how to perform specific work tasks.
A2. There is a training programme related to specific work tasks, and we can request to go to specific training events if we want to.
A3. There is a training programme related to needs assessment (e.g., through appraisals or performance reviews), and provision is related to this.
A4. There is a training programme based on needs assessment and training is assessed for effectiveness. Training is provided on how to learn, and reflection is encouraged.

A5. There is a needs-based training programme that is assessed for effectiveness. Training is provided on the skills required for the future. Critical reflection is encouraged in work time.

Q34. Do you feel supported in your development?

A1. No.
A2. I am supported if I ask for training related to my job.
A3. I feel supported in my professional development. There is a clear progression path for some people.
A4. Yes, we are encouraged to develop ourselves professionally and personally. There is a clear progression path for everyone. The NHS Trust and Department management tries to ensure we are happy.
A5. Yes, professionally, and personally. The 'next generation' and 'highflyers' are actively encouraged. Progression is mapped for everyone, though it may involve leaving to progress.

Q35. Do you get recognition for doing a good job?

A1. No, what I do isn't noticed.
A2. No, but that is because of my line manager.
A3. Yes, but that is because of my line manager.
A4. The NHS Trust and Department management tries to recognise when staff have done a good job, but there are no specific systems in place.
A5. There are systems, structures, and processes in place for the recognition/reward/progression of staff.
A6. Yes, the Library does this well. There are recognition/reward/progression systems in place to ensure everyone who does a good job is recognised.

Alignment

Q 36. How do you work with other teams?

A1. We all get on, but we don't really work together on things.
A2. We work with people from other teams on specific projects. Sometimes certain people from other teams will work with us.
A3. We work regularly with a specific other team.
A4. We have a system of 'internal customer' between teams.
A5. We all work together, with a system of ‘internal users. If one part of the system is not working well, then the whole system might break.

Q37. If a new member of staff joined your team, how would they know what to do?

A1. They would only learn from other people doing the job. There is no manual.
A2. There is a manual that documents the standard work processes. Not everything is in it though so they would learn some things from people doing the job.
A3. Everything is in the manual/practices and policies/job description.
A4. Everything is in the manual/practices and policies/job description. There is regular training to remind everyone.

A5. Everything is in the manual/practices and policies/job description, which are reviewed to ensure they are current. Training is regularly provided.

Q38. How does communication work in the NHS Trust and Department management?

A1. Limited information flows top down, from senior managers, to managers, to their staff.
A2. Information flows top down and goes up via the same route. Not everything is passed on by my manager/the managers in my team.
A3. Information flows top down and goes up via the same route.
A4. Information flows top down and bottom up. We are asked for our opinions. If my manager/the manager in my team is not good at passing things on, I can find a way round them.
A5. There are lots of ways of communicating, e.g., through the management structure, via meetings, through the newsletter, email people, or pop in for a chat.

Q39. How does the staffing structure of the NHS Trust and Department management work?

A1. The structure makes it difficult to work and communicate with other teams.

A2. The structure doesn't really make much difference.
A3. The structure makes it easy to work and communicate with other teams, and to see how the work we do fits with the overall strategy.
A4. The structure makes it easy to work and communicate with other teams and see where we fit. It is flexible so it can adapt to changing circumstances.

Q40. What is the purpose of the NHS Trust and Department management and how do you contribute to it?

Free text answers.

APPENDIX S

Rubric for mapping Quality Culture Assessment Instrument answers onto the QMM.

CMM Element	CCAI Question No	CCAI Answer	CMM Score
1.1.	Q3a	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
1.2a.	Q3b	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
1.2b.	Q4	All A1 or A2	Level 1
		A1 or A2, except organisation executive (A3, A4 or A5)	Level 2
		Senior staff A3, A4 or A5 A4	Level 3
		A4	Level 4
		A5	Level 5
1.3.	Q5	A1	Level 1/ Level 2
		A2	Level 3
		A3	Level 4
		A4	Level 5
		A5	Level 1/ Level 2
1.4.	Q6	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
		A6 non-senior staff	Ignore
		A6 PI	Level 1
1.5.	Q7	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
		A6	Ignore
2.1.	Q8	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
		A6	Ignore
2.2.	Q9	A1	Level 1
		A2	Level 2

		A3	Level 3
		A4	Level 4
		A5	Level 5
		A6	Ignore
2.3.	Q10	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
		A6	Ignore
2.4.	Q11	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
		A	Ignore
2.5.	Q12	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
		A6	Ignore
2.6.	Q13	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
		A6	Ignore
2.7.	Q14	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
		A6	Ignore
2.8.	Q15	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
		A6	Ignore
3.1.	Q16	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
3.2.	Q17	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
3.3.	Q18	A1	Level 1
		A2	Level 2

		A3	Level 3
		A4	Level 4
		A5	Level 5
3.4.	Q19	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
3.5.	Q20	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
3.6.	Q21	All A1	Level 1
		All A1, except organisation executive (A2 or A3)	Level 2
		Senior staff A2 or A3, other staff A1	Level 3
		Managers / professional staff A3, junior staff A1	Level 4
		All A3	Level 5
4.1.	Q22	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
4.2.	Q23	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
4.3.	Q24	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
4.4.	Q25	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
5.1.	Q26	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
5.2.	Q27	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
5.3.	Q28	A1	Level 1
		A2	Level 2

		A3	Level 3
		A4	Level 3
		A5	Level 4
		A6	Level 5
6.1.	Q29	A2	Level 1
	Q29a	A1	Level 2
		A2	Level 3
		A3	Level 3
		A4	Level 4
		A5	Level 5
6.2.	Q30	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
6.3.	Q31	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
7.1.	Q32	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
7.2.	Q33	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
7.3.	Q34	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
7.4.	Q35	A1	Level 1
		A2	Level 2
		A3	Level 2
		A4	Level 3
		A5	Level 4
		A6	Level 5
8.1.	Cross tabulate responses to all Qs by Q2	There are no similarities in the pattern of responses.	Level 1 / Level 2
		The pattern of responses is similar between certain grades.	Level 3
		The pattern of responses is the same aside from specific and discrete areas.	Level 4
		The pattern of responses is the same.	Level 5
8.2.	Q36	A1	Level 1
		A2	Level 2
		A3	Level 3

		A4	Level 4
		A5	Level 5
8.3.	Q37	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
8.4.	Q38	A1	Level 1
		A2	Level 2
		A3	Level 3
		A4	Level 4
		A5	Level 5
8.5.	Q39	All A1	Level 1
		Some A1	Level 2
		A2 (no A1)	Level 3
		A3 (no A1)	Level 4
		A4 (no A1)	Level 5
8.6.	Q40	Approach to the purpose of the organisation is dependent on respondent's specific work.	Level 1
		Approach to the purpose of the organisation is dependent on respondent's work unit or area.	Level 2
		All understand the overall aims and purpose of the organisation. Most understand their contribution to achieving them.	Level 3
		All understand the overall aims of the organisation and their contribution to achieving them. Organisation executive understand how all staff contribute to the achievement of organisation aims.	Level 4
		All understand how the overall aims of the organisation contribute to the achievement of the aims of the parent organisation, and how they contribute to achieving them.	Level 5
8.7.	Cross tabulate responses to Q26, Q27, Q28 by Q1 and (separately) by Q2	There is no similarity in the pattern of responses.	Level 1 / Level 2
		The pattern of responses is similar (but not the same), or the same between certain groups.	Level 3
		The pattern of responses is the same apart from specific and discrete areas.	Level 4
		The pattern of responses is the same.	Level 5
8.8.	Cross tabulate responses to Q22, Q23, Q24, Q25 by Q1 and	There is no similarity in the pattern of responses.	Level 1

	(separately) by Q2		
		The pattern of responses is the same between certain groups.	Level 2
		The pattern of responses is the same within team / location / grade.	Level 3
		The pattern of responses is the same apart from specific and discrete areas.	Level 4
		The pattern of responses is the same.	Level 5

APPENDIX T

Guidance for Deploying the Collaboration Research Culture Assessment Instrument

The Collaboration Research Culture Assessment Instrument is a questionnaire of 40 questions. All but one of the questions requires the respondent to select an answer from a multiple-choice list. All questions are mandatory. Most respondents find it takes around 15 minutes to complete the questionnaire.

General Guidance

There is an optimism on the role that assessment technology tool can play to support research collaboration culture and learning. Digital assessment tool facilitates remote and cross-cultural collaboration, enable synchronous (real-time) and asynchronous interaction, and support digital proficiency through exposure to new assessment tools. Technology also allows for learning efforts to be adapted and personalised according to the needs of an individual, as well as for nearly real-time feedback to enable reflective practice by both learners and instructors. While there are many benefits of online collaboration and learning, it also presents challenges. Online collaboration and learning can exclude people who don't have access to devices or the internet, online platforms can sometimes be less understood to use, and learners may not have enough digital literacy to fully participate. Fortunately, there are ways to mitigate at least some of these challenges.

Also consider the context in which the tool will be used. Every context has its own unique needs; for instance, a research group in a developing country or an environment that the development of digital technologies is not encouraged may need a different tool than a research group that is in a country that the development of its digital technologies is part of it strategic economic policies with even a top government official or department to oversee its growth. In addition, a participant's digital literacy level, type of digital device, or even their location or the amount of time they have, are central for determining the best tool to use. To help apply the assessment from this digital tool to specific contexts for working and learning, the following tips might be useful.

Technology's potential to support working, learning, and research collaboration culture is only as powerful as the way in which it's applied. For example, when deciding on a tool to support a specific function, we must evaluate whether people are more likely to access content from mobile or desktop, whether they will be willing to absorb the learning content and how comfortable they are with using familiar personal platforms for professional purposes. These "analogue" components determine the success or failure of digital tools (World Bank, 2016).

Tips Relevant for Tailoring

Before you run it at your institution assessment, you must tailor it for your organisation to ensure the results are meaningful and the respondents are able to answer the questions.

You should insert the name of your institution and director where indicated. The questionnaire refers to "the organisational research collaboration assessment" throughout, if your institution or organisation is known by a different name, you should replace "the organisational research collaboration assessment" with the exact name (this is particularly important in converged services where institution or organisation may be viewed by some as only a department which is a part of the service, not the whole). You should go through each question and answer to make sure that the language used, especially the terminology, will be understood by your respondents to have the intended meaning.

Questions 1 and 2 require that you provide a list of answers that are appropriate to your situation. Question 1 is used to aggregate the responses by team. You should choose team names that staff members will identify with, and an appropriate level of granularity for the results to be useful to you. Question 2 is used to aggregate responses by the level of the staff member within the organisational hierarchy. You should choose an answer list that will do this and be meaningful to your situation (the questionnaire used Grade, but you may use job title, or any other description). If you have a multi-site service, you may want to add a third question to the 'About You' section – asking where respondents work. You can then aggregate the results by location if you want to.

Tips Relevant for Administration

The instrument should be administered using an online survey tool, such as Survey Monkey, Bristol Online Surveys, or an in-house application. To provide a complete and accurate picture as possible, you should administer the questionnaire to all members of staff at your institution or organisation and aim for a 100% response rate. Questionnaires of this nature receive the best response rate if run on a relatively short timescale (e.g., possibly not more than three weeks), though you will need to consider the timing to ensure no particular groups are unable to complete it.

Tips Relevant for Data Protection

You must take care to ensure that the data provided by respondents is held anonymously and securely in accordance with data protection rules. This is your responsibility. You must also take care to ensure that the minimum number of people have access to the raw data, as it would be possible in most institution or organisation to determine who had provided a particular response by combining the responses to the attribute questions. The survey administrator should aggregate and analyse the data before reporting it to anyone.

Tips Relevant for Analysing the Results

The responses to each question on the instrument should be aggregated. The mode average response (i.e., most frequent) is taken as the 'result'. You should use the rubric for mapping answers on to the level of an element of the Collaboration Maturity Model.

Three of the elements of quality culture (8.1, 8.7, 8.8) do not have questions on the instrument. Instead, these are assessed by cross tabulating the answers to specific other questions by team membership and/or level within the hierarchy.

If the responses are spread over several answers, the results should be cross tabulated against team membership and level in the hierarchy to see if this produces different responses between groups and the same responses within groups. If so, these differences should be reported. If no groupings can be determined, then the main modal responses should be reported.

APPENDIX U

Rubric for Mapping Answers on Level of an Element of the CMM

	Level 1 Ad hoc	Level 2 Aware	Level 3 Defined	Level 4 Managed	Level 4 Continuous
Management of the organisation					
Strategic plan					
Management of alignment (achieve strategic plan)					
Progress monitoring					
Performance measurement					
Research project management process					
Environmental sensing					
Stakeholders (bottom up)					
Partners - Gathering feedback					
Partners - Collation of feedback					
Partners - Action because of feedback					
Stakeholders (top down)					
Organisation - Gathering feedback					
Organisation - Influencing organisational decisions					
Wider context (inside out)					
Wider context - Involvement of staff in profession					
Wider context - Gathering feedback					
Wider context - Contribution to profession					
Learning organisation					
Staff empowerment					
Staff involvement in change					
Nature / level of learning					
Attitude to mistakes					
Attitude to risk					
Staff encouragement to innovate and creativity					

Attitude to change					
Attitude to change					
Perception of drivers for change					
Attitude to research collaboration and innovation					
Definition of collaboration (including locus of control)					
Attitude to research collaboration improvement					
Perception of responsibility for research collaboration improvement					
Types of collaboration improvement initiatives					
Leadership					
Vision and value setting					
Trust					
Inspiration and motivation					
Investment in staff					
Attitude to staff (as an asset)					
Training provision					
Development of staff					
Recognition of staff					
Alignment					
Vertical alignment					
Horizontal alignment					
Consistency					
Communication flow					
Staff recognition of where they fit into the overall scheme					
Structure					
Alignment of attitude to research collaboration and creative innovation					
Alignment of attitude to change					