A STUDY OF THE INDUSTRY/UNIVERSITY/GOVERNMENT (UIG) COLLABORATIVE PROJECT ORGANISATION

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ABSTRACT

Research projects are a subset of project management that is gaining attention. Primarily driven by the need for innovation to boost economic growth. This need has brought with it an impetus for researchers to work together between enterprises and gain the benefits of cross-sector collaboration.

The surge of interest has been attributed to the increased importance of collaboration between university, industry and government, theorized by Etzkowith and Levdesdorff (1995) and termed the Triple Helix. Their work led to the recognition that successful innovation depends upon the effective selection and management of the research project portfolio and the research partners. Studies in this area largely focus on how well the relationships are either working or not working, and there is little published literature that seeks to understand what is particular to each of these environments that causes difficulties when working together across the 'cultural gap' (Kirkland, 2010).

Existing studies have identified several key differentiators that create barriers to effective collaboration. The present study aims to develop these areas into a more complete framework and contextualise the factors (in the present research called 'differentiating themes') for each of the three sectors. A multilevel approach was taken to understand the areas of difference between team member and key informant participant levels, while incorporating a project approach across the traditional project components of phases and constraints.

The findings of this research are based on a thematic analysis of the current literature. Nine broad themes of: funding, project, leadership, teamwork, completion, scientific endeavor, intellectual property, ethics and career, were further divided into sixteen subthemes. These describe the main areas of difference – or tensions between the sectors involved in the collaboration. The data collection was guided by a data collection model developed for this study.

The study also measured the perceived outcomes of the collaborative effort, using the Strategic Alliance Formative Assessment Rubric (SAFAR), developed by Gajda (2004), which seeks to capture growth in a collaboration over time, and is used to measure both the inputs and outputs of the collaboration. The survey yielded 94 responses.

Semi-structured interviews focussed on how both context and individual experience influence the themes, using a representative sample of team members and key informants from each sector, with twenty interviews conducted in both New Zealand and Australia. New differentiating themes were identified through the interviews and added to the original framework: main themes of collaboration, project management method, communication, internationalism and project mishaps, and subthemes of trust, contract management, task segregation, profitability and influencing.

The study explored the impact of the differentiating themes as either contributors or influencers to the collaboration, as well as their impact on pre-project, project, and post-project phases in a framework for use by all parties involved in the UIG.

The study has added to our current understanding of this project type through the development of a more encompassing framework, taking in multiple themes within the

UIG collaborative style project. It has produced findings that consider the influencing dynamics of the sectors and participants addressed, from the perspective of both collaboration and project level determinants including the importance of collaborative outcomes.

The study highlights the formation of collaborations, ongoing influences, and the differences found which account for many of the barriers to both start-up and ongoing collaborative development. This study also highlights the need to develop strategies for collaboration including between sector strategies to advance the benefits of collaboration, performance measures that reward collaboration, and the necessity to understand and accommodate the outcomes needed by all participants. The study has also increased the understanding of the complexity of the processes involved in UIG collaboration.

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CHAPTER ONE

INTRODUCTION

1.1. Introduction

This thesis seeks to build a comprehensive understanding of the university-industry-government (UIG) collaborative research project environment, from now on called UIG collaboration. In so doing it considers all the key differentiators, both internal and external, that influence the collaboration, and seeks to provide insight into the importance of the multiple differences that either facilitate or impede progress with regard to perceived success.

The collaborative relationship is examined through a review of the existing literature by looking primarily at the areas of conflict within the combined organisational forms. The study first establishes a framework, based on the findings represented as differentiating themes. It then seeks to develop this understanding, based on the experience of recent and current collaborations and expert knowledge. The focus of the study is the impact of the projects, processes and perceptions of the collaborative project outcomes.

The collaborative agenda is being driven mainly by government policy, and the edict has given rise to two main streams of discussion, one being termed the Triple Helix (Etzkowith & Levdesdorff, 1995), the other focusing more specifically on university-industry collaborations. In both areas, research is being consolidated as a result of information gleaned from systematic literature reviews. Most research efforts, however, are concentrated on the university-industry connection with limited research to date on the effects of the three UIG collaborative entities or from a targeted practitioner approach.

To address the aims of this thesis, it was necessary to understand the effects of the three entities of the UIG collaboration and their more extensive networks. It was also necessary to put them into the context of cross-border collaborations. As such, an Australasian approach was used with subjects, representing all parties in the UIG collaboration across New Zealand and Australia. The study was conducted using an online questionnaire and a set of in-depth discussion with both key informants and team members.

This chapter begins by providing an overview of the research background and problem orientation in the subject. It then outlines the primary rationale and drivers for the research before presenting the research objectives and methods of the thesis. The final section describes an overview of the thesis structure.

1.2. Background to the area of research interest

Increasingly, universities are being called upon to be central actors in the economic development of countries and regions. Their direct involvement with industry has increased, with the fundamental basis of the Triple Helix embedded in the political economy (Todeva & Etzkowitz, 2013) and policies to promote university-industry (U-I) networking (Etzkowitz, 2012). This has led to a growth in collaborative research projects, with many examples being cited across the globe, with some specific examples in the New Zealand and Australian region:

- In 2016, the New Zealand government launched the National Statement of Science Investment (NSSI) setting out a ten-year strategic plan, whereby the Ministry of Science and Innovation outlined its directive to build high-performing science and innovation systems to help transform New Zealand into a more diverse, technologically advanced, smart nation.

- In 2016, the Australian government set out priorities and targets for collaboration in their annual Australian Innovation System Report to double the level of collaboration between Australian businesses, universities and publicly funded research agencies over the next decade.
- On 17th February 2017, New Zealand and Australia signed a new Agreement on Science, Research and Innovative strategy, with six primary goals, one of which is to make science relationships more commercial and more cooperative.

Across the globe, many other initiatives have been developed.

While policies can create the conditions for innovation to flourish, they rely on the quality of partnerships and connections for delivering effective collaborative projects. Building these connections and optimising their performance is an ongoing challenge.

The central role of a university is to develop knowledge and produce innovative solutions, and it should, therefore, be of great interest to understand how collaborative projects are both developed and managed. This perspective gives the current research a multi-layered theoretical perspective, focussing on collaborative project management, and linking the collaboration process with outcomes. For collaborative project management, the view is on bridging the gap between traditional project management and the management of innovation (Soderlund, 2002; Simon, 2006; Bredillet, 2007), and the practice-oriented approach defining a more human element on projects (Blomquist et al. 2010; Kapsali, 2011). These two approaches embody the individual areas of inquiry: the project process and human interaction. Linking collaboration processes with their outcomes further develops the effects of these variables on the project utility.

The study also focuses on the outcome of the collaboration and its dependency on the collaborative variables, with the primary concern being the study of the three collaborative aspects of the process: relational interaction, outcome, and interconnectivity between the two.

University scholars had given this area of collaborative work little attention until external political forces gave it new impetus. Together with these external forces on academic research, the internal force through academic research management units has also been exerted, and with this new discipline, more credence has been given to the notion that projects within the collaborative space need specialist management.

However, the issues around a lack of adoption of project methodologies in academic research were first discussed as early as 1977 by Agassi in his study entitled "The methodology of research projects" and noted a general reluctance by methodologists to study research projects and develop detailed evaluations. More recent studies by Bubala (2016) and Jasienski., Candi and Rzeznik (2015), still note this lack of adoption.

The developing body of knowledge in relation to the UIG collaborative endeavour, as with much universal project literature, focuses on the difficulties and challenges that obstruct the collaborative effort, including both setup of UIG collaborative efforts and their management (Ankrah & Al-Tabbaa Omar, 2015; Fernandes, et al, 2016; and Ramli, 2015) with few studies attempting a more holistic framework approach (Bstieler, 2014; Conhoto, 2016; Fernandez-Esquinas, 2011; and Freitas et al., 2013). In those studies that have attempted such an approach, there is little detail of the significance of each of the factors (Anrah & Ramli, 2015 & Bruneel, et al., 2010), how they affect each segment (Canhoto, 2016; Eom, 2010; Freitas & Lind et al., 2013; Wilson, 2012), stakeholder analysis (Fernandes, 2016; Kirkland, 2010; Shibayama et al., 2012), project progress

(Canhoto, 2016; Chin, 2011) and outcome. Frasquet (2011) also looked at relationship channels, different language, generation gap, lack of entrepreneurial spirit amongst universities and limited promotion of university activities, as issues creating difficulties in UIG collaboration. There is a small number of papers that examine all literature that facilitates or inhibits UIG collaborations, such as Rybnicek and Konigsgruber (2018), but their research does not include the third Triple Helix entity of government interaction. The differentiating themes that have been identified in the literature are presented in the following sections of this review, with an explanation of current literature relating to each of the individual points. The objective is to explore these differences for their impact on the collaborative project in direct relationship with the setup and progress of UIG collaborative research.

1.3. Problem orientation

Despite this newer body of literature and a number of case studies, many UIG collaborative projects fail to deliver. Commonly cited reasons for failures include the different motivations and objectives of the organisations involved (Casey, 2004; Rohrbech & Arnold, 2006); variable levels of commitment (Harris, 2007); failure to establish trust (Davenport et al., 1999); unclear requirements (Barned et al., 2002; Barnes et al., 2000); and poor planning and progress monitoring (Braglia & Frosolini, 2014).

The subject of project management has been studied widely over the last two decades in almost every area of business, including the creation of models and frameworks for use in both commercial and not-for-profit enterprises. Project knowledge has been explicitly developed in specific sectors, including construction, government, and information technology in order to understand the differences between these industry types, as well as in order to develop further methodological approaches. This has given rise to the notion that there are unique characteristics and complexities dependent on both business and project type.

The existence of these unique and complex characteristics, dependent on both business and project type, suggests that project context plays an important factor in achieving project success. Contingency theory within the project management field has been applied to the project context since the late 1980s (Donaldson, 2006), in several areas including selecting and tailoring the best methods to suit the project environment as a moderator of project success (Joslin & Muller, 2014). It has been shown that the most successful projects are those developed specifically for the industry and organisation in which they reside, and that they should be aligned to the inherent context factors (Fitzgerald, Russor, & Stolermann, 2002; White, 2002). Cooper (2007) observed that many projects are being mismanaged because they are using tools and techniques that are not appropriate for the project type, or because inappropriate criteria have been applied. The choice of tools and techniques begins at the 'framework' or 'model' level. As with other project types, research projects have been studied and are getting more attention due to the need for innovation to boost economic growth across the globe. As part of this need, there is an impetus to bring university research into the scope of other project areas. Universities have always played an essential role in society as active producers of knowledge through academic research. The need to collaborate within the commercial sector is, however, is a more recent role for universities. The UIG collaboration has subsequently emerged as the third mission of universities (Etzkovitz & Leydesdorff, 2000).

Some interesting themes have emerged from the literature around the types of UIG relationships. Perkmann et al. (2011) first identified five types of UIG relationships: licencing, academic entrepreneurship, collaborative research, contract research, and consulting. While it is possible to discount licencing as primarily a contract for property rights, the other types of UIG relationships needed to be considered within a revised framework.

Most studies have taken an approach that identifies areas of conflict, Bruneel, E'Este and Salter (2010) took a different approach, looking at how to reduce reported barriers to collaboration. They noted that the main barriers that needed to be broken down were around orientation related issues, and obstacles related to conflicts over IP and university administration transactions. In all cases of barrier reduction, however, experience and time reduced most fundamental problems.

The areas outlined above are treated separately in the extant literature, possibly due to a dichotomy of thinking arising from different schools of thought:

- Characteristics of collaboration: takes time, effort, does not reap quick rewards
- Characteristics of project management: fast, cost and outcome focused

The characteristics show the two subjects as being almost in opposition, yet there is a current trend towards UIG collaboration, which is mainly bound in research projects. This provides a possible explanation as to why the literature to date has been able to identify what is not working, with less emphasis on what we need to make this project style work.

As mentioned above, project management frameworks and methods have been developed in several areas of project work, with construction and information technology being two areas that have been given much attention. However, the development and use of project management frameworks and methodologies within university research projects have attracted little attention to date. Studies have concentrated on the dynamics of collaborative project teams, and how to obtain material project deliverables, with little attention paid to fundamental differences in organisational culture and goals, and how these differences could impact the production of the deliverables.

Research into the management of academic research projects remains one of the last project types to be focused on in this field. The early literature identified an unwillingness of academics to adopt project methodologies (Agassi 1977), while Blankevoort (1983, p.1) suggested that ‘‘tools should be developed for the management of creativity to make project management complete as a recognised profession’’. However, little advancement has been made, subsequent to these studies, beyond a body of discursive papers by academics, reporting why traditional project management does not fit into academic research projects (Barbolla, & Corredera, 2009; Blindenbach-Driessen & Dalen., 2010; Buijs., Smulders, & Meer, 2009; Subramanian., Klein., Jiang., & Chan, 2009). One of the main arguments for this thinking is the apprehension among many researchers that the perceived business approach of project management (Riol & Thuillier, 2015), will affect academic research, leading to increased bureaucracy and decreased autonomy (Bode, 2000). It could also be argued that, without methodology specific to this project type, academic research will be driven by traditional project methods, hence the call for specificity.

The impetus to focus on this style of collaboration has developed through the call for universities to become increasingly active as central actors in the economic development of countries and regions. Direct involvement with industry has increased, and policies have been designed to promote university-industry networking (Givliani, 2009). The question about the amount of management practice that should be exercised in academic projects remains unanswered, however, even in innovative organisation projects (Brown & Eisenhardt, 1997). In line with this, Shenhar and Dvir (2007) argue that there are no generic models to manage projects with academic collaborations differently according to their type. The management of complexity and uncertainty should identify the need for flexibility, and it should address the ways these factors could be embedded in planning, execution and evaluation, to allow for enough originality to increase innovativeness (Yeo & Qiu, 2003).

Simon (2006), who studied the "actual work" of project managers for creative projects, tried to bridge the gap between what is termed traditional project management and the management of innovation, by distinguishing between three main approaches: traditional system, process, and practice. He recognised, however, that, depending on how one counts, there are more approaches to project management (Anbari, 1985; Bredillet, 2007; Simon, 2006; Söderlund, 2002). Regardless of the number of approaches in conventional project management, what we do know is that "conventional project management approaches do not seem to work for academic research" (Lori et al., 2009). Ambrox et al. (2008) also noted that collaborative research by academia and industry could be a powerful source of innovation.

To build an understanding that is based firmly on empirical evidence, research has recently taken a more practice-oriented turn as noted by Blomquist et al. (2010) where the focus is on the actors and their activities rather than on models and their application. The traditional approach has contributed to the development of tools, methods, and generalisations used by practitioners in different industries all over the world. The process-oriented approach has, on the other hand, contributed to a more human element in projects (Blomquist et al. 2010). Only recently have studies that take a practice perspective at the outset appeared in the general field of project management. Kapsali (2011) supports this finding noting that the mobilisation of collective knowledge through projects is an essential element. In projects where ambiguity increases and goals are only broadly or partially defined, collective creativity has to be fostered, channelled and managed, through a basic understanding of the collaborative organisation culture.

Empirical evidence has found that, in circumstances where the outcomes of project activities are less than predictable (uncertainty), and where these activities involve multiple stakeholders across organisational boundaries (communication complexity), operational flexibility (equifinality) and boundary management (causal embeddedness) become very significant to successful practice, more significant than traditional formalisation and control mechanisms (Kapsali, 2011). It can also be concluded that efforts for exploring more flexible ways of managing academic projects are marginal and are not widely examined or discussed. Further research is needed to identify the applicability and suitability of different systemic models in various collaborative environments.

Collaboration is a process in which autonomous actors interact through formal and informal negotiation, jointly creating rules and structures governing their relationships and ways to act or decide on the issues that brought them together; it is a process involving shared norms and mutually beneficial interactions (Thomson, Perry & Miller, 2014). Inherent in this definition are process-related activities such as making a joint decision on rules to govern the collaboration; using an effective administration system to support effective communication; and working through differences to arrive at a mutually beneficial relationship, all of which take commitment to process over time (Thomson et al., 2014).

An additional trend in research project management which relates to UIG collaborations is the increase in pressure from different stakeholders to explain the impact of project outcomes and their importance to the end-user. While researchers have reported a business approach to projects (Winch & Carr, 2000; Winters, Sandersen, Elvin & Levene, 2006), modern thinking points to the importance of flexibility in the project approach (Shahu, Pundir & Ganapathy, 2012). In turbulent and innovative environments, research and development rarely end according to the original plan (Steffens, Martinsuo & Artto, 2007). In many cases, this means that identification of outcomes is only possible near the end of a project. Evidence of the need for a variety of methodologies to suit multiple industries and situations has been available for some time, and many new methodologies have been tailored accordingly. However, literature looking at how the UIG collaboration works has only recently started to gain academic interest, with few attempts made to explain the differences in this particular environment that can be reflected in a specific framework or method.

Therefore, the primary rationale for this study comes from an attempt to understand this unique research environment, and to recognise that, within the growing body of project management knowledge, there is a necessity to capture this distinctiveness in a manner that will aid the ongoing relationships of UIG collaborations.

1.4. Significance of the study

This study represents a unique approach to the broad topic of UIG collaboration by focusing on the concrete end of the continuum. The UIG collaboration generally lacks direct observations, and to address further the need for a multilevel understanding of the management of these creative teams and projects, research needs to be progressed to develop further understanding of the incongruent areas found in the literature. Underpinning the research is the application of collaboration theory related in relationship to project management, framing the gap found in previous studies.

The drivers for the study centre on the significance of project deliverables in publicly and privately financed research collaborations, and in particular, the issue of how each sector can manage their stakeholders with regard to the project results. From this discussion, it is valid to argue that there is a need for research into the UIG collaborative relationship for several reasons.

Firstly, there is a lack of specific project frameworks and methods directed to the UIG research collaboration (Agolla, 2018; Barbolla, 2009; Buijs, 2009; Hughes, 2008).

Secondly, there is a significant amount of literature which attempts to fit conventional project models into academic research projects (Cassanelli, Fernandez-Sanchez, & Guiridlian, 2016; Cann, 2008; Caughron, 2008; Kirkland 2010; Hodgson, 2011).

Thirdly, there is a link between the initial justification for UIG collaborative projects which led to their funding, and the method for determining the success of the outcome (Hammerstedt, 2007; Han & Heshmati, 2016; Lichtenthaler, 2011; Simon 2006; Sullivan 2009).

There is also a lack of specific literature in the Australasian region;

a) no UIG collaboration studies have been undertaken in New Zealand or Australia;

b) of the models that exist outside of New Zealand and Australia, none have been subjected to research scrutiny or assessed against current research projects;

c) there are no comparative studies between university, industry or government bodies to see if such methodologies are transferable between the different forms of collaborative agreements.

This study will address these gaps by discovering the personal perceptions of employees in the UIG arena in Australasia, and also add to the exiting knowledge regarding UIG collaborations.

The collected data can potentially be used by organisations developing looking to develop their collaborative approach, to create policy, procedure and training in this area. The study also has the potential to heighten awareness for the need to develop collaborative efforts and identify the need to develop its practice. The research is also important to researchers and scholars as the collected data will potentially provide a foundation for further research on the topic of UIG collaborations, a previously underdeveloped style.

1.5. Justification of the study

Collaboration in project work is often by necessity rather than design, and there are few examples in the literature of purposeful collaboration not aligned to a defined project. Nevertheless, literature in this subject area does indicate multiple factors that influence both the input and the outcomes of a University Industry Government (UIG) collaboration. However, there is a knowledge gap regarding the importance of each of these factors and the extent to which they impinge on the outcomes of the collaboration.

Gaps also exist in the understating of ongoing benefits of these collaborations, including how to quantify their effectiveness, reflecting again the complexity of the subject. The insufficient identification of benefits and measures has also led to a lack of incorporation of collaborative development into role descriptions and business planning except in exceptional cases, either led by an individual in the case of university researchers, or in out of office hours for industry researchers, or forced through government edict. Where models of collaboration are found, the tasks are often segregated to a department specifically directed with identifying and developing collaborative partnerships.

The purpose of this study therefore was to investigate the collaborative effort using several dimensions. First the effect of the factors noted in the literature, of which sixteen were identified and explored using a data collection model developed for this study. The purpose of this model was to provide a systematic approach towards organisation type and participant level, and across traditional project phases and constraints to identify the relative importance of each factor and produce a more holistic approach encompassing the study from the different perspectives employed. As the study also intended to develop understanding of how the factors impinge on the outcomes of the collaboration, the perceived outcomes of the collaborative efforts were also studied, using the Strategic Alliance Formative Assessment Rubric (SAFAR), developed by Gajda (2004), which seeks to capture growth in a collaboration over time using eight input and outcome goal measures. From here, the study aimed to produce a research collaboration framework for discussion, in order to more fully understand current practice and outcomes.

1.6. Study objectives and research questions

The objective of this research is to better understand both the projects and processes in the context of UIG research collaborations. The research takes a mixed method approach beginning with a narrative literature review to look at existing relevant themes in the literature which relate to the research topic, and to produce a more complete picture of all sides of the collaborative process. To begin, the focus was placed on several existing themes in the extant literature:

- proposed UIG collaborative project models

- controversial topics within UIG collaborative projects
- other relevant topics that relate to this area in the literature

In order to identify the topics that are deemed important, the research identifies areas where the parties to the collaborative project may be working with opposing ideals, or topics where they may all be struggling with similar issues. The identified differentiating themes are presented first with an explanation of contemporary literature relating to the individual points, followed by a discursive section which looks at the implication of these findings on the collaborative project process.

From here, the study identifies and examines the areas noted in the current literature and presents them in the form of a themed framework. The themed framework is then refined through a mixed methodology approach, using a qualitative survey and semi-structured interviews to provide a more detailed analysis.

A data collection model was developed to view the data from the perspectives of industry, university and government and the dual levels of key informants and team members. Subsequently, the framework was updated, and a collaborative model proposed, together with principles of difference for this collaborative style.

To achieve the goal, a number of research objectives were identified:

i) To identify differentiating themes for university-industry-government (UIG) collaboration that define the unique characteristics of their project environment and the tensions between these approaches;

ii) To examine the challenges these recognised differences may present to university-industry-government (UIG) collaborations from a project management perspective;

iii) To examine how the themes identified impact on the collaboration outcome, either positively or negatively, drawing on collaboration theory;

iv) To develop a research-informed framework to assist in the management of university-industry-government (UIG) project collaborations.

1.7. Organisation of the study

This section gives a chapter by chapter outline of the thesis.

Chapter **two** presents a review of the literature and gives an overall view of the existing knowledge of the UIG collaborative project and collaboration theory that supports project work. With regard to the UIG collaborative project, the 16 differentiating themes identified from the literature are outlined and discussed with reference to relevant research and theory.

In respect to the collaboration theory that supports project work, different approaches found in the extant studies are identified, and their applicability to this research is discussed. The knowledge gaps identified are then used to structure the research questions.

Chapter **three** sets out the study's theoretical framework and methodology. The chapter presents the data collection model for this study based on the literature review and research questions. This theoretical frame serves as a guide to subsequent data collection and interpretation. The planning and implementation of the empirical part of the study are also discussed. The methodology for this study is a mixed-methods approach, and data collection methods involved the use of both a quantitative questionnaire and qualitative interviews. The questionnaire survey sampled UIG projects looking at the effect the 16 differentiating themes have on both the project and its perceived outcome. A series of interviews with key informants and project team members sought to obtain a greater depth of information and understanding around each themed factor under study. Issues such as reliability and validity are also discussed in this chapter.

Chapter **four** presents the results from the analysis of the quantitative questionnaire data, and the qualitative data from the interviews with both key informants and team members. The mixed-methods approach allows for triangulation of data from three separate sources: the literature review; questionnaire responses from current collaborative projects across Australasia; and semi-structured interviews with key informants and team members.

Chapter **five** presents a discussion of the empirical findings as they relate to the research questions, with consideration of their significance to the collaborations. A collaboration framework is also proposed, which seeks to outline a body of knowledge for future collaborative projects. Key contributions to knowledge are presented.

Chapter **six** looks at the complexity of the proposed framework and the primary difference found in this collaboration type. The primary areas of difference show which of the differentiating themes differ between the sectors of university, industry and government.

Chapter **seven** reports the key findings of the study and provides the conclusion to the research. A summary of the theoretical contributions and managerial implications of this study are presented. Limitations of the study are then discussed with suggestions for the possible directions of future research.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter presents a review of the published literature for collaboration and project management in the context of the university, industry, and government, partnership model. This partnership model is still quite new, and interest in its performance has been steadily growing over the last two decades. While the system itself is being discussed at some length, the mechanisms of the partnership have received less attention. The two subject areas identified for study, collaboration and project management, relate directly to this partnership type and, as with systems and mechanics, they have been developed quite independently in the literature.

The chapter begins with the introduction of collaboration theory development, followed by a review of the literature specific to the UIG collaboration, relating directly to the sub-texts of collaboration theory, collaboration cultural gaps, partnership development, measures of success and project management practices and processes for this partnership type. An analysis of individual themes from the extant literature follows, and finally, the links between collaboration theory and project management are discussed, and their significance to the research questions examined.

2.2. Collaboration theory development

Collaboration has been studied extensively since the 1960s, although the earliest paper that mentions collaboration was Beaver and Rosen (1978) in their paper "Studies in scientific collaboration".

The definition of collaboration is still being refined within the field; however, general definitions have been proposed, such as that given by Mattesich., Murray-Close and Monsey (2001, p.11):

> A mutually beneficial and well-defined relationship entered into by two or more organisations to achieve common goals. The relationship includes a commitment to mutual relationships and goals, a jointly developed structure and shared responsibility, mutual authority and accountability for success, and sharing of resources and reward.

Other perspectives on collaboration are more comprehensive:

> Collaboration is a process in which autonomous actors interact through formal and informal negotiation, jointly creating rules and structures governing their relationships and ways to act or decide on the issues that brought them together, it is a process involving shared norms and mutually beneficial interactions (Thomson et al., 2014, p23).

According to Sullivan and Skelcher (2002), collaboration gives practitioners and researchers room to permeate organisational and scholarly boundaries to spur inter-organisational, sectoral or inter-governmental partnership through vertical and horizontal engagement. Collaboration assumes shared interest, motivation and common goals, and collaborative partners always have the same vision in a given research project. However, the rationale for collaboration may differ significantly. Sullivan and Skelcher (2002) provide three theoretical perspectives on collaboration: optimist, pessimist and realist.

The optimist perspective on collaboration takes a positive and altruistic view of collaboration, thus seeing stakeholders as altruistic people with less interest in the immediate but more in the ultimate. It creates a world whereby collaboration is driven by partners' interest to achieve a better society through a shared vision built on sustainable partnership rather than one-off collaborative partnership. In this view, collaborative research would involve academics and practitioners working together in equal partnership from the inception and design of a research project through production to the consumption of its output and beyond. This theory assumes that sustainability and long-term partnership are the driving forces in collaboration rather than a single project-based partnership. The motivational factor for collaboration from the optimist perspective emanates from the exchange theory that reflects the desire to solve common problems by sharing and finding common solutions. According to the optimist theory perspective, collaboration is driven by identifying a shared problem with partners aiming for long-term sustainable collaboration to address the problem. Approaches to such collaboration include collaborative betterment, where one partner invites a similar partner that shares the same ideal for collaboration, and collaborative empowerment which involves engagement in setting partnership priorities from the formative stage to the consumption of the research (Himmelman, 1996).

Contrary to the optimists, the pessimist perspective views collaboration as driven by the motivation to enhance the power of the stakeholders. This theory derives from resource dependency theory (RDT). The collaborative relationship entails mutual dependency, with the desired motive by each partner to control and influence the behaviour and modus operandi of the other. This is closely related to the exchange theory of the optimist perspective but differs in its view of the end product of collaboration. While exchange theory perceives of collaborators as altruistic and committed to sharing a common interest above the interests of individual organisations, resource dependency theory sees collaboration as an opportunistic channel, where partners strive to enhance their power/resources and control the behaviour of others. Power is central to this theory (Emerson, 1962). Since the organisations or collaborators are primarily interested in a collaborative effort that would enhance their power or resources, it presupposes that their participation in any collaborative endeavour is based on guaranteed success in enhancing their resources and power; otherwise, such collaboration is perceived as unproductive. Benson (1975) provides a more subtle view of this theory and argues that behind every organisation, certain key ingredients ensure their continued existence as an entity. Collaboration is dependent not only on the extent to which the outcome will enrich the resources of the organisation but also on how the aftermath will add credibility to their future work. In inter-organisational collaboration, partners might not focus on the financial power of potential collaborators, but also on the wider capital, including networks and interests that might manifest from working together. From this perspective, the motivation for collaboration hinges on the political economy of securing both current and future valued resources (Sullivan & Skelcher, 2002). This perspective sees collaboration mainly as an opportunity seeking venture; collaboration can occur at any stage of the research process as far as it will enrich the power and resources of the organisation in the end.

Realists take a more pragmatic approach, focusing on the influence of change on collaboration, which is capable of swaying collaborators to either side of the spectrum from altruistic motivations to resource and power motivations. A clear view of the realist perspective is offered by Alter and Hage's (1993) evolutional theory, which argues that the dynamic nature of collaboration is informed by political, economic and technological changes and the incessant demand for quality in services that has propelled organisations, institutions and agencies to seek better ways of delivering services through collaboration. Collaboration is an evolving process that requires learning and adaptation; it is not an automatic activation of action but depends on contextual factors and is enhanced through learning (Sullivan & Skelcher, 2002). Like the pessimist perspective, the realists consider that collaboration might come in at any stage of the research process. What is important in this view is the influence of change on an organisation's decision to take part in a collaborative research project. The organisation's philosophical approach to collaboration might be swayed as a result of changing patterns and demands by donors, governments, or other stakeholders in international development. Value for money, service efficiency, donor requests, opportunism and other factors can trigger collaboration at any stage of research.

A final issue which emerges from the literature is the importance of individual chemistry in research collaboration. While institutional buy-in is crucial for academic-to- practitioner research collaboration, project team skills and knowledge, collaboration experience and personal motivation are found to be key determinants for successful collaboration (Amabilet et al,2001; Hanley & Vogel, 2012). There are clear advantages to collaboration including broadening perspectives and joint learning; strengthening evidence; accessing funding, people, data and networks; and enhancing dissemination and the sharing of research outputs that feed into policy and practice. These advantages need to be balanced against the risks and impediments that arise from power imbalances and differentiated perspectives (Jung, Kudo, & Choi, 2012).

In light of an unclear understanding of collaboration, it is vital to understand the drivers behind the relationship, as noted by Jami and Walsh (2017). Critical thinking and action to clarify the meaning, intent, applications and outcomes of inter-organisational relationships like the UIG collaboration are necessary in order to understand whether the popularity of such collaborations is grounded in its efficacy as a means of achieving specific outcome, or as a result of symbolism and ideology.

2.3. Collaboration theory and measurement in the UIG Collaboration

As mentioned previously, collaboration as a subject is a common theme in management literature, and the literature specifically studying collaboration in the UIG partnership has seen a significant increase in the past 20 years, starting notably with the work of Etzkowitz and Leydesdorff (1995) who first termed the phrase: the Triple Helix – university, industry, government relations (UIG)" p15. The Triple Helix hypothesises that interaction in the UIG collaboration is the key to improving the conditions for innovation in a knowledge-based society, with industry as the locus of production, government as the source of contractual relations, and the university as a source of new knowledge and technology (Etzkowitz, 1995). This interaction has been studied from various perspectives, but these studies have been described as fragmented, and lacking an efficient comprehensive view (Ankrah & Omar, 2015).

Thirty-two notable studies relating directly to the collaborative endeavour were carried out between 2010 and 2019. The findings presented in Table 2.1. show a breakdown of four descriptive studies, eighteen qualitative studies, nine quantitative studies, one mixed-methods study, and four descriptive studies.

Table 2.1. Analysis of studies between 2010 and 2018 covering related topics to the UIG Collaborative project endeavour

Article	Research	Data	Method	Research results
Anantatmula (2010)	Project manager leadership role in improving project.	Literature review and 69 semi-structured interviews.	Qualitative	Defining project processes and roles is the first and most important step to managing and leading projects successfully. The project development is dependent on the project leadership role in establishing trust and open communications.
Bruneel, E'Este, and Salter (2010)	Investigating the factors that diminish the barriers to university-industry collaboration.	503 questionnaires, regression analysis	Quantitative	Prior experience of collaborative research lowers orientation-related barriers and creates greater levels of trust.
Eom, Lee, and Keun (2010)	Determinants of industry-academy linkages and their impact on firm performance: the case of Korea as a latecomer in knowledge industrialisation.	Korea Innovation survey data, regression.	Descriptive	Among the determinants of UIG cooperation, traditional firm characteristic variables of size and R&D intensity are not significant, while participation in national R&D projects are, which is in contrast to European countries and reflects the significance of government policies in UIG cooperation in latecomer economies.
Kirkland (2010)	The management of university research.	University site review.	Descriptive	A framework is suggested to guide university research management.

Al-Ashaab, Flores, Boultsinou, and Magyar (2011)	A balanced scorecard for measuring the impact of industry-university collaboration, production planning and control.	Semi-structured interviews at ten UK companies.	Qualitative	Confirmed that a collaborative balanced scorecard (CBSC) is a useful tool to measure, track and improve the impact of conducting collaborative projects with universities.
Chin (2011)	Project management methodology university-industry collaborative process.	19 structured interviews (11 universities, eight industry)	Qualitative	An outline of the requirements and components required of a project management methodology (PMM) designed specifically for the management of UIC projects.
Perkmann, King and Pavelin (2011)	Engaging excellence? Effects of faculty quality on university engagement with industry.	HEBCI dataset for UK universities	Quantitative	In UK universities in technology-oriented disciplines, departmental faculty quality is positively related to industry involvement. In medical and biological sciences there is a positive effect of departmental faculty quality, but this does not apply to star scientists. In social sciences, some support for a negative relationship between faculty quality and particularly the more applied forms of industry involvement.
Ramos-Vielba, and Fernandez-esquinas (2011)	Beneath the tip of the iceberg: exploring the multiple forms of university-industry linkages.	Official registry of research teams UK 765 surveys. Factor and cluster analysis.	Quantitative	Providing policy implications for university administrators and policymakers. A focus on patents and spin-offs as indicators of collaborative research ignores the limits of many of the economic and productive contexts in which universities are embedded. It may also be detrimental to the strengthening of emerging trends that are oriented towards softer collaborative experiences and other forms of knowledge transfer.

Schiele and Krummaker (2011)	Consortium benchmarking: Collaborative academic – practitioner case study research.	8 case studies	Qualitative	Shows how consortium benchmarking supports the production of relevant knowledge for both academics and practitioners, and presents five aspects usually neglected in traditional multi-case research; practitioner as coresearcher, team base, different sources of evidence, focus on best practice and stimulates meta-discourses
Sugandhavanija, Sukchai, Ketjoy and Klongboonjit (2011)	Determination of effective university-industry joint research for photovoltaic technology transfer (UIJRPTT) in Thailand.	150 questionnaires, 13 interviews, factor analysis.	Mixed-methods	The path model with factors related to characteristics and perspectives of the university and the industry as well as joint research mechanism and their linkages to higher growth and improved economic and quality performance of the U–I joint research is developed and validated. The developed model empirically explains interactions between the factors and the outcome factors and can assist the government, the university and the industry to devise target strategies to improve the growth and performance of UIJRPTT.
Frasquet, Calderon, Cervera (2012)	University-industry collaboration from a relationship marketing perspective: an empirical analysis in a Spanish university.	322 questionnaires,	Quantitative	A structural equations model is built and tested, whose results show that communication is a key building block of relationships, having a positive effect on satisfaction with the relationship, trust and functionality of conflict, and that trust and commitment increase the level of collaboration of firms with universities.
Kato, Masatoshi,	Development of university life-science programs and university-industry joint research in Japan	Literature review, regression analysis	Quantitative	The expansion of new university educational programs contributed to the promotion of university-industry joint research and, these collaborations increased following the 1998 legislation

and Hiroyuki (2012)				to promote technology transfer from universities, and the 1999 legislation to allow universities to retain rights on their inventions made with government research funds.
Primas (2012)	Perceptions of the collaborative process in a professional learning focused university community school collaboration.	Twelve individual interviews and two group interviews.	Qualitative	The study found that participants perceived collaborative processes in the areas of collaborative structure, communication practices, characteristics of collaborators and organizations, and group dynamics.
Shibayama, Walsh, and Baba (2012)	Academic entrepreneurship and exchange of scientific resources: material transfer in life and materials sciences in Japanese universities.	698 surveys, regressions analysis	Quantitative	The findings indicate that high levels of academic entrepreneurship in a scientific field are associated with less reliance on the gift-giving form of sharing (generalized exchange) traditionally recommended by scientific communities, and with a greater emphasis on direct benefits for givers (direct exchange), as well as a lower overall frequency of sharing. Suggesting that the increasing emphasis on commercial activity may be fundamentally changing the normative structure of science.
Wilson (2012)	A review of business-university collaboration.	Iterative evidence gathering	Qualitative	A set of 30 recommendations to help UK business - university collaborations become a world-leader.
Woodland and Hutton (2012)	Evaluating Organisational Collaborations: Suggested Entry Points and Strategies.	Literature review and CEIF framework.	Qualitative	Findings indicate that use of the CEIF to operationalise and assess the construct of collaboration can enable the evaluator to ascertain how collaborative efforts correlate with indicators of organisational impact and outcomes.

Banal-Estanol, Macho-stadler, and Perez-Castrillo (2013)	Research output from university-industry collaborative projects.	Literature review and regression analysis.	Qualitative	The study found that the type of the project (measured by its level of applicability) increases the type of both the university and firm partners. Also, the quality of the project (number and impact of the publications) increases with the quality of the researcher and firm, and with the affinity in the partners' preferences. The collaboration with firms increases the quality of the project when the firms' characteristics make them valuable partners.
Freitas, Geuna, and Rossi (2013)	Finding the right partners: institutional and personal model of governance of university-industry interactions.	UIPIE survey data, regression analysis.	Descriptive	Results indicate that ignoring personal contractual arrangements with individual researchers, amounts to overlooking at least 50% of university–industry interactions. The econometric estimations suggest that personal contractual interactions are used relatively more by small firms involved in technology and open innovation strategies, while institutional interactions are mostly used by large firms that vertically integrate R&D activities.
Freitas, Marques, and Paula de Silva (2013)	University-industry collaboration and innovation in emergent and mature industries in newly industrialised countries.	24 interviews	Qualitative	The findings show that university research and development projects with firms in emergent industries are less likely than projects with firms in mature industries to be the result of academic initiatives and public calls for research projects, or to be wholly financed by major public research sponsors. In emergent industries, the role of students and firm employees is crucial for mediating between public research organizations and companies.

Lind, Styhre, and Aaboen (2013)	Exploring university-industry collaboration in research centres.	Interviews, three research centres	Qualitative	Four broad forms of collaboration are suggested: distanced, translational, specified and developed collaboration.
Perkmann, Tartari, McKelvey, Autio, Brostrom, D'Ester, Fini, Geuna, Grimaldi, Hughes, Krabel, Kitson, Llerena, Lissoni, Salter, and Sobrero, (2013)	Academic engagement and commercialisation: a review of the literature on university-industry relations.	Literature review 36 articles, regression analysis.	Qualitative	Identification of the individual, organizational and institutional antecedents and consequences of academic engagement.
Bstieler (2014)	Trust formation in university-industry collaborations in the U.S. biotechnology Industry: IP policies, shared governance, and champions.	UI collaborations survey data, correlations.	Descriptive	The study indicates that flexibility and transparency of university IP policies and shared governance by UI partners are positively related to trust formation. The activities of UI champions amplify the positive effects of shared governance while reducing the importance of university IP policies for trust formation between UI partners, and positively related to knowledge transfer and innovation performance. The findings suggest that despite widely reported industry concerns over the

				control of IP, UI research partners can develop a trustful environment and thereby plant the seeds for a successful collaboration.
Ankrah and Al-Tabbaa (2015)	University-industry collaboration: A systematic review.	Literature review descriptive analysis.	Qualitative	The review resulted in identifying five key aspects, which underpinned the theory of UIC and are integrated into an overarching process framework.
Fernandes, Pinto, Machado, Araujo, and Pontes (2015)	A program and project management approach for collaborative university-industry R&D Funded Contracts.	Eight interviews	Qualitative	The results show that emphasis should be given to structured objective setting, good progress monitoring and effective communication.
Pohjala, Puusa, and Iskanius (2015)	Potential of a community of practice in promoting academia-industry collaboration: A case study	Seven case study interviews	Qualitative	The study contributes to the research on CoPs adding to the understanding of shared knowledge as a basis of university-industry collaboration. With new empirical evidence on the power of working in the communities for more efficient and innovative approaches and recommends that academia and industry select the open innovation strategy in their CoPs to achieve next-level collaboration.
Ramli (2015)	Success factors in reducing orientation and resources-related barriers in university-industry R & D Collaboration, particularly during development research stages.	Eight interviews, four academic and four industry leaders.	Qualitative	The results show several factors that reduce orientation and resource-related barriers, including research ensure both sides attend the meetings, leaders communicate among each other, developing Gantt charts, industry provide facilities and academics train new assistants.

Canhoto (2016)	The co-production of value in digital, university-industry R & D collaborative projects.	12 structured interviews (six industry, six universities)	Qualitative	A conceptual framework is developed that explicates how individual, organisational, and external factors shape the type of interactions and the platforms used in R&D collaborative projects. It also proposes five practical principles to develop collaborative R&D projects.
Fernandes, Pinto, Machado, Araujo, Pontes, and Machado (2016)	Perceptions of different stakeholders on managing collaborative university-industry R & D funded contracts.	170 questionnaires, purposeful sampling, non-parametric tests.	Quantitative	This paper describes how the identified key program management activities/practices are dependent on the program stakeholders' characteristics, namely contractual relationship - university vs. industry, professional category, role in the program context, PM experience, level of education, gender and age.
Garousi, V., Peterson, K., Ozkan, B. (2016)	Challenges and best practices in industry-academia collaborations in software engineering.	Literature review, descriptive analysis	Qualitative	The study identified 10 challenge themes and 17 best practice themes, the most common ones being to hold regular workshops and seminars with industry, assure continuous learning from industry and academic sides, ensure management engagement, the need for a champion, basing research on real-world problems, showing explicit benefits to the industry partner, be agile during the collaboration, and the co-location of the researcher on the industry side.
Huang and Chen (2016)	How can academic innovation performance in university-industry collaborations be improved	survey of 141 Taiwanese universities,	Quantitative	The results showed that UIC-subsidized universities have more advantages for developing their UIC environment and improving academic innovation performance. Also, that a formal UIC management mechanism might be the most essential factor for

		regression analysis		enhancing the academic innovation performance of non-UIC-subsidized universities.
Olga Bychkova (2016)	Innovation by Coercion: Emerging institutionalisation of university-industry collaborations in Russia.	Literature review and 54 semi-structured interviews	Qualitative	The case demonstrates, the outcome of such a policy is rather negative, however some positive side effect are the practice of the shared-use equipment and helps to stimulate changes in industrial vision of the academic partner.
Rybnicek and Konigsgruber (2018)	What makes industry-university collaboration succeed? A systematic review of the literature.	103 papers analysed between 2000 and 2017 from EBSCO Business database.	Quantitative	The research proposes a novel conceptual model, to organize and categorize influencing factors and their interrelationship within the collaboration process.

The three most notable studies were carried out by Ankrah and Al-Tabbaa (2015), with a systematic review of the UIG collaboration literature between 1990 and 2014; Garousi, Petersen and Ozkan (2016), with a more specific industry study of the collaboration style appertaining to software engineering; and Rybnicek and Konigsgruber (2018) with another systematic review of the UI collaborative literature between 2000 and 2017. In each case, however, the studies do not extend to the role of government or government-run entities as proposed in the Triple Helix model; their focus is on the university-industry collaboration only, and there is also no ranking against the factors under review.

Ankrah and Al-Tabbaa, (2015) carried out a systematic review of the university-industry collaboration literature over the period 1990-2014. In their study, they selected 109 papers from 1500 considered pertinent to the topic, looking for dominant themes of study. Five dominating themes emerged from their analysis: organisational forms of collaboration; comparisons of motivations for university and industry partnership; the formation process; activities during the collaboration; and factors that facilitate or impede the collaboration.

Of the themes found, two of these sections are of interest to this study, being factors that facilitate or inhibit university – industry collaborations (UIC), and UIC outcomes. In factors that facilitate or impede UIC, Ankrah and Al-Tabbaa (2015) identified seven main headings: (1) capacity and resources; (2) legal issues, institutional policies and contractual mechanisms ;(3) management and organisational issues; (4) issues relating to the technology; (5) political issues; (6) social issues; and (7) other issues, noting that the heading Management and Organisational factors, was accountable for 45% of the studies. A comparison of these subheadings to those of the current literature review shows that eight areas discuss subjects relevant to this study, relating to the subthemes of funder priorities, project justification, governance, leadership, teamwork, completion goal, ethics and career focus.

In their section on UIC outcomes, Ankrah and Al-Tabbaa (2015) have identified seven main headings: (1) economic related; (2) institutional related; (3) social related; (4) deviations from mission or objective; (5) quality issues; (6) conflicts; and (7) risks. A comparison of these subheadings shows that four areas discuss subjects relevant to this study, relating to the subthemes of asset distinction, collegiality, intellectual property ownership, and ethics.

The second study, Garousi et al, (2016) who also referenced Ankrah and Tabbaa's work (2015), looked at challenges and best practices in industry-academic collaborations from the specific view of software engineering, and also completed a systematic literature review. This study looked specifically at challenges that stop the two communities collaborating: both are large research communities, but not necessarily in a collaborative manner. Their study identified 33 papers that covered the specifics of their research questions, out of which 10 challenges were identified: lack of research relevance; research method related; lack of training, experience and skills; lack or drop of interest / commitment; mismatch between industry and academic organisations; communication- related issues; human and organisational factors, management-related issues, resource-related issues, and contractual and privacy concerns.

While the second study is smaller, Garousi et al, (2016) are more focused on the subjects of the current study, being factors that challenge this type of collaboration. A similar comparison of these headings to both those of Ankrah and Tabbaa's study (2015) and the current literature review shows that 11 areas discuss subjects relevant to this study. The themes of research method, experience and skills, the mismatch between industry and academia, communications related, human and organisational factors, management related, and contractual and privacy concerns were discussed. However, their work does not develop these findings beyond the initial identification process.

Both studies show subjects that are pertinent to mapping the current knowledge base of the university-industry collaboration, indicating where academic interest is most significant. Their work can be used as a starting point for a more focused literature review on these topics, such as the current study which focuses on those differences inherent in each of the project environments, particularly from a perspective of areas that may produce cultural dichotomy. These differences have the potential to cause difficulties and even conflict between industry and academic projects when working in partnership.

The third study by Rybnicek and Konigsgruber (2018) was a systematic review of the UI collaborative literature between 2000 and 2017. The analysis is similar to that carried out by Anhrah et al. (2015), taking in a further three years of literature up to 2017. In this study, 103 papers were selected, compared to the 109 papers from Ankrah's research. While the study by Ankrah et al. (2015) focused on factors that facilitate or inhibit UIC, Rybnicek et al. (2018) looked at factors that directly relate to the collaborative process, identified as institutional, relationship, output and framework factors. There are no additional factors reported that are of interest to the current study, but they take into account institutional factors: as resources, structure, willingness to change, processes and controlling These factors are not, however, developed beyond the reporting stage. While Rybnicek et al. (2018) takes institutional factors into account, Ankrahet al. (2015) does not, but as Rybicek notes, they are of interest and warrant further investigation. Rybicek et al. (2018), also takes into account several moderators, being scale, level, phase and discipline, but these, too, are taken directly from the literature without development and are reported as of interest but yet to be investigated.

Several quantitative studies include data sets that are more extensive than these studies, although many do not examine specific factors that impact this project style. Ramos-Vielba and Fernandez-Esquinas (2011), for example, provide a sample set of 765 questionnaires but this study looks at the forms of university-industry linkages. Frasquet, Calderon and Cervera (2012) provide a sample set of 322 questionnaires and looks at collaboration from a relationship marketing perspective. Of those studies that are looking at factors that affect the collaborative process, three are based on quantitative surveys. However, these studies have very focused participants both from the perspective of the level of participant chosen and the breadth of business sampled. Bruneel (2010) provides research on a sample set of 503, based on the records of research projects funded by the Engineering and Physical Sciences Research Council (ESPRC) in the UK between 1999 and 2006. Specifically, the research was addressed to the lead person named on each grant, or the key contact person if this was different. Mu and Chen (2016) provide a research sample of 141, based on Taiwanese universities, and as such does not survey the research partners from industry or other research entities. Perkman (2011), similarly to Bruneel, uses a UK database, in this case, the Higher, Education, Business and Community Interaction survey (HEBCI), and looks at the effects of faculty quality on university engagement with industry.

There was only one study in the set that used a mixed methods analysis: Sugandhavanja (2011) with a dataset of 150 questionnaires and 13 interviews. This research also has limitations in its sample in that the research is specific to the photovoltaic technology transfer research in Thailand.

Specifically looking at the analysis of these studies, the qualitative review of Ankrah (2015) uses descriptive analysis, the quantitative studies of Ramos-Vielba (2011) uses factor and cluster analysis, Frasquet (2012) uses simultaneous equations modelling, an expanded form of factor analysis to confirm factors found in the literature review. Bruneel (2010) and Perkman (2011) both use regression analysis.

The only mixed methods paper, Sugandhavanija (2011), uses descriptive and factor analysis to examine effective university-industry joint research for photovoltaic technology transfer. No papers were found that sought to generalise findings across the three organisational types of university, industry and government research entities, or that looked to generalise their study across industry types, though both Ramli (2015) and Bruneel et al. (2010) have looked at factors that affect this style of collaboration. Neither of these studies sought to rank the importance of the factors on the collaboration, or the perception of the factors regarding a successful collaborative outcome. As such, this study aims to add this knowledge to the current research body of knowledge in this area.

2.4. Collaboration cultural gap

Much of the literature concerning the UIG collaboration concentrates primarily on the existence of the effects of the so-called ‘cultural gap’ (Fernandes, 2015). The factors identified include conflict over ownership of intellectual property, academic freedom to publish, differences of priorities, and time horizons.

The collaboration culture gap is one that has been known for some time, Simon (1967) noted that when academics and practitioners come together, they separate again like oil and water, stating that it is “easy to describe the intended product, but less easy to produce it” (p.16). Since identified, the topic has been discussed widely; academics operate in different closed social systems that cannot be integrated (Kieser & Leiner, 2009). Companies emphasise concrete tasks and measurable results, whereas universities discuss matters at an abstract level (Pohjola, Puusa & Iskanius, 2015).

While it is widely understood that there are substantial barriers to successful collaboration and knowledge exchange between universities and industry, few studies have attempted to measure and map these perceived barriers or investigate what may reduce them (Bruneel et al., 2010). Much of the research on UIG links relies on secondary information on the problems and challenges involved in collaborating.

Findings also conclude that complementarity is less apparent in primary and social science disciplines and that there is a need to consider a division of labour among universities whereby some researchers specialise in advanced research, and others in business engagement (Sainsbury & Turville, 2007).

2.5. Partnership development

Collaboration literature on partnership development strongly supports the notion that there is a wide range of linkages that develop between agencies and within organisations. Peterson (1991) postulates that there is a three-point continuum of interaction for strategic alliances and suggests that this continuum begins with cooperation, whereby fully independent groups share information that supports each other's organizational outcomes. This is followed by coordination; whereby independent parties align activities or co-sponsor events or services that support mutually beneficial goals. The final stage is collaboration, where individual entities give up some degree of independence in an effort to realize a shared goal.

Bailey and Koney (2000) extend the work of Peterson and Hogue (2001) and make a case for coadunation as the farthest point on the integration or linkage continuum, implying the complete relinquishment of autonomy of at least one partnering entity to strengthen a surviving organisation. The prevailing consensus through this work is that collaboration is a journey, not a destination.

Similar models have been presented in the literature and commonly focus on stages of collaboration through which interagency initiatives might move. Gajda (2004) has argued that groups would pass from lower to higher stages of collaboration before they can be effective, in a similar manner to the development of high-performance teams as discussed in Section 2.9.10 (teamwork). These stage theories describe levels of collaboration, with the lowest level being little or no collaboration and the highest level being full collaboration or, ultimately, complete unification. The models differ on the number of stages, the range of levels included, and the definitions of various stages, but they have much in common (Fray, 2006).

A summary and comparison of the various stage approaches to collaboration among groups offered in the literature is shown in Table 2.2. Uniform terms are used to label stages and the table includes a seven-stage model, which extends the previously identified stages to include the possibility that, while both groups may exist, there may be no collaboration whatsoever between them (Fray 2006).

Table 2.2. Stage models of collaboration

Coexistence	Communication	Cooperation	Coordination	Coalitions	Collaboration	Coadunation
		Peterson Model (1991)				
		1		2	3	
	Networking Levels of Community Linkage Model (Hogue,1993)					
	1	2	3	4	5	
		Bailey & Koney Mode (2000)				
		1	2	3	4	
	Networking Levels of Integration Partnering Model (Gajda, 2004)					
	1	2	3	4	5	
Seven stages of Collaboration (Fray, 2006)						

The presence of coadunation as a level above collaboration in many models appears to assume that cooperating groups want to attain a level of collaboration that may develop into a wish to merge or unify or become one. Frey (2006) hypothesise that grant partners' legitimate goals for collaboration are perhaps much more moderate.

What is evident, however, is that collaboration brings autonomous organisations together to fulfil a common mission that requires comprehensive planning and communication on many levels (Mattessich, Murray-Close & Monsey, 2001). Also, the risk to each collaborating organisation is greater because each member contributes its resources and reputation (Mattessich, Murray-Close & Monsey, 2001). Collaborative engagement is seen as a value creation activity during which benefits are generated, and risk can be appraised. Both parties are free to enter these relationships with their decision based on the benefits they can expect from collaborating. For academic researchers, two considerations are relevant, one being the task-based complementarity between industry work and their research and the other being mobilisation of funding from industry. Industry's involvement is promoted by a desire to source knowledge from skilled and reputable researchers, resulting in a preference for cooperation with high-quality researchers (Perkmann, King & Pavelin 2011).

2.6. Collaborative measures

There have been few efforts to underpin academic engagement conceptually, which stands in contrast to commercialisation where entrepreneurship theory has been applied. (Perkmann et al., 2013). Effective systems, however, do not emerge spontaneously or without a systematic design.

Ambiguity and lack of proven efficacy mean that neither the concept nor the outcomes of inter-organisational collaboration are well understood (Longoria, 2005). Authors are starting to postulate the possibility that the scholarly quality of research and relevance can be merged into a pragmatic science approach, high in both rigour and relevance (Andersen, Link, Johnson & Burnham 2001; Tushman, O'Reilley, Fenollosa, Kleinbaum & McGrath 2007). This involves realigning stakeholder expectations in the research process (Hodgkinson & Rousseau, 2009; Starkey & Madan, 2001), in the hopes of bridging the rigour-relevance gap in management research (Hodgkinson & Rousseau, 2009). The aim is to avoid forces pushing academics and practitioners 'back to their camps' (Anderson et al., 2001).

The more measurable definitions show a developing picture that seeks to qualify complementariness between collaborative partners. The Triple Helix theory depicts a three-way partnership between universities, industry and government as part of a coherent system underpinning innovation and economic progress (Etzkowitz & Leydesdorff, 1995). Better grounded in empirical evidence, however, Smith (2003) finds a 'hybrid regime' linking commercial and academic activities using a positive feedback loop. According to the finding of Perkmann (2011) these hybrid regimes where the best researchers are always those who engage most with industry but limit their exposure to operating in only some fields are found mostly in allied fields.

Less of the empirical work has dealt with the determinants of inter-professional collaboration, particularly its organisational and systemic determinants (Martin-Rodriquez, Beaulieu & D'Amour 2005).There are, however, two growing areas of discussion around collaboration success factors: one evaluates high-level factors that should be taken into consideration in the form of an evaluation framework; and the second discusses how to identify at what stage of collaboration a partnership is in order to assess collaborative value.

Mattessich, Murray-Close and Monsey (2001) identified six factor categories that need to be aligned to some degree to ensure effective collaboration: trust and partner compatibility; common and unique purpose; shared governance and joint decision making; a clear understanding of roles and responsibilities; open and frequent communication; and adequate financial and human resources.

Woodland and Hutton (2012) developed six action steps to take collaboration through successive stages of planning and evaluation to improve collaboration. These six action steps comprise the Collaboration Evaluation and Improvement Framework (CEIF)

(Woodland & Hutton, 2012). The six steps are (1) determine a Shared purpose; (2) raise collaboration literacy; (3) inventory and map communities of practice; (4) monitor stages of development; (5) assess levels of integration; and (6) assess inter-professional collaboration.

Combining both areas of discussion, are more concrete forms of formative evaluation such as the Strategic Alliance Formative Assessment Rubric (SAFAR), which captures central principles of collaboration to evaluate the process and capitalise on the synergistic power of collaborative efforts, and which places them on a progressive continuum to collaborative integration (Gajda, 2004). This rubric seeks to create a way to capture and understand growth in collaboration over time, from a qualitative and a quantitative manner. The observed facts about the development of strategic alliances, for which principles of collaboration can be derived in this rubric, are shown in Table 2.3.

Table 2.3. Strategic alliance formative assessment rubric (SAFAR).

Level of integration	Purpose	Strategies and tasks	Leadership and decision-making	Interpersonal and communication
Networking 1	Creating a web of communication Identify and create a base of support Explore interests	Loose or no structure Flexible, roles not-defined Few if any defined tasks	Non-hierarchical Flexible Minimal or no group decision making	Very little interpersonal conflict Communication among all members infrequent or absent
Cooperating 2	Work together to ensure tasks are done Leverage or raise money Identify mutual needs but maintain separate identities	Member links are advisory Minimal structure Some strategies and tasks identified	Non-hierarchical, decisions tend to be low stakes Facilitative leaders, usually voluntary Several people from "go-to" hub	Some degree of personal commitment an investment Minimal interpersonal conflict Communication among members clear, but may be informal
Partnering 3	Share resources to address common issues Organisations remain autonomous but support something new To reach mutual goals together	Strategies and tasks are developed and maintained Central body of people Central body of people have specific tasks	Autonomous leadership Alliance members share equally in the decision-making Decision-making mechanisms are in place	Some interpersonal conflict Communication system and formal information channels developed Evidence of problem solving and productivity
Merging 4	Merge resources to create or support something new Extract money from existing systems / members Commitment for a long period of time to achieve short and long-term outcomes	Formal structure to support strategies and tasks is apparent Specific and complex strategies and tasks identified Committees and sub committees formed	Strong visible leadership Sharing and delegation of roles and responsibilities Leadership capitalises upon diversity and organisational strengths	High degree of commitment and investment Possibility of interpersonal conflict high Communication is clear frequent and prioritised High degree of problem solving and productivity
Unifying 5	Unification or acquisition to form a single structure Relinquishment of autonomy to support surviving organisation	Highly formal legally complex Permanent reorganisations of strategies and tasks	Central typically hierarchical leadership Leadership capitalises upon diversity and organisational strengths	possibility of interpersonal conflict very high Communication is clear frequent prioritised formal and informal

The SAFAR rubric represents multiple levels of integration mapped against varying purposes, strategies and tasks, leadership and decision making and interpersonal and communication stages. It was primarily developed to assist practitioners with the development of a strategic alliance predicated on collaboration by understanding and utilising the principles of collaboration theory (Gajda, 2004). When gauged against the five-step evaluation process, the rubric helps to evaluate the process qualitatively, in order to measure the relative strength of the collaborative endeavour over time.

2.7. Project Management

Collaboration in projects is not a new subject: industry and universities have been producing innovative solutions for many years, mostly through collaborative projects that use partners within the same industry band, industry to other industry partners or university to other university partners in a shared partnership style. While collaborations between industry and universities do happen, they have been developed without external drivers to progress these relationships. Now with funding bodies such as the Ministry of Science and Innovation (MSI) mandating the necessity for mixed university-industry collaborations (UIC's), we find a business venture model with very little research around its formation, function, and working features. MSI does, however, understand the benefit of the university's unique knowledge base and knows that it can be a significant resource in a company's innovation strategy (Pertuze, Calder, Greitzer, & Lucas, 2010).

Unlike collaboration, project management has had more rigour produced around its execution; we expect to take a set of 'lessons learned' from a project, which are transferable into similar types of projects in the future. However, the university-industry collaboration is still relatively new, and while we have much extant information about industry projects, very little exists about university project work. This distinct lack of university project focus leads the second half of the literature where literature relating to university-industry collaborations is reviewed in order to assess the nature of these collaborations, and to identify the marked differences that will be used as a starting point to understanding their reported differences. Universities are reported as having an inability to adopt any of the current project frameworks and methods found in general project practice (Kirkland, 2010) which is the basis of the ‘cultural gap’.

It is not only universities that have shown sufficient differences in project practice for the existing industry frameworks and methods to be called into question. Three other industries have shown enough gap to get the current project management body of knowledge (PMBOK) extended to fit their unique environment. The PMBOK was developed by the USA Project Management Institute (PMI) in the 1990s and has since been adopted as the leading global project management framework. From here, three extensions have been developed: the *software extension to the PMBOK guide* the *construction extension to the PMBOK guide* and the *government extension to the PMBOK guide*. These three sectors, while based on the original PMBOK, show enough variance to warrant their own unique frameworks. The same notable variations can be seen in the university and academic settings, and while a PMBOK review is not in the scope of this study, we should note the possibility of an eventual production of a PMBOK for the university sector.

While academics are not readily adopting project management practices (Morris, Pinto, & Söderlund, 2011), they are not shying away from its study, and many excellent papers are being produced on the subject. Project management frameworks are frequently cited in the academic literature; specifically the project management body of knowledge (PMBOK), methodologies such as the critical path, rapid application design, and agile as well as tools and techniques such as Gantt charts, work breakdown structures, and net present value. There is also a growing body of literature coming out of other fields such as psychology, where planning has been found to have a significant effect on the quality of a researcher's output when studied as a component to the management of creativity and innovation management. Caughron and Mumford (2008) specifically used the critical path method in their study.

Projects are known for their uncertainty and difference, and industry practitioners are used to producing frameworks, methodologies and principles that work with individual project types. The study of research projects in the field of software development has resulted in the development of a set of principles to combat these difficulties (Chin, 2004; Highsmith, 2004). Even with such advances, academics are still unconvinced that current methodological thinking captures the dynamics of their environment enough to be used beneficially (Lattuca, Terenzini, harper, & Yin, 2009).

At this stage, it is important to note the three levels of project management practice: project management frameworks, methodologies, and tools and techniques and described in the Project management body of knowledge (PMBOK) 2017:

1. Project management frameworks: A framework is a meta-level (a higher level of abstraction) through which a range of concepts, models, techniques and methodologies can either be clarified and/or integrated.
2. Methodologies: A methodology is an explicit way of structuring project thinking and actions. Methodologies contain model(s) and reflect particular perspectives of 'reality' based on a set of philosophical paradigms. A methodology should tell us what steps to take, in what order and how to perform those steps but, most importantly, the reasons 'why' those steps should be taken, in a particular order.
3. Tools and techniques:

a. Tools implement techniques, providing leverage for performing a specific task. In this sense, they are extensions of a technique, and like techniques, tools must be deployed at the proper times in the project.
b. Techniques represent ways for performing specific tasks ("how to"). A variety of techniques may be used on a project. It would be counter-productive to use a technique at the wrong time on the project, which means the effective use of techniques is dependent upon a defined methodology.

Within these three levels of project management knowledge, we acknowledge that ‘one size does not fit all’, hence the development of multiple methodologies. We also know that even with the plethora of methodologies being produced, we have none to evaluate against academic research. Jordan et al (2005) investigated the difference between various research projects and found, similarly, that their analysis supported the need for multiple methodologies within the university research realm. Boeme (2002) also noted that the best approach for organisations was to evolve towards the best balance of plan-driven and agile methods to arrive at a blend that best meets their individual needs as well as the project needs, though neither researcher found a suitable framework or methodology for mapping.

Barnes et al. (2002) postulated that the pattern of common themes indicated in their study of aerospace and automotive industry/academic collaboration projects showed that a generalised set of guidelines could be developed for the effective management of collaborative research and development projects, such as a specific framework for universities. The collaborative project body of literature on which this study is based gets closest to the phenomena of academic research projects and would be the first step towards such a framework. The current trend in the literature, however, is to look either at how well the relationship is or is not working, rather than what could be developed to help the relationship succeed. The majority of literature published to date on this topic is case study based, but by examining the literature on collaborative arrangements, it is clear that there are significant differences between industry and academic projects. The differences highlight areas where culture and procedure differ and warrants the need for further investigation: the aforementioned 'cultural gap'.

Barnes, Pashby and Gibbons (2006) suggest that the majority of the problems associated with the 'cultural gap' can be alleviated by proper project management. However, one must always bear in mind that successful project management techniques can contribute to the achievement of projects, but will not stop a project from failing to succeed (Shahin & Jamshidian, 2005), therefore it is worth applying project management techniques as a foundation, but it is not the only factor that is needed to produce successful outcomes.

Beyond the differences identified, there are some recent studies which use a themed approach to understand the UIG process, and which identify a more extensive list of themes than those previously identified. Marcos and Denyer (2012) identified two major themes of knowledge integration, and the nature of the relationship between the two communities, and these were organised into conceptual constructs of setting deadlines, engaging debate, losing momentum, different perspectives, lack of resources, topical and timely response. Plewa, Korff, Baaken and Macpherson (2013) looked at variables too, using communication, understanding, trust and people, although these researchers also viewed the differences as drivers on the collaboration.

Marcos and Denyer (2012) looked at the 'relevance gap' between management theory and practitioner use and logged issues against a four-phased project approach using conception, imagineering, dissemination and exploitation as the documented phases.

Plewa et al. (2013) used a similar phased approach using approach, pre-linkage, establishment, advancement and latent phase. What is interesting about these phased approaches in trying to understand the UIG process is that none have used a traditional project approach to their methodology, even though previous works have identified a lack of process studies (McAdam et al., 2006).

The literature review also highlighted other interesting areas that had not previously been considered, including the types of UIG relationships that are being studied. Perkmann, King and Pavelin (2011) identified five types of UIG relationships: licencing, academic entrepreneurship, collaborative research, contract research, and consulting. While it is possible to discount licencing as primarily a contract for property rights, the other types of UIG relationships have been considered in the review.

Bruneel, E'Este and Salter (2010) took a different approach to most studies, looking at how to reduce the reported barriers to the UIG collaboration, and noted that barriers which need to be broken down are around orientation related issues, obstacles related to conflicts over intellectual property, and university administration transactions. In all cases of barrier reduction, experience and time reduced most of the inherent issues.

Frasquet, Calderon and Cervera (2012) looked at collaborations from a failure perspective, using the variable of relationships, which were then analysed against the following factors: lack of entrepreneurial spirit among universities; limited promotion of university activities of appeal to companies; different language; the generation gap; lack of time; and relationship channels. These differences could be seen as beneficial areas to look at in the study and, in some cases, may be themed.

This following section presents the theoretical material relevant to areas of difference between industry, academic and government collaborative projects through a review of the UIG collaboration literature. It begins with an appraisal of the main themes found from collaboration and a project management view, followed by a discussion of each theme, and their significance to the research question. Table 2.4. sets out the 16 key differentiating themes identified from the literature and how they present within each type. The main differentiating themes are presented together with sub-themes that have a relationship to the overarching theme. The main classifications of *funding, projects, leadership, teamwork, completion, scientific endeavour, intellectual property, ethics* and *career* are identified and used at the basis of the framework. From here the primary sources of literature drawn from each area are shown. Implications of these critical differences in UIG collaborative projects are then explored in the discussion section.

2.8. Thematic analysis and theme development

This section is presented using a thematic analysis approach to the UIG collaboration and is based both on the collaborative effort and on the contradictory forces in the project setting.

2.8.1. Thematic approach and development

Thematic analysis can be seen as a foundational method for qualitative analysis (Braun & Clarke, 2006). It is the first qualitative method of analysis that researchers should learn, as it provides core skills useful for conducting many other forms of qualitative analysis. Indeed, Holloway and Todres (2003) identify "thematising meanings" as one of a few shared generic skills across the qualitative analysis.

Thematic analysis is a method for identifying, analysing, and reporting patterns (themes) within data. It organises and describes the data set and helps to interpret various aspects of the research topic (Boyatzis, 1998).

In this literature review, the extant data has been searched for all identifiable differentiating themes; however, more frequent instances of a theme's occurrence in the literature is not seen as an understanding that the theme itself is more crucial to the study subject. Additionally, the 'keyness' is not necessarily dependent on quantifiable measures, but in terms of whether it captures something important in relation to the overall research question. (Aschbrenner, 2015).

2.8.2. Thematic method

This thematic analysis is driven by the researcher's theoretical and analytic interest in this area and is thus more explicitly analyst driven. As such, the coding of the research will be a two-phase process. The first phase will be quite specific to the research question (which maps onto the more theoretical approach) and it be suggested through analysis of the framework. The second phase will provide for flexibility to be built into the study to allow for research to evolve through the coding process (which maps onto the inductive approach). As suggested by Braun and Clarke (2006) this will go beyond the semantic content of the data, and start to identify or examine the *underlying* ideas, assumptions, conceptualisations and ideologies that are theorised as shaping or informing the semantic content of the data.

The theoretical approach requires engagement with the literature prior to analysis, and the main themes will be used as the initial codes. As part of the refinement of the differentiating themes, the 16 original themes have been collapsed into nine main themes to give structure to the more significant themes, and also for demonstrating the hierarchy of meaning within the data. A thematic map has been developed that shows the relationships between the main differentiating themes, sub-themes and the core concept of collaboration surrounding the main organisational entities that make up the study topic being university, industry and government. The thematic map is shown in Figure 2.1.

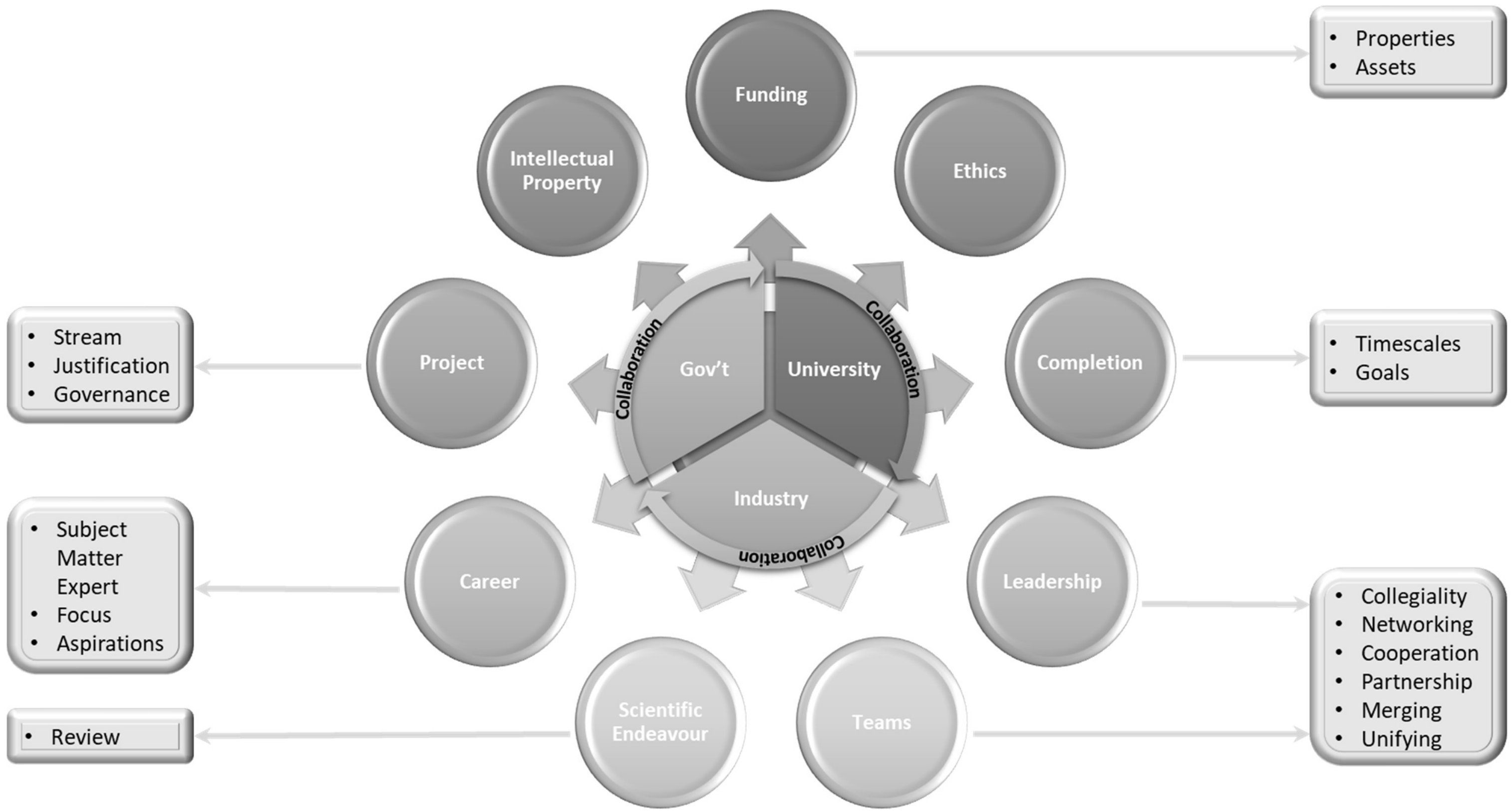

Figure 2.1. Thematic map

2.9. Thematic discussion

The original framework incorporates the three perspectives of university, industry and government perspective, with collaboration as a supporting principle. The main findings from the literature of these themed differences are firstly presented in Table 2.4., following which each is discussed in more detail. The university-industry-government collaboration will be termed the UIG collaboration in future reference.

Table 2.4. Themed differences in university, industry, government collaboration projects

Theme	Sub-theme	University (academic) Projects	Industry (commercial) Projects	Government Projects	Literature
1. Funding	a. Funder priorities	Main funders are external bodies or external business.	Main funders are the business community that the project is being commissioned by.	Government funding of R&D in both academic and commercial environments to foster collaboration, but primarily reliant on the choices of profit-seeking corporations.	Gulbrandsen and Smeby (2005) Harman (2010) Marcos and Denyer (2012) Liu et al. (2017) Cosh and Hughes (2009)
	b. Asset distinction	The main driver is 'public good'.	Main driver is Return on Investment.	The main driver is 'public enterprise'.	Shmaefsky (2002) Barnes et al. (2002) Liberatore (2009) Jordan et al. (2005) Gluckman (2015)
2. Project	c. Project justification	Research stream is justified	The strategic fit needs to be justified.	Evidence-informed planning and policy	Tomczyk (2005) Hazelkorn (2005)

		mainly through funding decision.		development, with economic prosperity.	Kirkland (2010) Hammerstedy and Blach (2011)
	d. Project streams	One-off projects in streams of research – should be flowing or connected as longer career research stream.	A one-off piece of work – if connected becomes a programme.	Political agenda and survival dictate research.	Sa Couto (2008)
	e. Governance	Scientific research and other university managerial requirements drive the process.	Current project management and other managerial requirements in business drive the process.	Rules, contracts, relationship management practices, raking systems and other coordinating mechanisms that oversee performance.	Aghion et al (2009) Leisyte et al. (2009) Kirkland (2010) Harrison and Callan (2013) Todeva and Etzhowitz (2013)
3. Leadership	f. Leadership	The principal investigator is a leader who is also passionate	A project manager is an independent party whose vested interest is a positive career output	Government initiatives support economic potential and economic growth areas.	Barnet et al. (2002) Jordan et al. (2005) Frasquet et al (2012)

		about the work they do as an owner of the outcome, possibly for future research.	for their future career. They are usually not the owner of the outcome.		Boardman (2009) Bernal (2012)
4. Teamwork	g. Team collaboration process.	Team collaboration often stops before dispersion and teams tend to stay together for the next research project.	Team collaboration goes from forming to dispersion.	The team fosters the collaborative approach through funds and initiatives.	Lovelace et al. (2001) Montoya-Weiss et al. (2001) Colarelli et al. (2003) Etzkowitz (2012) Gratton and Erickson (2007) Hoegl et al. (2007) Flores et al. (2009) Plewa et al. (2013) Etzkowitz and Ranga (2003)
	h. Collegiality	New collaborators	Team members are changed as they	Collaborators foster ongoing collegiality	Holman (2000)

		may join in if the research is in their interest area, some may leave due to different research project interests.	progress their employment and organisations, usually for longer project roles or larger functional roles.	through partnership initiatives.	Fear and Doberneck (2004) Turner and Simister (2004) Stackhouse and Day (2005) Barbolla and Corredera (2009) Marcos and Denyer (2012) Hughes (2014) Etzkowitz (2011)
5. Completion	i. Timescale uniformity	Longer processes due to scientific rigour.	Shorter processes due to lack of need for scientific rigour.	There are limited politically led timescales.	Boronico et al. (2011) Barnes et al. (2002) Herroelen and Leus (2005) Koole and Spijker (2000)

	j. Completion goal	The goal of repeatable science, with academic outcomes.	The goal of project deliverables or outcomes.	The goal of economic growth.	Jordan et al. (2005) Sullivan and Beach (2009) Kirkland (2010) Marcos and Denyer (2012) Barton et al (2017)
6. Scientific endeavour	k. Scientific Review	Projects need to be peer-reviewed, so have to follow rigorous scientific methods.	Projects have lessons learned – but are not peer-reviewed.	Projects depend on the subject.	Schindler and Eppler (2003) Scarbrough et al. (2004) Boronico (2011) Benda and Engels (2011) Eisenhardt et al. (2016) Sarpong et al. (2017)
7. Intellectual property ownership	l. Ownership of the project's Intellectual property	The intellectual property of the individual, for individual credibility and to	The intellectual property of the organisation for strategic advantage.	Intellectual property rights are kept by the entity that develops it.	Osburn and Mumford (2006) Hughes et al (2008) Kirkland (2010)

		possibly commercialise.			Alexander et al. (2010) Olsson and Berg-Johansen (2016)
8. Ethics	m. Project working ethics	Project ethics always need to be considered.	Project ethics rarely an issue.	Ethics depends on the project.	Hansson (2009) Kirkland (2010)
9. Career	n. Career focus	Career credentials are measured through research PBRF (performance-based research fund) or national equivalent (e.g. RAE).	Career credentials measured through success.	There is no dominant career path.	Bayney (2009) Etzkowitz and Dzisah (2008)
	o. Career aspiration	Researchers are usually career researchers with the aim of becoming senior researchers.	Project managers are usually career project managers or aiming at a senior management role.	Government officers are from many backgrounds, but with the aim of wanting to make a difference.	Bayney (2009)

	p. Subject matter experts	Long multi-project research, often life-long collaborations due to research streams, not very interchangeable.	Project managers stay with similar projects and industry alignment but are also very interchangeable.	Work experience is usually in a government office.	Calderhead (2002) Bruneel et al (2010)

2.9.1. Funding

2.9.1.1. Funding from a collaboration perspective

Several forces impact the environment in which the UIG collaborative project takes place. The shift in the funding model is a crucial one which may require a change in academic researcher thinking. Funding is often the main driver of the research goals and is currently pushing control away from the academics towards industry collaboration (Perkman, 2007). It is yet to be seen with the new funding model where the weight of research will be gained from the government; whether industry will obtain more government grants with named university collaborators, or whether academics will seek more industry partners to obtain funding from the new models. While the competition for funding is not new, the sectors where the competition comes from might be.

Applied forms of research which are more aligned with industry research mean more quantifiable outputs and therefore less time to postulate (Perkman, King & Pavelin, 2011). Reports done on UIG collaborations show evidence of more publications and more entrepreneurial results, but also show that industry research is more geared towards secrecy to gain a competitive advantage, while academic research requires open dialogue and debate for peer assessment. Collaborative links are, however, necessary for both parties, not just for idea sharing but for facility sharing and cutting down on costs of both equipment and overheads in the project. There also needs to be a balance between knowledge and marketable products, and this expectation needs to be set before a project begins. As noted by Gann & Salter (2000), innovation and research projects have many difficulties which need to be explored to gain an understanding of the project which gives all members the same credence and includes the deliverables that satisfy all the organisations involved. Usually, this would be in the form of an engagement model or a project charter, setting out the rules of engagement, beyond that typically included in the contract document. Uncertainty and difference do not have to be parts of the collaboration project if expectations around the project are set into a framework for practice. One result of the change in funder environment is the change from a relatively friendly and informal relationship that governs such joint projects to a more formal, legal one, in which universities have onerous obligations to deliver against contracts with stringent ethical requirements (Kirkland, 2010). This results in closer regulation of the activities of individual staff and research teams who deliver the research.

Expectations are discussed in the literature, and education for the industry is seen as a critical benefit from academic collaboration in the form of knowledge transfer. Credibility is, to some extent, conferred by title and institution, but this is seldom sufficient to persuade practitioners that value can be added through collaboration. Regardless of knowledge, it has been proved that credibility still needs to be earned (Hughes, 2008). The perception of the business of university innovation and the value of academics needs further study; there are few works written to date, and of those that exist university- business ventures were reported to have a high failure rate (Hughes, 2008).

Universities that are aiming at knowledge generation and innovation with industry partners may need to market their value more heavily to those industries, as they are not yet perceived to supply innovation as a differentiator in many markets. It is also not clear how universities can offer calculable project results that help to shape the future without being dictated to by the needs of industry funders. There are obvious benefits to academics in the form of real-world issues in practice for academic study. There are, in addition, benefits to both parties in the form of access to leading-edge research.

2.9.1.2. Funding from a project perspective

A project, whether instigated by industry, university or government, cannot begin until funding is gained, and this is the first fundamental difference between the project types. The collaborative model has separate funding scenarios producing a fundamental difference in the way the research is funded for each partner. With funders being the main driver of research goals, the fund holder has the stronger weight on what these may be. Businesses are usually the primary funders of their commissioned collaborative projects, spending between 3% and 15% of annual turnover on research each year, (Ministry of Research and Science Technology, 2006), while the funds for academic projects come mainly from external bodies or external business. An example of this is shown in Figure 2.2.

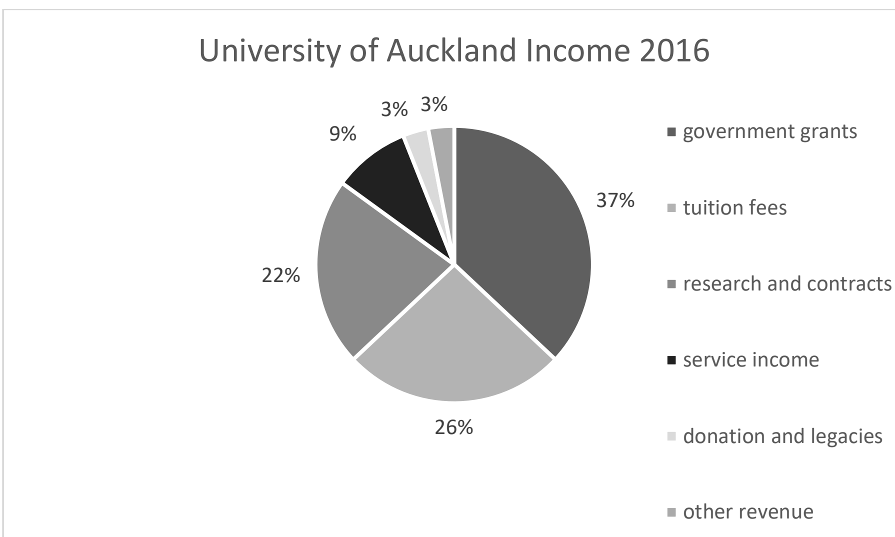

Figure 2.2. University of Auckland income 2016

The University of Auckland 2016 funding profile shows that the external research income equates to 22% of overall revenue, with no internally proportioned funds for research. While the pie chart does not show the external provenance of the income, it is enough to note that it is external to the university and has to be gained mainly under competition with other research bodies. A large proportion of this research activity is highly expensive, involving considerable staff time and high-level expertise, and often requiring the use of highly expensive equipment and materials. For this reason, the level of internal and external research funding that universities can attract is of utmost importance in the production of high-quality research outputs, including scientific papers, discoveries, and inventions that can be patented or otherwise protected under intellectual property legislation. (Harman, 2010).

There has always been a strong global trend for joint research, specifically amongst universities, and by the late 1990s, joint university-industry scientific papers accounted for about half of all industrial, scientific output (Calvert & Patel, 2002). The trend across the whole OECD (Organisation for Economic Co-operation and Development) area is that private companies increasingly fund university research, with the share of basic funding for universities measured as decreasing. Successful universities and university researchers manage to combine academic excellence with industrial contacts and entrepreneurial contributions (Van Looy, Ranga, Callaert, Debackere & Zimmerman, 2004), and most empirical studies also show that external sponsors give more money to institutions which have high-quality researchers, (Kohrman, 2008).

Substantial applied research is also frequently undertaken by universities and government-subsidised research centres both to serve the direct needs of industry without direct collaboration, and to develop national innovation strategies through new products and industrial processes and through contributing solutions to social and economic issues (Harman, 2006). While we know that the funding priorities involved in industry/university collaborations differ significantly for each party, the collaborative relationship is consequently of equal significance to academic and industry science.

Having identified this direct funding difference, it is essential to note the two main areas of impact on the collaborative project. The first is a difference in each of the collaborative parties' funding bodies and therefore the priorities of that funder; and the second is a difference in how each of the collaborative parties views its asset outcomes from a project.

2.9.2. The difference in funder priorities

At the beginning of any project, the funds are approved due to the possibility of a desirable project outcome, and the provenance of these funds produces different project performance styles. Gulbrandsen (2005) found that the type of funding gained, whether internal or external, gives a significant relationship style difference between funding and research performance. Professors with industrial funding describe their research as applied to a greater extent than professors without such funding. They collaborate more with other researchers both in academia and in industry, and they report more scientific publications as well as more frequent entrepreneurial results, so the trend towards collaboration has been shown as a positive one.

The trend is also continuing with universities in many countries establishing closer and more useful links with other research providers and stakeholders, particularly private research institutes, industry laboratories, business firms, and government laboratories. These links take a variety of different forms, including joint research centres and research appointments, shared use of facilities, industry funding of university research, and consultancy arrangements between universities and research users (Harman, 2010). It is not surprising that universities would want to grow these relationships, as this is where the majority of their research funding is gained.

Funding in the private sector, though, has its difficulties. For one, the fund holder is most usually the decision maker, and as such, funding can also be seen as a device of control for the industry collaborator. Barnes et al. (2002) in their study of six industry/academic collaborations noted that after a directional change in the project, two of the primary funding organisations withdrew after stating 'we weren't getting a reasonable return on our investment' (p275).

For industry though, there are many incentives. In their study of 210 life sciences companies, Blumenthal, Causino, Campbell and Louis (2006) found that more than 60% of companies investing in academic research have realised patents, products, and sales as a result. It was also noted that the sponsorship of university research did not differ significantly from the return on investments in research conducted elsewhere, giving no disadvantage to the collaboration.

Results are not always enough, however. Although research relationships with academic institutions can produce benefits with immediate commercial value, industries perceive themselves as depending on the academic sector more for the access to ideas, knowledge, and talented potential researchers than for specific marketable products or services. Blumenthal (2006) surveyed a number of companies with research investments and reported the following observations: 56% of the companies surveyed depend on faculty members to "keep staff current with important research" 53% depend on them to provide ideas for new products; and 37% rely on them to aid in recruiting able researchers. Only 29% of companies reported that they depend on faculty members to invent products that the company will license (p371).

As noted in Section 2.9.11 the values of the academic research environment are often at odds with the values of industry research. The industry is oriented towards secrecy to gain a competitive advantage, while academia requires open dialogue and debate for peer assessment (Natural Sciences & Engineering Research Council, 2007). Industry research is also seen to be geared towards applied research rather than basic research. To bridge this gap, government funding has focused on promoting collaboration among knowledge-based organisations by providing national innovation strategies.

2.9.3. Differences in asset distinction

A second fundamental difference is how academia, industry and government make distinctions in asset accretion between commercial and academic collaborative science. Academic science is primarily conducted for the sake of knowledge; commercial science is done for marketable products; and government science is for public enterprise and to guide the economy, seeking to fill the inadequacies of the private sector. Although they all work within the same principles of research, they follow a different set of rules (Shmaefsky, 2002).

It is not unexpected, then, that many academic managers still contend that their environment is 'unique' and not amenable to a generic project management framework, or project management models and techniques (Liberatore, 2009). Indeed, there are ambiguous links between project costs and performance measures and the overall achievement of differing goals on one plane, and the realisation of benefits to the collaborative partnerships on each of the others. The commercial nature of such collaborations has led to a need for a better understanding of project outcomes, as is evident from the use of such measures as Net present value and Cost-benefit analysis. These are measures not currently used in academic research projects, and for a long time, there has been a call for robust empirical evidence to see the results of the commitment of public money to tangible outcomes (Clarysse et al., 2009). This is also apparent in academic research where the impact and influence of the research is an agenda that has been gathering impetus over the last few years. This agenda is a coming together of two divergent concerns. The first, from the funders of research, draws on results-based management and is concerned with getting value-for-money from research spending. The second, more typical of those in the development studies research community, is concerned with whether research in this area is making a difference (Sumner et al., 2009). Jordan et al (2005) also looked at the managerial tensions around such risk, time and size of possible payoff, and the differences in task, process and outcomes depending on the mix of scientific and technological research, all of which need to be clearly defined.

This payoff is not unknown in project management circles and was traditionally referred to as the triple constraints (Shenhar, & Dvir, 1997) shown in Figure 2.3. The triple constraints model has been a primary concept for teaching project management, used as a project success measurement method. The triangle represents the model with the scope on the horizontal leg, time on the left leg, cost or resources on the right leg and quality in the centre of the triangle, the quality of the output being the driver of the outer three attributes.

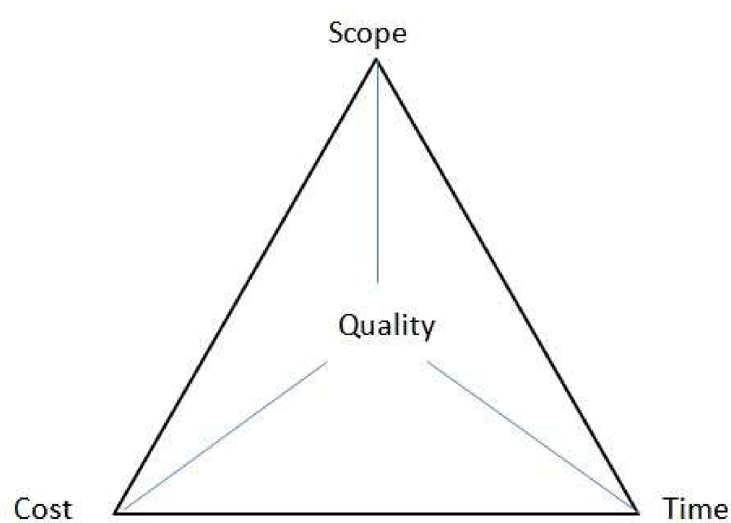

Figure 2.3. The project management triple constraints model (Shenhar, & Dvir, 1997)

The challenge of every project is to be successful within the constraints surrounding them. These three elements of a project are known to work in conjunction with one another. Where one of the components is restricted or extended, the other two components will then also need to be either extended or increased in some way or restricted or reduced in some way. There is a balancing of the three elements that allows for the successful planning, resourcing and execution of a project. However, this has been replaced in recent years by the project management diamond (Avon & Dvir, 2007) shown in Figure 2.4., which now weights the quality of a project on an equal basis to the other three constraints and recognises the expectations of the project as the central driver. These are currently used as the critical elements of a successful project and are the areas that determine whether a successful outcome has been produced.

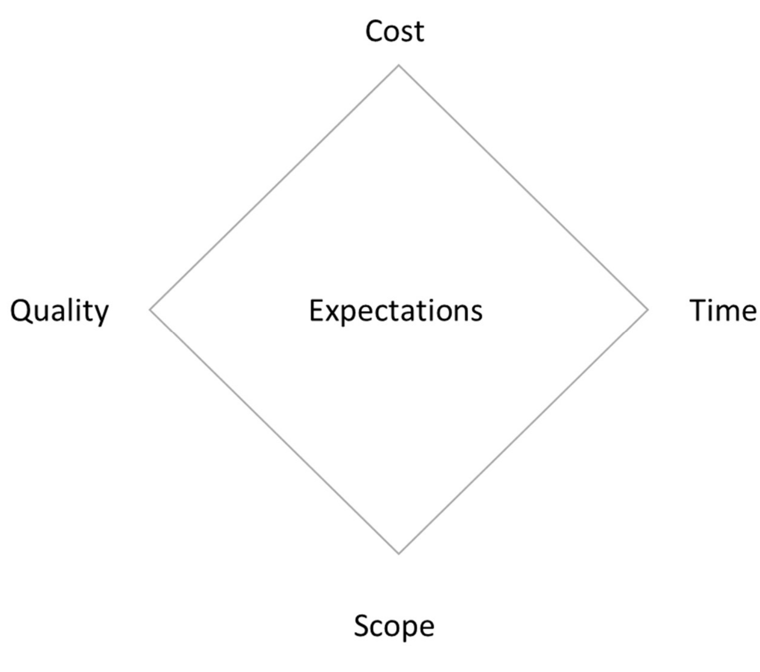

Figure 2.4. The project management diamond (Avon & Dvir, 2007)

Commercial researchers, however, are very much concerned with the potential of commercially viable outcomes from their research, as is evident with their use of Net Present Value and Cost-Benefit Analysis. While academic researchers are also concerned with their outcomes, there is often no compelling need for commercialisation of academic research, or for the process of getting to that outcome. These are almost 'nice to haves', with the main focus being public good. In most cases, commercial researchers need, however, to justify the spending and the commercial viability of their projects before they can begin. Governments have similar processes to industry where a business case is required for projects to continue whether they are for an internal department or strategic importance that may change government policy.

Consequently, to gain and maintain a collaborative relationship, it is important to ensure that all associates realise a reasonable level of proprietary gain from the partnership, even if the nature of their involvement in the project is subject to change. From this discussion, we can see that there is a difference in the driver for the organisation types. The commercial organisation is driven through a return on investment; the academic organisation's driver is primarily that of the public good; and the government organisation is driven primarily for public enterprise, but also proposes to aid collaboration between academic and industry entities. Both how a project is funded and what outcome desirability each partner has in the project are differences that need to be acknowledged before the research project begins.

2.9.4. Project

2.9.4.1. Project from a collaboration perspective

Another area of significant difference in the collaborative environment is the principle of the organisation's project work or how the organisations projects are enacted. Project work in industry has a short-term completion view, and while corporate short-termism has been a subject of ongoing debate, a recent survey by the McKinsey group (2017) with a data set of 615 publicly listed companies suggests that pressure to deliver reliable short-term results has increased over the past five years. In comparison, university academics follow streams of similar projects which are strung together, either to explore a subject further or to explore different facets of a topic, and this may continue for their full career. Government, while setting policy, may only see projects undertaken during the term of the governing party. With this in mind, the academic will usually build and maintain relationships with others in a similar field, running research groups and creating a long-term view of their subject, including sending links to industries within their research area to expand their collaborative base. A track record of successful collaborative research may also be an academic driver, and capitalising on these pre-existing or heritage relationships also increases the chances of project success (Gratton, 2007).

2.9.4.2. Project from a project perspective

Understanding the management of research projects is a topic still in its infancy, with only one global project body of knowledge (project management body of knowledge or PMBOK) to interpret the needs of all forms of projects. The original PMBOK is based on traditional types of project work that have a distinct flow from beginning to end. A second agile PMBOK was added in 2018, developed specifically to deal with iterative project types; both were produced by the Project Management Institute in America. What a researcher needs to do in their work is paramount to designing any framework or methodologies that can accommodate their needs. Shenhar (2001) noted that there is little if any recognition that the difference between types of research projects has translated into the need for different project management practices, and there is very little empirical evidence on better understanding what research workers want or need to do their work (Jordan et al 2005).

Knowing the drivers of research collaborations is fundamentally diverse. Given that their distinction of assets is also quite different, it is not surprising that the justification for research in each organisation will differ. As Lindgreen, Benedetto and Verdich (2019) noted, there needs to be sound reasoning behind the work that is to be done to gain initial funding. For university projects based on a stream of research or the researcher's stream of expertise, justification may need to be made by linking prior and future research into the same area of study. While short streams may be carried out for industry or government projects, a previous stream of work in the same area is not a pre-requisite for project justification in either, and as such is another point of difference. For each of these areas, the rationale has to fit in with the governance structure, which is again quite different between industry, university and government. Within collaborative projects, however, all three governance structures need to be accommodated.

This also includes the planning of a project which is primarily done to relieve uncertainty. While a plan does not have to be all-encompassing, it should include as much information as is known at each stage and the plan is also used to set the expectations around governance, leadership, intellectual property, collaboration, communication, and outcomes which in the case of the collaborative project are multi-faceted. There are many issues around planning which serve the purpose of expectation setting, and these need to include deliverable outcomes with an understanding of the effort required to achieve them.

Applying any form of project management looks at both facilitators and inhibitors that impact successful operation. In the case of the UIC, those factors which were correctly managed had a positive effect on the perceived success of knowledge and technology exchange; and those that were neglected or mismanaged tended to have a corresponding negative impact on the perceived success of knowledge and technology transfer (Ankrah & Al-tabbaa, 2015).

2.9.5. The difference in project justification

Project justification begins with the research concept, following which the initial goal for industry research is to design and execute a plan, within the budget available, that leads to a favourable decision for the company that commissioned the research. Companies rarely allow freedom of research; projects have to follow the strategic direction of the company. In industry, objectives are the descriptions that support corporate direction, such as increased revenue and decreased expenses, and are usually realised at a future time (Tomczyk, 2005) justified through accounting practices such as Internal rate of return and Net present value.

Hammerstedt (2011) pointed out that a faculty member in most instances can study any area of interest, "follow their nose", provided they have the skill set and connections to raise the funds necessary to support that research. As a result, this aspect, so critical to the knowledge-based economy, must be protected. If the funder is in industry it is unlikely that an academic can have this same freedom; government grants are more likely to fund such research. It is government agencies such as the Ministry of Science (MIS) that are moving the focus away from pure government funding and towards industry funds. Also linked to academic project justification, has been a move towards competition and selectivity, ensuring that core research funds are increasingly allocated according to criteria of quality and performance. As with many of the past university research drivers, the primary motivation for change has come from outside the academic institution, and to some extent outside the higher education system as a whole (Hazelkorn, 2005).

The industrial research fit has therefore primarily been driven by the need to justify projects against strategic goals or criteria, where academic research is mainly justified through the funding decision, which may increasingly be a decision made by an industry funder with a different case for project justification.

2.9.6. The difference in project streams

The difference in project justification for an academic research project as established in the above section is related to the need for an academic career to be established, with academic researchers showing a clear strategy in the way they see their research developing. This often includes how the researcher will develop and extend their research field if there is a possibility to run their own research group and establish productive collaborations (Manchester University, 2011). A career in academic research should be flowing or connected and can become a career research stream run by a dedicated academic, with other academics joining due to an inherent field of interest.

Commercial projects, however, are defined as a temporary endeavour undertaken to create a unique product, service, or result. They are temporary in that they have a definite beginning and a particular end. There are few definitions of duration, except that projects are not on-going efforts, and should be finite (Sa Couto, 2008). The research project definition does not emulate the description proffered for commercial projects, but there needs to be a distinction made between the longer-term research streams in the academic field and the intentions of industry to appreciate the project driver.

Government projects are defined on both a local and global level, following policy and economics, and can fall into both streams of work and temporary endeavours, which is driven by the political agenda of the current government party in power and is often survival based (Harrison & Callan, 2013).

Research streams are often incorporated into the academic's employment contract. Academic employers want to see an excellent research track record and feel that the best is yet to come. A researcher generally has to have thought through a strategy for the way they see their research developing. As previously stated, this includes how the researcher will establish and extend their research field, develop a research group, and develop productive collaborations. Manchester University (2011) and Kirkland (2010) also noted that governments seek greater accountability from universities, and that this is linked to the monitoring of research outcomes, and tied to research funding by measuring a range of criteria, including publications, research income, research students and environment and esteem (p319). In contrast to this, project managers in industry are unlikely to need to string together a set of projects to prove a stream of work; their success is measured more on leadership competence. Muller and Turner (2007) identified the correlations between success and project managers' leadership competencies, using a composite measure of project success; they then confirmed their results in a leadership competency profiling project in 2010.

2.9.7. Difference in governance

As well as justification and streaming of projects, we have to look at how the projects fit into the corporate governance structure of the organisation, and again, this differs in the three entities. General corporate governance deals with how the suppliers of finance to corporations assure themselves of getting a return on their investment. This question has not traditionally been asked of a university (Kolt, 2010). While a quality delivery is a high expectation, return on investment from a fiscal view has not been on the governance agenda until recently.

Such new academic research policies and modern governance arrangements (efficiency, effectiveness and output-oriented cultures) have become increasingly important, and these new policies are transforming the role of academics (Leisyte, Enders & Boer, 2009). In line with this trend, Aghion, Dewatripont, Hoxby, Mas-Colell and Sapir (2009) observed that, while academic research is a complex area, universities can only pursue frontier research effectively if they have the discretion to direct resources and researchers towards what is believed to be the most promising paths, and this is unlikely to involve industry funding. Outputs from universities studied in the UK and USA showed a direct correlation between the success of outputs and the autonomy given to the university. Generally, academic institutions are recognised as autonomous actors with varying degrees of interdependence, and with legislated commitments to external stakeholders, and to local and national government for their governance (Kezer, 2004) through the rules, contracts, relationship management practices, ranking systems and other coordinating mechanisms that oversee performance.

The former remit, however, being progressed by such government bodies as MSI, is moving universities towards more industrial collaborations for research funding and research outputs, and managing their obligations and potential liabilities, using contracts to manage the process. Universities assuming responsibilities in this manner need to observe strict confidentiality and ensure that appropriate managerial procedures are in place (Kirkland, 2010). The commercial governance model used refers broadly to the rules, processes, or laws by which businesses are operated, regulated, and controlled. The term can refer to internal factors defined by the officers, stockholders or constitution of a corporation, as well as to external forces such as consumer groups, clients, and government regulations as mentioned previously. Governance of any organisation will dictate which research projects are chosen to complete.

2.9.8. Leadership

2.9.8.1. Leadership from a collaboration perspective

If we look at the industry, university and government environments, we find distinct working styles, which, when put together, should produce synergies. Looking at the project leader in each organisation, the academic leader's method is one of a pragmatic scientific approach (Harwood & Hadley, 2004) perfectly suited to project planning; these characteristics would ensure that preparation for the essential elements needed in the project are covered for smooth delivery. The industry project manager has a focus on the commercial aspects of time, scope and cost (Peterson, Fischer & Wingate, 2009) with the commercial outputs as a focus, and government leaders would ensure that the initiatives support economic potential and economic growth areas.

2.9.8.2. Leadership from a project perspective

Following on from funding and project fit, leadership is widely debated in collaborative projects, with much discussion around which party should lead, and whether this leader should be the funder, or whether there should be joint leadership. There is also discussion around the ways that the project leader should assign work to the other collaborative team members. There are also many issues cited regarding location or co-location of teams to make the leadership role an easier one (Curlee, 2011; Drucker, 2010; Juli, 2010; Toth et al, 2012). When we look at leadership within this collaborative environment, we find the likelihood that leadership style may not be the same. The collaborative party may be a dual collaborator of industry to university, government to university or industry to government, or a tri-party arrangement with all three entities involved. The mix of collaborators will also dictate what they need to achieve from the project.

A study by Anantatmula (2010) looked at the importance of the project leadership role to innovation projects. His study showed that defining project processes and roles is the first and most important step of managing and leading projects successfully. These definitions lay the foundation to create clarity and communication expectations, and to employ consistent processes amongst the team. It was found that innovation is dependent on the project leadership role to establish trust, open communications for knowledge sharing and team development.

2.9.9. Difference in leadership

Within the university environment, many projects can be counted as innovative; specialist researchers are the norm, and intellectual property is the likely outcome. The principal investigator is a leader who is passionate about the work done and is the owner of the outcome, as noted by Greenhalgh and Rogers (2010).

Industrial project managers are leaders who rarely owns the project outcome. They are also usually a project manager by profession and not a researcher. Their vested interest is a definite career output, for their future career. Their tenure means they are rarely the owner of the outcome. Government projects can be either, depending on their aim.

Barnet et al. (2002) covered leadership in a study of six similar aerospace and automotive industry/academic collaboration projects, in which they found that, for a successful project, the leader needed to be an experienced project manager, with the ability to provide a definition to the project in the ways shown in Table 2.5.

Table 2.5. Leadership qualities

- Clearly define objectives
- Clear responsibilities
- Good project planning skills
- Realistic aims
- Good project monitoring
- Clear reporting and meeting structure
- Good resource planning
- Adequate skills and training
- Effective communication

Within these project management skills, the study noted some crucial issues that came out of the collaboration:

- The importance of collaborative experience amongst partners
- Commitment as a vital characteristic of successful collaboration
- Trust amongst partners
- Continuity of personnel (particularly continuity of the project manager)
- Corporate stability in all partners

When the leader is not the owner as in many collaborative projects, there is a need to manage perceptions and issues on both sides regarding such individual needs as the academic's right to publish and the industry's right to a patent. Given that these issues are reflected in the findings of the current literature review together with the others noted, the difference in leadership and consequently ownership of the project outcomes leads to a differing set of objectives throughout the project. Principal investigators are passionate about the work for their future career path; while industry management is directed more towards a structured objective setting, with progress monitoring, and effective output management to run the collaboration process; and government leaders are looking to have an impact in their role.

2.9.10. Teamwork

2.9.10.1. Teamwork from a collaboration perspective

While studies may show that collaborative networks improve the chances of project success, this message is not as well known in industry. There are reports of relationship problems in industry and university collaborations, including organisations that did not believe in the power or the collaborative network to innovate (Ateah., et al. 2011), or were not able to convince other employees in their own company to do so. There was also mistrust towards the academic world by industry teams. While no empirical evidence was found, it could be postulated that the lack of trust in the academic team may be due to the increasingly collaborative nature of academics, which is in opposition to the lack of intrinsic trust in a newer team put together by the industry collaborator. The longevity of teams for project success is a subject with very little research reported as this is in contrast to the traditional project frameworks. In direct opposition to this, in university settings, continuity of teams is essential to the success of on-going streams of work. Barbolla and Corredera (2009) also postulated that previous collaborative relationships leading to collegiality appeared to produce better results, and that longevity is a crucial component. So while the difference in collegial natures is reinforced in tenure, this should be of benefit to the collaboration. This past embedded learning process is also a benefit to future projects.

Many areas relate directly back to traditional project methods, such as the need to team-build regardless of time or physical location of the project. Also, the collegiality of the university team as opposed to the quite disparate industry team structure poses the issue of how we put two entirely different teams together in a coherent project. As well as collegiality, there are issues around the control of the team and which leaders can successfully direct both teams. This model emulates that of many consulting teams in industry, although these specialists tend to do multiple similar projects. Rather than extending the subject, it may be possible to develop their engagement models to use with research collaborations.

2.9.10.2. Teamwork from a project perspective

Leadership is seen as crucial to the success of collaborative projects (Muller, 2010). Project outcomes, however, are dependent on the leader building and understanding their team. Team collaborations in industry projects have many models, as shown in the book Organisational Models for collaboration by DeFillippe (2002), that show and describe how to put together a team, get the team to a productive state quickly to produce the project deliverables, and then disband them efficiently when complete. These models are the basis of industry teamwork and, by their nature, do not allow for longevity of teams. As mentioned earlier, these models reflect the one-off nature of projects as we currently categorise them. Universities, however, do not have the same distinctions, working on streams of projects with team-members that may work together on multiple projects over long periods; university researchers will actively seek out others in their field of expertise to develop their subject. Putting these different styles together potentially means that on the university team there will be a set of collaborators who are used to working together as a team, and conversely an industry team who may be virtual strangers.

This difference in collaboration also leads to a difference in collegiality. There is little if any need for collegiality in the industry project team when members know that the team will be disbanded upon completion, and members will move back into either previous organisational roles, where original collegiality is based, or onto another project with another set of strangers. University researchers, however, will have a propensity to keep collegiality in their team with a view to future project endeavours together. From a research perspective, Jordan et al (2005) suggests that emphasis on more radical advances such as those in innovation is best accomplished by a complex team, but that the integrating of this diverse knowledge set is often too great a challenge and commonly means giving up some organisation autonomy because the scope of expertise may reach across more than one organisation. The analysis done by Jordan shows that more complex projects (defined as those involving six or more departments) have significant variance in organisational and environmental attributes due to this inherent complexity, at least as perceived by the scientists and engineers involved.

2.9.11 Difference in team collaboration

The way that academic research teams work is quite different from traditional project teams. The system for conventional project team development works systematically through several stages and has not changed since it was introduced in 1965. The team comes together, works on one project and adjourns, as shown in Figure 2.5 (Tuckman, 1965).

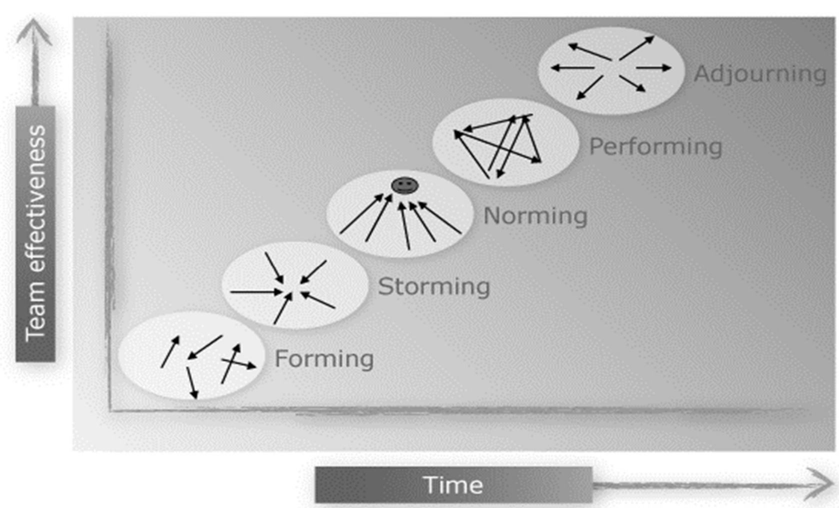

Figure 2.5. Overview of team development stages (Tuckman, 1977)

The last stage of the process; adjourning, is much less of a distinct act in academic research. Researchers, due to their specialism, usually have much longer, multiple project collaborations, or even life-long collaborations, so the forming, storming, norming and performing stages will happen with considerably fewer iterations in the lifecycle of their research. Heritage relationships as they are known, are already built based on trust, which is necessary for a successful collaboration. Forming teams that capitalise on pre-existing, or heritage relationships, increases the chances of a project success, while new teams, particularly those with a high proportion of members who were strangers at the time of formation, find it more difficult to collaborate than those with established relationships. Newly formed teams are forced to invest significant time and effort in building trusting relationships before performing well (Gratton, 2007).

The high-stress environments of projects are well documented and discussed (Hoegl, Ernst & Proserpio, 2007) and the tensions around innovative advances have also been looked at as a factor that needs to be acknowledged in any methodology scenario. The pressures of creating a team, while innovating, for each project entered into, is also reported as a known tension. With the steady growth in collaborative and interdisciplinary research, there is a need to cover as many potential options as possible to eliminate stress. The growing complexity of these relationships has led to the development of a significant body of academic work analysing the relationship, such as the Triple Helix model Erzkowitz (2002). In the Triple Helix configuration, research, technology, and development networks are increasingly found to change the relevant environments for research and development.

2.9.12. Difference in collegiality

The ability to forge good relationships is a research skill which featured highly among the attributes identified as being important by research managers in an international survey by Stackhouse (2008), and both the New Zealand and Australian governments have taken on a facilitative role by producing initiatives that foster ongoing collegiality through partnership initiatives. Where people think and act collegially, there is a fundamental and shared commitment to recovering the joint assumptions and perspectives they hold to be true about the nature of their work, which binds them together in that work (Smyth, 1989). In order to understand the fundamental foundations of university management, it is vital to appreciate its links and sentiment towards collegiality. It is also important to recognise that it provides autonomous conditions for academic activities and focuses, avoiding strict models of management and administration (Fear & Doberneck, 2004).

In their study of critical success factors for university-industry research projects, Barbolla and Corredera (2009) found that mature knowledge and a good command of the necessary expertise to undertake a project, high confidence in the university team, and confidence in the project results were critical factors in the success of projects. Interestingly the potential for disaster and risk planning were not critical success factors. Barbolla and Corredera (2009) also postulated that previous collaborative relationships leading to collegiality appeared to produce better results. Traditionally, projects are temporary structures and do not offer longevity, as they are predominantly engaged in the creation of unique products or services. While they require cross-functional skills for successful execution as with university research, they are characterised by organisation, implementation, and the evaluation of work performance constraints and environmental uncertainties (Turner & Simister, 2004).

The collegial culture of academic researchers allows for autonomy and freedoms recognised as indicators of scholarly empowerment. Conversely, the managerial culture of industry that values fiscal responsibility and practical supervisory skills, and that conceives of the institution's enterprise as the indoctrination of specific knowledge, skills, and attitudes, is that mirrored in industry (Bergquist, 1992). The difference in the collegial natures of industry and university teams is reinforced in the longevity of their collaborative styles of work but should also be of benefit to the collaboration. Whereas some differences found could be seen to cause tensions or opposing views, collegiality in a team is a positive factor and a benefit to the project.

2.9.13. Completion

2.9.13.1. Completion from a collaboration perspective

Many of the areas addressed in the literature relate directly to the project environment and how these projects tend to differ in set-up, execution and completion. At the start of all planning exercises, the project looks at aims or deliverables to find where it is planning to conclude; as such, there is a need to incorporate deliverables from all collaborators (Fraser, Farrukh & Gregory, 2003). Those deliverables aid towards an understanding of where the parties want the project to go for the rest of the team. Like innovation, this is not an exact science and change along the way is acceptable as long as it is communicated and documented well. Due to the differing focus of each collaborative partner, it is essential, therefore, that these deliverables are verified by the organisation owner, either a sponsor or steering committee to avoid a later conflict of ideas. There is also a balance that needs to be reached between the need of university researchers to extend their thoughts into future work based on the current project, and the need of the industry and government teams, which will be focused on the short-term completion of the project.

The drive for deliverables in innovation might be an unrealistic goal of university research, which is not always going to be immediately quantifiable but has been reported as more possible in collaboration with industry. These outcomes are being driven by traditional project pay off models and accounting tools not used in university research. The definition of successful outcome needs to be understood by both parties, and while it may differ, more than one deliverable is possible in a project. As noted by Myers (2019), there is also an inherent need for commercial researchers to justify spending and commercial viability of their projects before they can begin, also in difference to university researchers.

While timescales might be longer, there is a reasonable justification for this in university research projects, and to cover this need may mean a closure phase directed by the university researcher that incorporates the extra deliverables needed. Therefore, while the end of a project is consequently the end of collective learning (Shindler & Eppler, 2003) for industry, it need not be for university. The disjointed industry process typically causes time delays on future projects together with stress as team learning ramps up from the beginning again; lessons could be learned from the university collaborator on scientific review and the ability to create a more extensive knowledge base for future projects. Scientific review, especially in the form of peer review, is an essential difference in collaboration between industry and academia. Replication is not an issue in regular project work because, in many cases, projects do not need replication to be accepted as a credible piece of research. The review is also relatively unimportant in many instances until a project goes wrong. Peer review, however, is a quintessential idiom in science.

2.9.13.2. Completion from a project perspective

Timescales are essential to all projects (Salkeld, 2016), with the aim being always to move towards the goal of completion in a timely manner, and, in the case of a research project, towards research goals; predicting accurate timescales is a vital role of the project leadership. Timescale is heavily dictated by the method a project uses to produce the outcome, and methods are built around how to use the optimum path for successful completion as prescribed by the constraints of time, cost, scope and quality in the project constraints model (Ebbesen & Hope, 2013). There are many methods being used in current project management practice, all with the aim of completion as the primary goal, and whilst a plethora of methodology exist, none has been developed relating to this collaborative project style, as such no method is available to determine the different definitions of complete for this style of project. Other project domains have many methodologies written to guide a project through to completion. Table 2.6. lists 18 agile methods mainly used for software development projects. Many of the methods may appear similar, and this is related to the uniqueness of projects: one size does not fit all, and the project leadership decides which method to use. Like many other project developments, many are based on a similar method with a few specific differences and all are based on the PMBOK framework. The top six methodologies in Table 2.6. are the main methods used in software development, and each of those listed below has been developed progressively from the top six methods.

Table 2.6. Software methodology examples

List of software development methodology
• Waterfall development • Prototyping • Incremental development • Spiral development • Rapid Application development • Extreme programming • Rational Unified Process • Agile software development • Object-Oriented Programming • Scrum • Team software process • Top-down programming

- Unified Process
- Domain-specific modelling
- Lightweight methodology
- Object modelling language
- Structured programming

What has not been produced is a methodology that incorporates the scientific rigour needed in university and other scientific research with the completion of academic goals. University collaborators need their work to be peer reviewable; most industry collaborators do not. To incorporate the necessary review points and documentation requirements for a peer-reviewed project, we need to include phases that allow for these needs in parallel or an extended timescale for academic completion. This is in direct opposition to current project thinking with many methodologies being written to cut out extensive reviews and controls to complete more expediently. Timescale needs are therefore quite different from these collaborative parties.

This also means that their definition of completion will differ. Many industry projects are disbanded before project documentation is complete, this being seen as the least important role of the team in many cases. Usually, the project leader is left to produce any 'lessons learned' documents, and if there is incomplete process work, it is passed over to be completed at a later date if necessary. The parts of the process that industry collaborators are least interested in are quite possibly the parts of the process that are of most importance to the university collaborators. This ultimately leads to an expectations difference throughout the project and of project completion.

2.9.14. The difference in timescale uniformity

Timescale is one of the borders on the project constraint model, and as such bounds traditional project work. While a timely result is also essential in university research, the force of this factor on academic projects is not as fervent as in industry or government. In their study of industry-university collaborative projects, Barnes, Pashby and Gibbons (2002) noted that university academic researchers raised concerns that the industrial partners' short-term focus and desire for quick results were being satisfied at the expense of academic progress. They also noted that many academic research projects are more open-ended, allowing for expansion and changes in plans, as new knowledge created during the project leads to further developmental awareness. The purpose of traditional project management is not to keep the project going beyond the initial goals.

Traditional projects, as mentioned above, are governed by the project constraint model, which essentially helps to identify methodology types and govern the process. The model quite simply points to which areas are the drivers on the project, around which methodologies and tools can be identified and used to satisfy the right drivers. In most industry projects, there is often a tight equilibrium between time, cost, scope and quality, leading to a completed project. It does not allow for methodologies which follow scientific rigour or research methods (Boronico, Zirkler & Siegel, 2011). The timeliness issues in UIG collaborations need not be an issue as long as there is an understanding when the collaborative process begins that specific goals of the project from an industry partner are needed sooner than perhaps the goals of the university researcher. Those assumptions, however, do need to be noted and added as part of the project methodology. Without the understanding of timescale necessity, projects could be deemed complete with differing standards.

2.9.15. The difference in the definition of complete

While timescale can be perceived as an issue on the project, the main question is more of what represents a project deliverable. Project methodologies are generally geared towards deliverables, and while deliverables are essential to all UIG collaborators, sound scientific research is equally, if not more, critical to academia, and needs to be incorporated into any methodology produced to run the collaboration. This leads to a more rigorous but longer process than in general industry projects.

Jordan et al (2005) looked specifically at types of research project success and noted that groups in technology-oriented projects rate project measures of success and laboratory-wide measures of success lower than did those in science-oriented projects. It was speculated that this might be because publications and patents are an accepted measure of progress and deliverables for research projects in a science-oriented organisation, while technology-oriented projects are measured against a different set of deliverables. This statement points to the understanding that one size does not fit all. Kirkland (2010) noted the same in his paper.

Looking at the current industry standards for projects, which are primarily governed by the institutional bodies that produce their standards material, the Project Management Institute denotes a deliverable as an end product to a project that meets project requirements. In full;

> A project is temporary in that it has a defined beginning and end in time, and therefore defined scope and resources.
>
> And a project is unique in that it is not a routine operation, but a specific set of operations designed to accomplish a singular goal. So a project team often includes people who don't usually work together – sometimes from different organisations and across multiple geographies.
>
> Project management then is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements.

(Project Management Institute, 2018)

The emphasis here is placed on commercial exploitation, through the sale or licensing of intellectual property or product, or the establishment of commercial gain or spin-out companies. This focus also explains why there is such pressure from university management and government to see tangible returns that can be quantified, and to complete a project from a commercial viewpoint. In recent years there has been increased recognition that innovation is a more incremental process than previously imagined, rather than being driven by sudden leaps forward. In addition, it has been recognised that what is transferred between universities and society is better classified in terms of broad knowledge than more specific technology (Kirkland, 2010). Therefore, the completion of innovative projects such as those likely to be delivered by collaboration is problematic by definition, with no common language around the deliverables these projects produce. This type of completion needs to be more thoroughly researched and understood.

2.9.16. Intellectual property

2.9.16.1. Intellectual property from a collaboration perspective

Intellectual property and its use in a project are governed through contracts. In the case of university research, this is perceived to be quite low risk. In collaboration projects contracts help to prevent any unnecessary uncertainty or disputes regarding ownership (Alexander, Ng, Kroll, Koster & Ellison, 2010). Industry tends to cover this through employment contracts allocating intellectual property to the organisation.

Who owns the intellectual property of research outputs is, therefore, a simple matter if there is only one researcher working on the project. Once anyone collaboratively joins the project, however, the subject becomes complicated, and there are intellectual property lawyers who specialise in the subject. Intellectual property and its use are usually negotiated in the initial contracting phase of a project (Merges, 1996). The project team members need to be aware of their obligations regarding intellectual property; however, he only ones involved to any extent in its negotiation will be those who are generating it, primarily the principal investigators from the university, and the company directors in the industry organisation. Government research contracts are individually negotiated; as such, this is a precursor to the project but is possibly the most crucial process. It will dictate the viability of the project to all parties that require the ability to publish results as part of their career credentials, as well as organisations that need the ability to produce commercially viable outputs, and government who want to optimise the economic return of the research done.

2.9.16.2. Intellectual property from a project perspective

Intellectual property created on the project is usually the responsibility of the project leadership, and while the intellectual property for all parties will be the developed outcome, how each party wishes to present or use that outcome often differs in the collaboration. It is, therefore, essential to understand the intellectual property needs of each to make the project workable. When we are discussing intellectual property, it is necessary to note that it may not be the property of a single leader: intellectual property may be owned either by each of the collaboration leaders or the company owners in the form of the company managing director, to whom the project leader will be reporting.

2.9.17. The difference in intellectual property ownership

Intellectual property is usually governed by the project owner and fits under the remit of project leadership; traditionally, the leadership owns the most significant proportion of intellectual capital in contract collaboration. Kirkland (2010) mentions expectations of rigorous procedures for the identification and protection of intellectual property; systematic analysis of research results; customer satisfaction; and broader dissemination and strategies as a major part of research projects. There is also postulation in his work that research management will increasingly need to imitate the processes of project management to ensure this reality.

Apart from intellectual property and projects with possible income through commercialisation, university project risk is perceived to be quite low. Research management and research funders are mainly interested in the intellectual property and outcomes of a project, and less in the process of how to get there. With large academic projects being controlled by contracts written around intellectual property ownership and knowledge building, the question of who owns the intellectual property is a vital component of the research, and of a researcher's credibility.

Industry ensures ownership of various forms of intellectual property, with employment contracts that contain a clear assignment of rights of the intellectual property that may be created by employees during their employment. Employee roles and duties evolve, and employment contracts are revised and updated, to prevent any unnecessary uncertainties or disputes regarding ownership (Alexander, Ng, Kroll, Koster & Ellison, 2010).

2.9.18. Scientific endeavour

2.8.18.1. Scientific endeavour from a collaborative perspective

While working on project outcomes, it is important to decide what methodology type suits the work to be completed. There are many methods used in industry, each with a different application. It is likely, therefore, that multiple methodologies will be needed for university research due to the schools of study available, and to the fact that it is an area where few are currently proffered. The higher level of organisation is the project framework such as the PMBOK, designed to encompass multiple methodologies.

Methodology for collaboration is still necessary as this would incorporate scientific rigour, with a framework being an essential starting point. The specific scientific review points and documentation requirements needed, as well as extended timescales or phases required for scientific review, would be incorporated into a methodology. It is also at this level that timescales and a complete understanding of the project are viewed by all parties. The concept of being complete may also refer to different points of time within a project for each of the collaborative parties. The issue here is that the parts of the process that industry collaborators are least interested in are quite possibly the parts of the process that are of most importance to the university collaborators, and possibly government collaborators if their research needs the credibility of a scientific review process for its acceptance. Scope for further research may be part of the process with regard to the university researcher deliverables, but this may need to be rolled into a separately funded project. Any guidelines produced also need to align with their host organisation (Boeme, 2002). However, a generalised set of guidelines could be developed for the effective management of collaborative research and development projects for the collaborators and tailored to suit the project under development.

A rigorous process is a given in university projects, and research funders are also now driving the review process in research projects. At present, the focus is on business-auditable processes, but there is also a call for compliance in the project environment. Universities are more heavily regulated than industry, and audits are not unknown, and these requirements also include ethics reviews. Reforms in many industries in the private sector are emerging but remain under-regulated, and as such they are being taken up more slowly with industry not always obliged to follow them. The case for research ethics should be easy to justify, as more stringent requirements help to safeguard the success of a project. Influencing the decision, however, is made much harder by the associated costs of such rigour. There are, therefore, a number of parts of a collaborative framework which are known to be needed in this partnership type.

2.9.18.2. Scientific endeavour from a project perspective

The difference in timescale and quantifiable completion for university collaborators centres around the need for all university research to have proper scientific rigour applied to it, which means it can then be peer-reviewed, replicated if necessary, and accepted as a credible piece of research. This also goes beyond scientific review into both the working ethics and the project ethics of a university researcher. Work ethics are also high on the agenda of industry collaborators, with project ethics less so, and scientific review is relatively unimportant in many instances until a project goes wrong. While no reports are yet produced specifically on collaboration project success rates, the Standish group provides a standard industry report, the CHAOS report, which reports specifically on information technology project success rates. Their most recent report in 2016 surveyed 50,000 projects from small enhancements to major systems re-engineering and found only 29% of I.T. projects were considered successful. They fit the criteria of completing on time, on budget and with the required features and functions. Nearly one in five (19%) of I.T. projects were considered failures, cancelled before completion, or having been delivered but never used. The rest (52%) were deemed challenged: they were finished late, over budget, or with fewer than the required features and functions, and these projects are precisely quantifiable. Whilst many reasons are reported as critical points of failure, the Standish group identified a number of common reasons for failure: inappropriate project selection; assignment of wrong project manager; lack of leadership support inadequately defined tasks and work breakdown structure (WBS); and misused management techniques. These reasons relate to many of the themes previously mentioned as differentiating themes in UIG collaborations.

When a project starts to go wrong, retracing the previous stages can be invaluable to a project leader's future success. There is perhaps a need here for industry to learn from scientific endeavour in light of reported project failures, and to take on a more rigorous scientific process. Currently, industry project reviews are in the form of project audits and quality control steps, both of which are left out if a project timescale or budget is under threat.

2.9.19. The difference in scientific review

There are many papers written which outline and debate the importance of scientific review. Boronico (2011) quantified the need for peer review as a quintessential idiom in science. The outcome of a peer review process is not solely based on historical data, though some form of judgmental assessment is implied. This assessment ultimately leads to forecasting the impact of the work under review. In the sciences, the 'impact' can be measured via citations. The effect of a peer review also requires the initial work to follow rigorous scientific methods.

Continuous improvement is not new in industry, but scientific peer reviews on projects are not usually part of the process. Marsick and Watkins (1999) claim that continuous systems-level learning is required if organisations are to improve continuously. Project organisations present unique challenges when it comes to embedding past project learning for the benefit of future projects. In part because they are temporary forms of organisation that disband upon the completion of their work, project teams often start solving problems again rather than learning from the experiences of previous projects within the same organisation (Scarbrough, Bresnen, Edelman, & Laurent, 2004). This repeatedly means that "the end of a project is consequently the end of collective learning" (Schindler & Eppler, 2003, p220). The reviews and past experiences are usually facilitated by cross-project leaders, often in the form of a project office process which embeds accumulated knowledge from previous project experiences into project management routines that are utilised across multiple future projects. While there is a process for past project experiences in industry, the scientific review of university research starts at the beginning of the project with rigorous scientific requirements and research ethics.

2.9.20. The difference in working ethics

Research is subject to more stringent ethical requirements than most other human activities, and a procedure that is otherwise allowed may be prohibited in research. Hence, risk-taking is more restricted in scientific research than in most non-research and industrial collaboration contexts, with an example being a questionnaire prepared in either sector. Privacy is better protected in scientific questionnaires than in marketing surveys, (Hansson, 2009).

Academic research is still governed by these rules, which are critical to the research base of universities, when collaborative external research contracts are gained. As a result, the relatively friendly and informal relationships that govern such joint projects have been replaced by a more formal, legal one, in which universities have onerous obligations to deliver against contracts with stringent ethical requirements (Kirkland, 2010), as noted in Section 2.9.1. This results in closer regulation of the activities of individual staff and the research teams who deliver the research.

Many industries in the private sector have specific guidelines for ethical operation, especially in the realms of human and animal research. Despite the level of recommendations and actual reform, however, many industries in the private sector remain under-regulated (Stranger et al, 2008). Even when specific guidelines for ethical operations exist, not all industry is obliged to follow them. For example, in Australia, a revision of the national statement included a new chapter dealing specifically with human genetic databanks (NHMRC, 2007), referring to all "custodians" of human tissue and/or genetic databases. New Genetics and Society 317 now have specific guidelines for the ethical operation of these resources, but only those operating with some level of federal funding are obliged to follow them (Stranger, 2008).

There is also evidence that some industries are more unethical than others, construction perhaps more than any other industry sector (Transparency International, 2005). There has been a considerable commentary on the growth and effectiveness of ethical codes of conduct (Bowen, Akintoye, Pearl & Edward, 2007; Ho, Lin, Chu & Wu, 2009). Ho et al. (2009) have commented on the 'need for business ethics management' (p.526) in the Hong Kong construction industry, where 'immoral practices and ethical misconduct are enduring problems' (p.526). Other scholars have noted that the construction industry generally has a poor ethical reputation and discussed its prospects for meeting demands for ethical improvement (Moodley, Smith, & Preece, 2008). Ethical conduct needs to begin somewhere, and it is mainly concentrated in learning and government institutions. The debate for why we need ethical behaviour is clear, but how to ensure it is less apparent. Perhaps a way to ensure it would be to include an ethics module as a curriculum choice in our learning institutions and our career training programmes.

2.9.21. Career

2.9.21.1. Career from a collaboration perspective

As well as the difference in the environments of the collaborative parties, the career paths of the individuals differ. An academic career is focused on the excellence of research and teaching (Hassan, 2013), usually in the same topic for the length of their career. Excellence in their career is also the focus of industry managers, but rarely with such a narrow topic focus, and it is similar for governments, as their backgrounds are not standardised. For industry, the focus is more likely an industry sector focus (Santoro & Chakrabati, 2002), such as telecommunications, or a functional area such as accounting, and with government they are likely aligned to a particular set of political party policies (Mair, 2008) within which they may have specific areas such as health, environment or agriculture. Convergence between groups may only happen on a single project. With the basis for each focus being quite different, the industry leader's career is more based in wealth creation, the university leader's career is based more in knowledge creation, and the government leaders with a mix of economic growth and knowledge creation. These differences can indirectly impact a project due to a lack of understanding of individual drivers and the reasons for specific output necessities. The industry career path is governed by the organisation hierarchy, with a management structure allocating duties in a similar manner to government careers. Academics are more independent in their work and, although governance is present, the ability to carve out their work path is much more open. It is important to note on all projects that subject matter experts are valuable resources, that university researchers provide that knowledge in many collaborations, and that no one person is expected to know everything necessary to complete the project. Consequently, if leadership is not shared, the project owner needs to understand the different dimensions and accommodate all sides.

2.9.21.2. Career from a project perspective

There is conflict inherent in managing projects in educational environments between the classical 'project management' approach and the way that academics and teaching staff, who are independent professionals, traditionally work (Kenny, 2002). Academics are rarely practitioners in the area of project management. Industry practitioners, on the other hand, may very well be working towards a portfolio management or senior scientist role, managing all the company's projects in the case of a small company, or several more substantial projects in a large organisation. Government officers have a similar range of responsibilities to industry practitioners, either being at the head of project work in a leadership role, or the primary expert while work is dictated in a hierarchical manner. Their paths may cross on some projects, but it is unlikely that either the industry or government project leader will stay in that role for their entire career, whereas a university project leader is likely to lead their stream of research throughout their career, based on an academic scientific discovery model.

The paths lead to quite different subject matter experts. A university researcher will continue to follow their subject matter as an area of expertise through their career, while the industry leader will usually focus their career on being an expert in an industry segment such as information technology, pharmaceuticals, or manufacturing, or a functional expert in a field such as marketing, accounting, or software technology. This provides individuals, the organisation and its shareholders with the ability to transfer between industry segments, on the basis of wealth-creation. Government officers are from many backgrounds, but they share the aim of making a difference. Their work experience is often in a government office where they may continue in their specialist area, but they are likely to take an advocacy or management role, rather than a research role. Alternatively, they will further their career in a similar style to industry.

2.9.22. The difference in career focus

The difference we see in career focus between the three entities puts the collaboration project leaders on entirely different paths. The commercial project manager's career credentials come through the measured success of their business achievement, which is predictably focused on the organisation in which they work, and this is similar for government officers for the section in which they work. Academic career paths come through the measurement of their teaching and research success, but the measurements are more frequently external to their organisation, currently in the form of the research PBRF (performance based research fund) in New Zealand, and their ability to gain research funding and the loose equivalent in Australia of the ERA (Excellence in Research for Australia).

Hughes (2008) stated that the credibility of an academic as an output of successful collaboration (e.g., the credibility of academics to bring value to the collaboration) from practice is not necessarily in place as a precondition: it has to be earned. While credibility is to some extent, conferred by title and institution, this is seldom sufficient to persuade the practitioner of value that can be added through collaboration. The perception of each participant's career focus in the collaboration team can be seen as a cause for tension in that their aims from the output of the project quite clearly differ, as do their inherent career paths.

2.9.23. The difference in career paths

In the majority of organisations, the hierarchy of competencies in projects is that of a project manager, program manager, and portfolio management. Successful portfolio managers are consumed not just by fulfilment of the needs of the business and budget plan, but also by the implications of this plan on both the portfolio plan and strategic plan. To possess the right blend of analytic and strategic competencies, therefore, portfolio managers are expected to impact the judgment and decision-making of the highest levels of governance in an organisation. There is a natural career progression from project management to program management and from program management to portfolio management, and on to higher senior management roles (Bayney, 2009). A similar managerial path is evident in government careers where seniority brings both new challenges and higher responsibilities.

University academics follow a different path entirely. For example, the University of Oxford studied the academic career path (Oxford, 2011), finding that academics cherish the freedom they have in choosing and developing their areas of research. Embarking on an academic career is, therefore, more of a unique career path. The rewards for the academic researcher come from longer-term outcomes of persistence, and the classic benchmarks associated with mature, thriving research careers. These benchmarks are widely understood: employment in an institution that encourages and rewards research; scholarships as reflected in peer-reviewed journal articles or their equivalent; a portfolio of externally sponsored research; substantial collaborative networks; appointments to prestigious panels or advisory groups; leadership in professional organisations; and awards recognising scientific contributions. In combination, such accomplishments facilitate promotion, stability, and longevity within one's institution. Ultimately, the developmental process comes full circle, evidenced by the senior investigator's active involvement as a primary mentor to younger colleagues about to embark on a similar journey (Oxford, 2011). While the differences in career path do not necessarily mean a difference in industry or university researcher-subject interests, there are differences in the way in which the subject matter experts' effort is portrayed.

2.9.24. The difference in subject matter experts

The subject matter is essentially the area of interest on which most managers and researchers base their careers. The commercial project manager alignment is in project management, working with similar projects, information technology, pharmaceuticals, engineering, communication and construction, etc., but is also interchangeable as their work is governed by the project process and rules of engagement. An academic researcher's alignment is usually directly to their subject of expertise and involves multi-project research streams, often bounded by life-long collaborations which follow an area of research through to its culmination. Moving between disciplines is not advised and, as such, the research path is not very interchangeable. The development of much pedagogical content knowledge, for example, requires the researcher to draw heavily upon their understanding of the subject, the strategies being used, and their past life experiences that might relate to their work (Calderhead, 2002). Subject matter experts are valuable resources; they provide the needed expertise in the collaboration. They can speed a project along, keep it on the right track, and quickly put out any fires that develop in the project along the way. The primary concern with using a subject matter expert is also the most basic, and that is whether the subject matter expert is indeed an expert (Lavin et al, 2007). The credentials that academic researchers bring with them to industry and university collaborations are some of the main strengths of their offering to a project, and this contribution needs to be exploited as an intrinsic asset to industry.

2.10. Discussion

The literature review explores the differentiators as found in UIG research collaborative projects, starting with projects that are run exclusively in any of the three individual environments. The goal of the review was to try and understand what makes the collaborative environment between the UIG partners unique as projects, with this area of concern largely overlooked in project management practice. As such, this literature review was designed to look at an identified gap in the literature around the UIG collaborative research project environment and methods.

Based on the limitations of the available literature, extrapolation into a framework is problematic, given that:

a) no UIG collaboration studies have been undertaken in New Zealand or Australia;

b) of the models that exist outside of New Zealand and Australia, none have been subjected to research scrutiny or assessed against current research projects;

c) there are no comparative studies between university, industry or government bodies to see if such methodologies are transferable between the different forms of collaborative agreements.

This lack of specific literature makes addressing the research goals difficult, however addressing this gap is an important outcome of the study. Similar observations were made by Blankevoort (1983) who noted that when comparing research projects to projects in more formal settings with tangible outcomes, tools should be developed for the management of creativity to make project management complete as a recognised profession.

The themed analysis developed from this review contributes to an understanding of why traditional project management methods do not translate well into the collaborative style under discussion. The key differentiating themes identified show multiple areas of incongruency between the types of projects. The broad differentiating themes of *funding, project, leadership, teamwork, scientific endeavour, intellectual property, ethics* and *career*, are further divided into subthemes, including the *longevity of teams, project justification, scientific and ethical review processes,* and *research streams*. Underpinning each of these differentiators is collaboration theory, with the view that all organisations exist to enable people to accomplish the joint actions required (Stacey, 2003).

There are also broader environmental concerns when we look at what makes collaborative projects exceptional. With an increasing awareness of the importance of research to provide both innovative and sustainable solutions, and national concerns for nations such as New Zealand and Australia to become knowledge nations (Warsh, 2006). This emergence of the knowledge nation has seen research contracts grow and international collaborations extend, and the continuation of this trend presents a host of challenges for the principal researchers on these projects, not least of which is how to develop the necessary skills deemed useful by each partner to enhance the project experience and outcomes. Together with this trend, the primary government funders are changing the landscape of funding such innovation, with a broader focus on the science and innovation sectors' ability to contribute to economic growth as noted by Avvisati and Jacotin (2014). Key aspects to this role are overseeing science and innovation investment; supporting infrastructure and fostering commercialisation; enhancing productivity; and achieving more comprehensive benefits through the application of research results (Demeritt, 2000). Use of these results in industrial terms consequently means more applied project research and less basic project research. There are no defined measures of how much of each type of research should or will be achieved. Accordingly, we do not know if this focus will stifle basic research, which refers to the study of pure science that is meant to increase our scientific knowledge base (Johnson, 2004). This type of research is often purely theoretical with the intent of improving our understanding of certain phenomena or behaviour but does not seek to solve or treat a problem. Universities traditionally fill this area of research, and there is also the possibility that this model will help such research. The new emphasis, however, is placed more on commercial exploitation, through the sale or licensing of intellectual property or product, and the establishment of commercial gain or spin-out companies, (Harrison & Leitch, 2010) Tangible returns are driving industry research, and a consequence of this funding model may also mean a fundamental change in the university employment model.

While this study has tried to incorporate all facets of collaborative research between industry, government and academic work, previous studies have looked specifically at university and academic work without taking government projects or influence into account. Reports have primarily reported reasons for failure, coming across similar issues with inappropriate project selection, assignment of the wrong project manager, lack of leadership support, inadequately defined tasks and work breakdown structure (WBS), and misused management techniques (Paletz, 2012). Those noted apply to some of the differences found in the present review, although specific reasons for failure are not considered, leading to a conclusion that some of the additional differences identified in this study are possible failure points that have not yet been formally identified.

The differentiating themes found are also common project themes across issues and success factors for all sides of the collaboration, indicating that a standard practice model for the effective management of this form of collaboration would provide a useful management goal. Such a model could be applied to future collaborative research projects, as a means of systematically improving their management practice and thereby improving the probability of success.

Many studies have noted that project work is that it is a complex and highly stressful environment, regardless of type including the findings of Leung, Chan and Dongyu (2011). One of the primary reasons for this includes the unknown nature of the work and the addition of more parties to the project as it increases in complexity. Research projects fall into the category of innovation in many cases, which involve many unknowns and in itself is an unusual state of work, with the unknown being standard practice. The nature of innovation has been widely studied in recent years, with increased recognition that innovation is a more incremental process than previously imagined, rather than being driven by sudden leaps forward. There is also an understanding that knowledge transferred between universities and society, is better classified in terms of broad knowledge rather than more specific technology (Kirkland, 2010). Given that a project is traditionally defined as "a temporary endeavour undertaken to create a unique product, service or result" (PMI, 2018), it is clear that there are many areas of research that do not fit this description There is, therefore, a requirement to define what kind of knowledge is to be produced in a collaborative project. Project management as a profession is designed to provide project success by the implementation of guidelines that clarify the project process, and that are designed to take the potential stress out of what is a highly stressful situation. Application of these guidelines should produce similar results for the UIG collaboration. The more pressure we can take out of the collaborative innovation process by well-thought-out initiation models, project structures, output definitions, governance and leadership choice, the more chance we have of gaining success. We know from the Triple Helix model that such collaborations change the relative environments for research and development (Erzkowitz, 2002), and this is demonstrated in the differences found between collaboration partners in this thematic review.

The thematic analysis produced focused on many individual issues inherent in the project, together with the above-mentioned broader implications, showing that many areas make these collaborations a unique form of project, without implying that the project environments have to conflict. There is a need to explore the implications of each of the themes on the project and postulate ways to accommodate the differentiators.

Each differentiator shows specific modes of work and priorities used by the teams involved in UIG research. At the points where areas differ within the project's progression, they can exert undue pressure on the interaction and, as such, are a primary source of potential stress and ultimate failure on the project. While each of the sub-themes found in the matrix could be research topics in their own right, this research's aims are to identify the nature of these differentiators and explore the extent to which they potentially impact a project. The view is then taken from both the positive and negative attributes that they may bring to this project style.

2.11. Conclusion

This chapter reviewed two related research topics: collaboration, and project management relating to UIG partnerships. Firstly, the extant literature regarding collaboration was reviewed. The significant study streams on collaboration were discussed, including the stages of collaboration as modelled in the literature. Secondly, the literature on project management was reviewed, and the main differentiators in the UIG partnership were discussed, including a themed analysis of the differentiators.

The literature highlighted the differences between the UIG collaborative project organisations and demonstrated the need for further research into the environment to improve their management capability and subsequently add to the body of knowledge on this subject.

The UIG collaboration generally lacks direct observations, and to address further the need for a multilevel understanding of the management of these creative teams and projects, theoretical integration, such as that found in the literature, will require more research at the concrete end of the continuum. This needs to include qualitative accounts of the project leader's actual actions, intuitive decision-making and rationale for completed projects. It was, therefore, proposed to progress research into this subject to develop further understanding of the incongruent areas found in the analysis. Underpinning the review is the application of collaboration theory to the primary research stream of project management.

The research questions for this study are based on the common issues related to collaboration and project management, and they have been framed to fill the gap found in previous analyses. The first research question being addressed through the literature review is:

Question 1: What are the key differentiators noted in the literature between university, industry and government (UIG) research environments?

From here, the second question to be investigated is:

Question 2: Of the key differences identified, to what extent does each impact the UIG collaborative form of project from both a project management perspective (phase and constraint), and a collaboration outcome perspective?

The questions aim to assess the extent to which each of the identified differentiators impacts the effective running of collaborative research projects using a cross-sectional analysis of newly completed projects (retrospective). This initial investigation will then be extended with the aim of a more in-depth analysis with both team members and experienced research leaders (prospective), evaluating the findings against the proposed thematic map shown in Figure 2.1. The research is underpinned with collaboration theory, using the formative evaluation approach of the Strategic Alliance Formative Assessment Rubric (SAFAR) shown in Table 2.3.

CHAPTER THREE

THEORETICAL FRAMEWORK AND METHODOLOGY

3.1. Introduction

To understand the phenomenon under investigation, suitable data collection methods need to be chosen, which enable the research questions to be answered. This chapter presents the research philosophy and the specific qualitative and quantitative data-collection methods chosen to address these questions. Firstly, the chapter will restate the research questions and discuss the epistemological considerations that underpin the study. Secondly, the chapter will discuss the use of the mixed-methods methodological approach and explain the strategy in detail. Data collection procedures are then described, following which the methods of data analysis are summarised. The final sections of the chapter look at the reliability and validity of the study and the ethical considerations, after which a summary overview is presented.

3.2. Principal objectives of the research

The research methodology needs to be designed to ensure it allows the research objectives to be addressed (Bryman & Bell, 2015). The primary goal of this research is to develop a more extensive understanding of how the differentiating factors observed in the extant literature influence the collaborative efforts of the UIG collaborative project endeavour, which is both the unit of analysis and observation. In chapter **one**, the principal objectives of the research were proposed as follows:

v) To identify key differentiating themes for university-industry-government (UIG) collaboration that define the unique characteristics of their project environment and the tensions between these approaches.

vi) To examine the challenges these recognised differences may present to university-industry-government (UIG) collaborations from a project management perspective.

vii) To examine how the key differentiating themes identified impact on the collaboration outcome, either positively or negatively, drawing on collaboration theory.

viii) To develop a research-informed framework to assist in the management of university-industry-government (UIG) project collaborations.

While this area of research is now starting to gain impetus within the scholarly community, the research to date has focused primarily on factors that facilitate or inhibit the UIG collaboration. The current study focuses on the differences in each of the project environments that cause difficulties and potential conflict when working in partnership, from a perspective of areas that produce cultural dichotomy, and the relative importance of each of these factors in providing a successful outcome. To address the objectives of such a multifaceted phenomenon requires a multifaceted methodology, as detailed in the section below.

3.3. Research design

3.3.1. The ontological and epistemological approach

The ontological position adopted for the present study is post-positivism, which has similar ontological and epistemological beliefs to positivism, although it differs in some significant areas. For this study, post-positivism claims that knowledge is more confident and objective than knowledge which originated from other paradigms (Creswell, 2009). The methodology is directed at explaining relationships such as those in the current study, which holds the approach that we can identify causes which influence outcomes (Creswell, 2009). The aim is to formulate laws or rules, giving a basis for prediction and generalisation. As such, a deductive approach is usually undertaken within post-positivism. The deductive methodology approach was used to reduce the complex interactions and their constituent parts to better understand complex relationships such as those postulated in the framework.

While post-positivism uses a deductive approach, the deduction is mainly concerned with testing or confirming hypotheses, which will not satisfy all of the aims of this study. As such, an abductive approach is adopted, which is also used to derive logical inferences (Creswell, 2009). The popularity of the abductive reasoning approach is relatively recent and can be used as an extension of deductive reasoning. This approach can be traced to Peirce (1929) who put forward the argument for abductive reasoning as the only true means to extend knowledge and produce theory (Bryant, 2009). Even in the most constrained experiment, the researchers may observe patterns in the data that lead them to develop new theories (Trochim, 2015).

The creative nature of abductive reasoning facilitates the development of rich theoretical concepts and relationships. As an intellectual operation, abduction provides extended reasoning and allows inferences to be made beyond what is explicitly stated in the data that forms the premise of analysis (Psillos, 1999). Abduction uses both deductive and inductive approaches. And moves from the empirical to theoretical dimensions of analysis. Dubois and Gadde (2002) found the logic of abduction is more useful than just the use of pure induction or deduction. Lukka and Modell (2010) state abductive is gradually accepted as an important part of interpretive research such as this. An abductive approach will, therefore, be used to extend the framework presented in the previous chapter.

3.4. Research strategy

Saunders, Lewis, and Thornhill (2009) defined the research strategy as a "general plan of how the researcher will answer the research questions (p75)". The research strategy adopted in this study began with the identification of the research problems. This was followed by an in-depth review of the relevant literature to inform the research, in order to identify previous research in this area, and gaps that should be addressed in order to pose the research questions and set clear objectives for the study. Differentiating themes for UIG collaboration from the extant literature were organised into main themes and sub-themes, to be used as the focal point for analysis through a mixed methods analysis, using a quantitative questionnaire, and qualitative semi-structured interview study approach. The use of a mixed-methods approach allows the researcher to aim for greater breadth and depth of data to provide a solid basis for theory generation (Johnson & Onwuegbuzie, 2004; Miles & Huberman, 1994). A mixed-methods approach was chosen above a single method approach such as exploratory case study or quantitative research, to overcome issues presented with individual methods. For instance, an exploratory case study approach provides very little basis for scientific generalisation as this uses only a small number of subjects (Yin 1984) and would not give enough breadth to answer the first objective of the research. Quantitative methods as Babbie (2010) and Muijs (2010) asserted emphasize statistical, mathematical, or numerical analysis of data collected questionnaires and surveys and focus on gathering numerical data and generalizing it across groups of people to explain a particular phenomenon. Quantitative methods can only handle cases of mono-causality which is rare in the social sciences. It is often difficult for only one factor to be responsible for certain actions or behaviours in the social sciences, and as such the technique is weak when dealing with multi-causality issues such as those noted in the literature review.

Therefore, in this current study, the mixed methods approach not only added depth but provided triangulation to the research findings. The benefit of combining qualitative and quantitative data is that it offered multiple views from different sources and perspectives, which assisted in explaining and augmenting the complexity of collaborative projects. The quantitative questionnaire and qualitative semi-structured interview strategy were chosen as the most suitable mixed-method approach as they offered a means of combining qualitative and quantitative data (Creswell, 2003; Perry, 1998). A concurrent triangulation approach was used as this is the most familiar of the mixed-methods models (Creswell, 2009), and provides the ability to compare results to determine convergence, difference or a combination of both as a means to validate the findings. This strategy is discussed further in the following section.

3.4.1. Mixed-methods design

The mixed-methods strategy was chosen as the most appropriate as it offered the best match with the research objectives under investigation. As has been asserted by Cameron and Sankaran (2013), the use of mixed-methods encourages the adoption of "more innovative approaches by using mixed-methods research designs not just for triangulation as a validation strategy, but also to add more in-depth investigation and a broader perspective of the phenomenon being researched" (p. 398). The questionnaire analysis seeks to find patterns within the complexity of the themes, while the complex relationships inherent in partnerships is explored and expanded through in-depth interviews. Using only a small number of methodologies in project research is not desirable to the development of the field itself, because it produces inertia and can limit the ability to produce new and interesting research. In addition to the authors cited above, several other project management researchers have recognised this and have proposed the adoption of different lenses from which to view project management problems (Bredillet, 2004; Cicmil, Williams, Thomas, & Hodgson, 2006; Malgrati & Damiani, 2002;).

Greene, Kreider, and Mayer (2005) also argued that mixed-method approaches are more comprehensive, as they include different aspects and perspectives and therefore yield results which provide the opportunity to address in depth the differentiating themes for UIG collaborations of interest which emerge from the initial study. The concurrent triangulation approach is the most familiar of the mixed-methods models (Creswell, 2009). The data is to be collected concurrently and then compared to determine convergence, difference or a combination of both as a means to validate the findings.

The ‘soft’ individual interview data is an adjunct to the ‘hard’ aggregate quantitative methods. The questionnaires are used to provide a range of information about the characteristics of this project type, while the interviews provide both longevity and depth to the discussion on the causes of difference between organisational types and project practices.

Structured questionnaires and semi-structured interviews are often used in mixed-method studies to generate confirmatory results, despite differences in methods of data collection, analysis, and interpretation. If ‘confirmatory’ results are being sought, researchers must create tightly aligned and structured instruments, present the construct in a simple, concrete, and highly contextualised manner and collect the two types of data with a minimal time gap (Harris & Brown, 2010). As such, the study was undertaken in two parts: a cross-sectional quantitative questionnaire and a qualitative semi-structured questionnaire.

3.4.2. Quantitative approach

The first part of the study involved the use of an online cross-sectional questionnaire.

The questionnaire was used to evaluate the challenges to the partnerships and project effectiveness presented by each of the differentiating themes for UIG collaboration identified in the literature review and included in the framework presented in Table 2.4. The questionnaire offered the ability to provide evidence of patterns and is seen to provide objectivity to the study (Kendall, 2008).

3.4.3. Qualitative approach

The second part of the study involved semi-structured interviews. The personal interview has the advantage that it allows an in-depth review to be made of a particular topic with the additional benefit that the interviewer is on hand to answer any queries the interviewee may have (Alshenqeti, 2014). According to Blaxter, Hughes, and Tight (2006), interviews offer the researcher the opportunity to uncover information that was not accessible using techniques such as questionnaires and observations. The main drawback of this method is the length of time that is involved for both interviewer and interviewee, and as such, only a relatively small number of subjects can be surveyed (Bryman & Bell, 2015).

3.5. Data collection model

This section presents the data collection model that was used to guide the data -collection, which is explained in the next section, along with the data analysis and the interpretation of the study. While the differentiating themes of the research area are theoretical, the framework of the research was conceptual. Frameworks have been described as the map for a study, giving a rationale for the development of research questions or hypotheses (Fulton & Krainovich-Miller, 2010). Similarly, LoBiondo-Wood (2010) said that the framework is the design and added that the research question, purpose, literature review and framework should all complement each other and help with the operationalisation of the design. Therefore, a data collection model was developed as shown in Figure 3.1., to guide the operational approach.

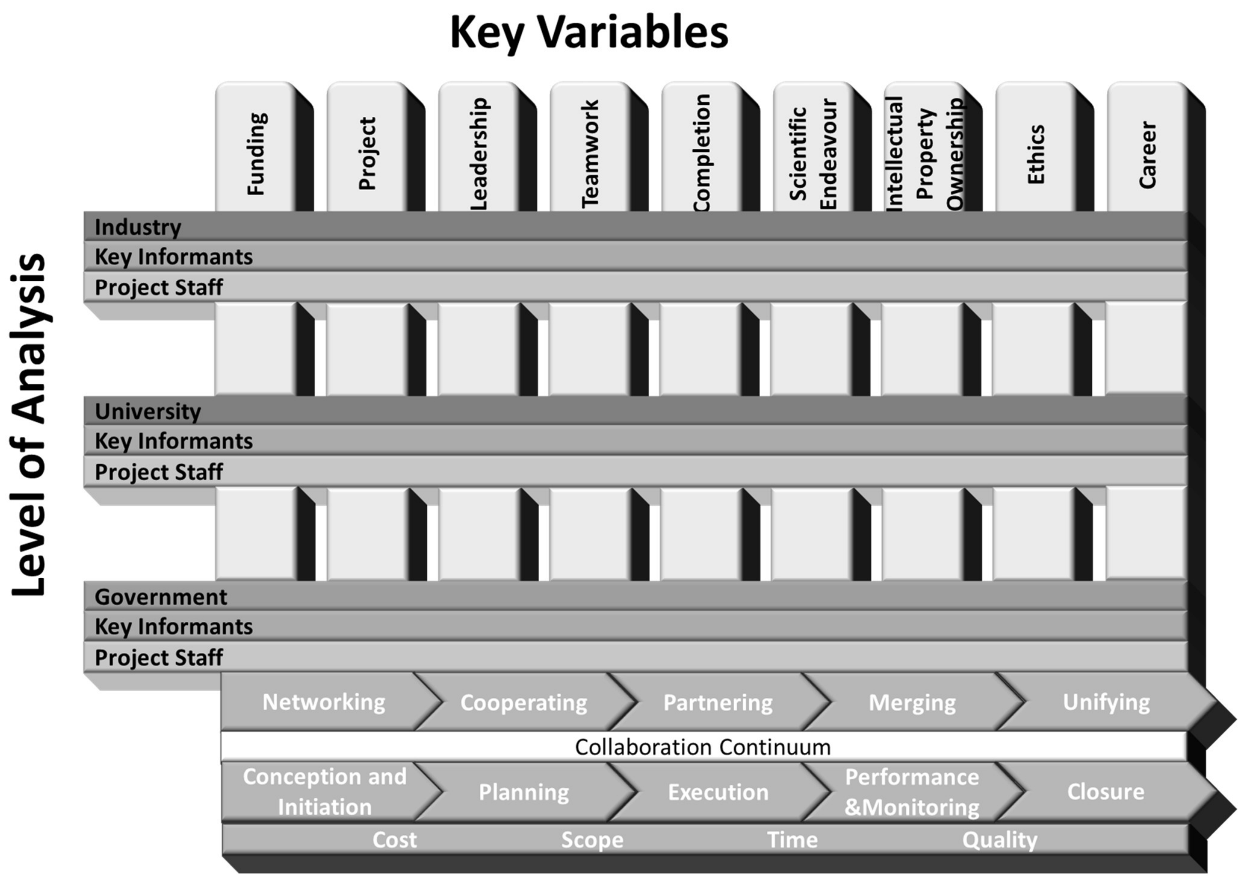

Figure 3.1. Data collection model

The data collection model was based on the analysis of current literature on the UIG partnership types which produced the wide range of factors which were presented in the literature review in Table 2.4 (differentiating themes for UIG collaboration) and which can potentially influence the partnership. The suggested framework was new in the sense that it includes many factors that were not found together in any of the current frameworks. While many of the differentiating themes presented in this work have been found previously, there have been no attempts to view these across the variety of business sectors, or differing staff levels of project team members and key informant experiences, or effect on collaborative outcomes. Macroeconomic issues have also been reported separately.

The data collection model shows three dimensions, with the level of analysis indicated by three rows, each representing the organisation type under analysis: university, industry and government. The organisational analysis level is further divided into key informants who are individuals with longevity in the collaborative research space and are those individuals that have been a party to multiple collaborative research projects. Their experience provides an overview over many years of practice in this collaborative project style and gives insight into the macroeconomic factors and general progression of this project type, including past and current trends in this area. At the organisation level, respondents were research managers or research directors responsible for full organisational research programmes. Project team members gave their perspective on a current or recent research project and provided detail around the process of the research project. This includes internal and external differences viewed across the project timeline. These individuals were at the level of project scientist, project engineer, project lead investigator, and project manager.

The second dimension outlines the differentiating themes: nine overarching themes identified from the literature review and developed into the thematic map for the study.

The third dimension is the foundation of the study, collaboration, which embodies both the first and second dimensions. Collaboration is shown across the stages of collaborative development reported in the literature review and shown as a linear progression on a continuum.

The initial themed framework in the literature review was developed by focusing on the differentiating themes found from the review. However, the views of the stakeholders in each of the organisational entities involved in these collaborations and their collaborative experience were required to integrate the model.

By using the analytical, data collection model, this thesis seeks to contribute to the literature on research project collaborations in four ways:

- The first original contribution involves ascertaining the importance of the differentiating themes from the perspective of the three key entities involved in UIG collaborations, the UIG research bodies.
- Secondly, the research contributes to knowledge by reflecting both the internal and external environments of the project by integrating the perspectives of key informants who provided an overview of many years in collaborative research, and those of project team members focusing on a specific piece of work inside a project.
- Thirdly, the research contributes to collaboration and project management theory by exploring the effects of the differentiating themes across the traditional project lifecycle, looking at the effect of the themes on project stages and constraints.

- Fourthly, the research was based on current collaboration theory, showing collaboration development across the lifecycle of a single project from the perspective of project key informants and project team members, including the view of key informants for ongoing research streams.

The data collection model helps to examine the four essential aspects of the organisation; staff, project lifecycle and collaboration, and was used to inform data collection and analysis to address the research questions in this study.

3.6. Data collection procedures.

3.6.1. Study Participants

The study participants for both quantitative and qualitative methods are those directly engaged in UIG research projects. The survey participants are members of the inherent professional organisations which include universities, industry, government and professional bodies that have an online public presence in this area of work. To achieve an adequate sample, participants from both New Zealand and Australia were surveyed. The study participants were selected through a purposive sampling method, which is a method primarily used to select individuals that have experienced the central phenomenon. This is a standard nonprobability method that is used most effectively when one needs to study a certain domain with knowledgeable experts (Tonco, 2007). In this study, the primary concern of the researcher was not to generalise the results of the research but to make the most of the opportunity to identify the emergent differentiating themes or theories. The aim was to pursue analytic generalisation rather than statistical generalisation (Yin, 2009).

Both New Zealand and Australian participants were included in the study to gather sufficient participants, as many collaborative endeavours in New Zealand are between countries due to the size of the population. There is, in addition, similarity of approach.

As noted in the introduction, there is a growing understanding of an Australasian approach which recognises political, economic, and cultural alignment, as well as the existence of substantial ongoing initiatives in the area. An example of this approach can be seen in the formation of NZInc strategy ‘advancing with Australia’ (NZTE, 2013) in which the New Zealand Ministry of Trade and Affairs set out a future vision for collaboration which includes the goal to make our science relationship more commercial and more cooperative.

As this was an Australasian study, therefore, an online search was conducted to identify the following groups that fit these criteria in New Zealand and Australia:

1. Universities
2. Government research organisations
3. Industry research organisations
4. Project management professional bodies

The search produced 65 research organisations in New Zealand and 134 research organisations in Australia. The breakdown by organisation type is shown in Table 3.1.

Table 3.1. Number of research organisations by type

New Zealand entities		**Australian entities**	
New Zealand universities	8	Australian universities	43
New Zealand crown and other government research institutes	19	Australian government research institutes	53
New Zealand industry research organisations	27	Australian cooperative industry research centres	32
New Zealand project management institute chapters	11	Australia project management institute chapters	6

A preliminary email was sent to each of the organisations identified, inviting them to be a part of the study. Of the organisations that volunteered, this included twelve universities, ten crown research organisations, eight industry research organisations, and three project management professional bodies. From these organisations, a respondent sample of 98 was achieved. However, it was impossible to calculate this as a percentage of responses (RR) as it is unknown how many of the individuals within these organisations work within this project type.

3.6.1.1. Purposive sampling

The survey aimed to provide enough data to produce a descriptive overview and comparison between groups. Purposive sample sets are widely used in qualitative research for the identification and selection of information-rich cases related to the phenomenon of interest (Palinkas, 2015) and are reported as yielding smaller sample sets. There are, however, few studies that discuss purposive sampling set sizes. Bernard (2002) noted that there is no cap on how many informants should make up a purposive sample, as long as the needed information is obtained. Purposive sampling of studies in this area of research that have used multivariate modelling start at N=36 (Perkman, King & Pavelin 2011). Random samples are deemed to be useful at N=100 and above (Dolores, 2007). This study produced 98 samples from purposive sampling methods. As this sample size is above the minimum purposive studies in this area, describing overviews and comparisons between groups is viable to be used to analyse the results.

3.6.1.2. Interview sample

The interview participants were accessed in two ways. The primary method involved those organisations which volunteered to be a part of the online survey study. A follow-on request was sent to respondents asking if they would be open to an interview on the topic and if they were happy with a similar request going out to their organisation's project team members. As the initial request was targeted towards key respondents within these organisations, being either primarily research directors, or head scientists, this satisfied the needs of the study on the key respondent level, and sending the request into the organisation covered the project team members' level. The online questionnaire also asked if individuals were happy to have a follow-up interview on the topic, and six of those interviewed responded to this request.

3.6.2. Instrument development

The research was designed to address the research needs of partner organisations which were involved in collaborative research arrangements. Both the survey and interview were tested utilising a pilot study. The purpose of the pilot study was to identify and eliminate any difficulties which respondents might have encountered in trying to complete the questionnaire as noted by Teijlingen and Hundley (2001). In particular, the pilot testing of the questionnaire was intended to ensure that the instructions were clear, that the questions were relevant and unambiguous, and that the questionnaire could be completed in a reasonable time.

The pilot study was carried out with three research project members; one individual was selected from each of the three organisation types involved in the study being university, industry and government being as similar as possible to the target population (Peat, Mellis, Williams, & Xuan, 2002).

The target respondents were contacted in advance to explain the objectives of the research and to seek their participation in the pilot testing of the questionnaire. The pilot study revealed that some of the terminologies used needed more explanation due to the lack of standardisation of some of the project management terms used in the subject. Appropriate amendments were made to simplify the terminology and improve the presentation in order to make the questionnaire easier to complete. The interview was then tested again with the same group, taking approximately 15 minutes to complete.

3.7. On-line survey design

The questionnaire was designed to assess the impacts of the differences and tensions between university, industry and government projects as expressed in the nine differentiating themes comprising the framework of the collaborative project. The effects of the differentiating themes were measured against the five traditional phases of a project: conceptualisation and initiation; definition and planning; execution; performance and control; and closure. They were also analysed in terms of the triple constraint model of time, cost, and scope to assess the quality of the project output. These phases and constraints are seen as critical factors in defining the framework of a project.

The questionnaire was designed in sections to cover each of the key areas. The first section covered the nature of the project team and collaborators, the type of project, and timeframe of the project as covered in the subject selection. This was followed by sections discussing the impact of the differentiating themes identified in the study to weigh their importance to the project, to look at their effect on both the traditional phases and project constraints, and to assess their impact on the overall collaborative process. Each section concluded with an open question exploring any areas of potential difference not previously found.

The impact of the differentiating themes was measured by asking participants to rate on a 7-point Likert-type scale the extent to which they agreed or disagreed that each of the differentiating themes presented ‘practical and cultural challenges’ to the collaborative project effectiveness, and these questions were then repeated against project phases and constraints. Collaborative outcomes were measured by asking participants to rate their perception of the collaborative process at both the inception and completion of their project. The open questions asked respondents to outline differences in relation to each of the major differentiating themes, phases and constraints for their collaboration. For example;

> Q15. Definition and planning phases: Please briefly describe how differences between commercial and academic projects affected your project management in the definition and planning project phase.

Differences in responses were identified to explore whether differentiating themes for UIG collaborations are perceived to be more or less challenging for different project categories (including project size, type, and timeframe). Moreover, differences between project team members' level responses in relation to challenges for each theme were identified. This analysis provides essential data against which the existing framework (Table 2.4.) could be assessed in terms of its validity and relevance across a range of project types, and from the perspective of academic, industry and government research partners.

The use of a 7-point Likert type scale also allowed for a midpoint to capture those respondents who were indifferent or undecided, as recommended by Sudman and Bradman (1983) to assess the quantifiable variables. Looking at the table of variables produced, some of the variables are quantifiable, i.e. Variable 1a. Funder priorities: the main commercial funders are the business community the project was being commissioned by, or an external body or business. As such, the percentage of each part of this variable was easily quantifiable. Conversely, there are also variables which are of a qualitative nature, i.e. Variable 7o. Career aspirations: in industry project managers are usually career project managers or aiming at a senior management role, whereas university researchers are usually career researchers with the aim of becoming senior researchers. In this variable, the assessment focuses on reasons why the leader in each case was working in their particular industry, and why they hold a particular position, and therefore it needs to be assessed qualitatively.

Each area was also designed to elicit the best practice specific to that variable to gain project effectiveness and success. A multivariate approach was required, which can account for variance analysis of both quantitative and qualitative independent variants and dependent variants.

The questionnaire was developed in an online electronic format using the Qualtrics research system. As noted by Wright (2005), there are many benefits from using an online survey platform, including two distinct advantages for this study: firstly, the questionnaires can be sent out directly to the research participants, giving access to individuals that would be difficult to reach through other channels; and secondly, the results can be both collected and fed into a statistical processing package for variance analysis while the interviews are being carried out concurrently. The questionnaires were sent out for dissemination through the Qualtrics email system between November 2016 and February 2017, with follow up requests between March and June 2017. The date of the receipt of responses was captured in the online system used. Table 3.2. shows a summary overview of the survey instrument. The full version can be found in Appendix 1.

Table 3.2. Descriptors of the survey instrument block sections

Block 1. Introduction	Block one introduces the participants to the survey
Block 2.	Block two asks the participant to confirm their consent and asks their country of origin.
Block 3.	Block three consists of ten questions and solicits information about the project and its members so that the analysis of results can be put into context. These ten questions are presented in three main sections. This section consists of nine questions, the first two of which look at the descriptive factors in the study, asking which sector they belong to, and their length of involvement in UIG partnership type projects. The next seven questions are specific to their current or most recent UIG project, asking first if the project in question was complete or close to completion. The response *close to completion* was used as a question to validate the results and ensure the records used were only for completed projects. The roles used within the study align to the different job descriptions found in the literature. The following questions as their role was on the project, the number of researchers involved in the project, being university, industry and government researchers, the length of project, the amount of funding, who provided the funding; being wholly university, wholly industry, wholly government or joint funding by two of the entities, or a tri-funded arrangement.
Block 4.	Block four looks at the importance of the difference between commercial, academic and government projects and seeks to establish which of the 16 differences found in the literature between commercially led, academically led and governmentally led projects are perceived by the project participants to have an impact on the successful management and outcome of a project where the two organisational types work together. Respondents were asked, using a 7-point Likert scale, at what level they considered the 16 differences to impact their project work, starting from (1) 'Very Low impact' through to (7) 'Very high impact'.
Block 5.	Block five consists of ten questions and looks to explore the differences between UIG projects further, looking at the extent to which each of the variables impacts on each of the five traditional project phases: conceptualisation and initiation; definition and planning; execution; performance and control; and closure. Each phase was also given a description to help guide the responses. For each of the project phases, the participant was asked which of the variables from block three impacted most on the successful

	management of the collaborative project. The question gives the ability to respond with multiple variables for each project phase. For each project phase, a companion question asks the participant to briefly describe how the noted differences affect their project management in that phase.
Block 6.	Block six consists of eight questions and looks to explore the differences between UIG projects further, looking at the extent to which each of the variables impacts on each of the four project constraints being cost, scope, time and quality. For each of the project constraints, the participant was asked which of the variables from block three impacted most on the successful management of the collaborative project. The question gives the ability to respond with multiple variables for each project constraint. For each project constraint, a companion question asks the participant to briefly describe how the noted differences affect their project management in that phase.
Block 7.	Block seven looks at the importance of the collaborative outcomes of the UIG project and seeks to establish the extent to which the themed variables impact on that outcome. The impact was assessed in the respondents' perception to outcome effectiveness, quality of working relationship, broadening of views, increase in network density, increase in power relationships, ongoing relationships, research streams, and the measure of collaboration. Respondents were asked, using a seven-level Likert scale, at what level they considered the project differences to impact their project relationships, starting from (1) 'Very Low impact' through to (7) 'Very high impact'. The final section of this block asks the participant if they have any other comments on the topic of collaborative outcomes.
Block 8.	Block eight looks at the relationships within the collaborative project. It seeks to explore these relationships at the beginning of the project from the four aspects of how the project was built at the beginning, how the strategies and tasks were built on the project, how the statements for leadership and decision making were built, and interpersonal and communication planning was built.
Block 9.	Block nine consists of the same four questions as those introduced in block eight, from the same four aspects of project build, strategies and tasks leadership and decision making, and interpersonal and communication. In this set of questions,

	participants were asked to reflect on the development of these aspects at the end of the project.
Block 10.	Block ten introduces the qualitative part of the research and asks the participants if they would like to be involved in an interview to explore the outcomes of the questionnaire further. If so, the request was to provide contact details for the participant in order to interview within the next month. The final section of the questionnaire also thanks to the participant for completing the questionnaire and aims them to an online results page which was available at the of the study, or if a personal copy was required to leave an email address for the report to be forwarded.

3.8. Semi-structured interview design and procedure

The interviews were conducted through three media types of phone, face to face and online video media platform (Skype), dependent on the geographical location of the participant. All the interviewees granted consent to the recording of the interviews, and interviews were recorded using a digital voice recorder (DVR). The benefits of using audio recordings were that the interviewer could focus on leading the discussions and avoid the delays involved in taking notes leading to more accurate transcription (Cavana, Delahaye, & Sekaran 2001; Denscombe, 2010)

The interview schedule was developed reflecting the topics of the online survey, a full version of which is shown in Appendix 2 together with the participant information sheet and consent form. Questions were phrased in such a manner to evoke frank and open discussion between the researcher and the participant. For example, the first question used read: “What is your experience within collaborative projects involving two or more partners, across different organisational types”. This question often generated an initial response in excess of 20 minutes. The questions acted as a checklist that the respondents were asked to address, although all of the questions were open-ended and intended to allow the participant significant latitude in responding (Galletta, 2013).

Interviews were carried out in an informal conversational mode and ranged from 40 minutes to two hours in duration. Participants were encouraged to give full and in-depth responses on the various topics introduced, and topics were explored to entice a fuller description of particular events or episodes as they presented in the conversation.

In order to encourage rich description and flow in the interviews, a flexible approach method was also applied to the interview structure in that questions were not necessarily asked in the order shown in the interview instrument, although in each case all questions were covered to assess their relevance to the specific experience of the participant. A rewarding aspect of the interviewing process and an indication of the robustness of the information given was the amount of strong participant emotion that was expressed as well as reports of the experience being both thought-provoking and captivating.

At the end of each interview, the recorded feedback was transcribed. Taking complete recordings of the interviews was essential to eliminate bias and poor recall, and minimal editing ensured accurate reproductions. The transcribed feedback and a copy of the interview recording were sent to the interviewees for confirmation or modification to eliminate transcription errors although there were no requests made by any of the interviewees to amend further or edit the interview transcripts. Anonymity was also maintained within the process. Table 3.3 shows a summary overview of the interview schedule, with the full version shown in Appendix 2, together with the participant information sheet and consent form.

Table 3.3. Descriptors of the interview schedule sections

Section 1. **Introduction**	Section one introduced the participants to the survey and asked them to discuss their experience in UIG collaborations to date. It then asked for general information about notable differences that might have been found between sectors, cultures, and project length.
Section 2.	Section two looked at the main themes in the study and whether they have had an effect on the management of UIG projects.
Section 3.	Section three looked at how the main study themes might affect a research project. This section took in the views of traditional project phases of conception and initiation, definition and planning, launch or execution, performance and control and close, and the main constraints of cost, quality, time and scope.
Section 4.	Section four looked at the nature of collaboration and the outcomes of collaborative projects.
Section 5.	Section five looked at how the collaboration was formed at its beginning and how this might have changed by the end of the projects.
Section 6.	Section six closes the interview by thanking the individual interviewee and offering to provide the results of the research.

3.9. Data reliability, validity and ethics.

3.9.1. Reliability and validity

Issues of validity and reliability of research instruments are of considerable significance to the findings of any scientific research. Validity and reliability issues serve as guarantees of the results of the participants' performances (Dornyei, 2007). Reliability refers to the extent to which a research instrument yields the same results on repeated trials, while validity refers to the degree to which the study reflects the specific concepts it aims to investigate. This study has used a mixed-methods approach, giving three primary advantages of enhanced validity of the evidence uncovered, as well as increased theoretical and practical contribution to the field.

First, the design enhanced the construct validity and the quality of inquiry inferences by using methods with offsetting biases with triangulated results, which was important to this study due to the longevity of the researcher in this subject area. The term triangulation of findings is a core principle of mixed-methods inquiry and is typically interpreted to mean that multiple methods echo each other's findings in a way that provide evidential saturation for a particular finding. The rationale for triangulating is that all methods have inherent limitations so that, by combining multiple methods, a researcher can counterpoise biases, to check whether results eventually converge. Ultimately, the validity and credibility of the research findings are better than they would have been if only a single method had been used (Creswell & Clark, 2011; Greene, 2007). For example, the systematic content analysis of documents through the literature review, together with the online survey and in-depth interviewing strengthened the construct validity of the research findings. Using multiple methods also strengthened the internal validity of the research findings and the robustness of any causal inferences.

While the quantitative approach identified patterns of regularity in the association between the collaboration themes and project performance, the qualitative approach was necessary to shed light on the mechanisms that triggered these patterns. Also, by combining multiple methodological lenses, the study was able to take a configurational approach, and identify causal packages, as opposed to assuming simplistic single cause and effect relationships (Pawson, 2013; Rihoux & Ragin, 2009).

Concerning external validity, the study relied on a robust multiple organisation design, with organisations across each level of the data collection model to display differences or similarities that emerge, which also allowed the perspective to be taken from an interdisciplinary understanding of the phenomenon.

A second advantage of using mixed-methods was the opportunity to reach a high level of understanding in the findings. As noted by Greene (2007), one of the assets of mixed methods inquiry is the possibility of generating empirical puzzles which provide a clear path for further knowledge accretion. In this case, the quantitative analysis weighted collegiality as a lower factor in a successful collaborative project, while the quantitative analysis confirmed this to be a significant network influence. Third, the research was able to increase its theoretical and practical contributions to the field by combining multiple theoretical strands. The interdisciplinary look at the problem unveiled complex conjunctions of cultural, internal, and external factors that affect the processes of collaborations in complex organisations.

These findings have clear, practical ramifications to inform the design of a new framework in the organisational types studied.

While a mixed methods approach was used in the study, the qualitative aspects were interviews which are often viewed as having poor reliability due to their openness to many types of bias particularly when drawing comparisons between data sets, (Brewerton & Millward, 2001). As this study was conducted by only one researcher, its reliability may be subject to question. To minimise this concern, the researcher developed the study protocol found in Appendix 2, which could facilitate an auditor to repeat the qualitative method of the research procedure to achieve the same outcome, as suggested by Castillo-Montoya (2016).

The qualitative results are used to add understanding and depth to the quantitative results, and as such, the coding process began with the existing themes, loading descriptive text against each theme. New codes were generated where existing themes did not adequately define the phenomena being described. All original themes were included in the qualitative coding to reduce interpretation in the comparison of results (Harris & Brown, 2010).

3.9.2. Ethics

In compliance with the Massey University's policy on research involving human participants, application for permission to undertake the interviews was made to the Massey University human ethics committee (MUHEC) prior to data collection. For this research study, a MUHEC application was lodged and approved by MUHEC on the 13th of November 2016. The ethics notification number is 4000016930. The research was moved from AUT to Massey University in 2016 before which full ethical approval was also given through AUTEC in 2015.

The introductory material for the interviews identifies the researcher as a Massey university student. It also explains that no individual respondent will be identified by name other than in the appendix lists by agreement, and confidentiality of response data will be assured. The initial introduction also includes that interviewees agree to the questionnaire by choice and that the choice of their project was made based on informed consent. A MUHEC approved participant information sheet is also being used as an introduction to the questionnaire, and interviewees were required to sign a consent to participate form with the same premise. Due diligence was taken with data collection and storage to ensure the participants and management information remain anonymous.

3.10. Summary

The literature indicated that several factors could influence the outcome of a UIG collaboration. However, there is a knowledge gap regarding the importance of these factors and the extent to which they impinge on the outcomes of the collaboration. The purpose of this study was to examine the factors through a systematic approach towards organisation type and participant level, and across traditional project phases and constraints to identify the relative importance of each factor from each aspect. The initial framework developed for this study was used to guide data collection, analysis and interpretation, to produce a more holistic approach and encompass the study from the different perspectives employed.

This chapter has outlined the research method of the study, including the choice of research approach, the criteria for participant choice, the procedure for data collection and analysis, and the ethical considerations. To capture the complex nature of this topic, a mixed-method approach was used, helping to develop the significant differences found in the quantitative instrument through the qualitative instrument. This chapter has provided the background information to the study, and a summary of the research goals.

CHAPTER 4

RESULTS

4.1. Introduction

This research is concerned with the collaborative project endeavours of university, industry and government entities in combined research projects where either two or three of the entities are involved, and in particular the nature of the collaboration before, during and after a research project, and the differentiating factors that impinge on a successful collaboration.

This chapter presents the results of the mixed-methods study. Firstly, the demographics of the participants are presented from both the quantitative and the qualitative studies. Secondly, the results of the quantitative data from the online questionnaire survey are presented. Finally, qualitative data from the participant interviews are presented, both in terms of their pertinence to the quantitative results, and in terms of new discoveries from the qualitative results.

The findings presented in this chapter address the following research question and objectives:

- How do each of the key differentiating themes identified impact the UIG collaboration from an overarching perspective, from a project perspective (phase and constraint) and from a collaboration outcome perspective?

The research question has been framed within the following study objectives:

i) To identify differentiating themes for university-industry-government (UIG) collaboration that define the unique characteristics of their project environments and the tensions between these approaches.

ii) To examine the challenges these recognised differences may present to university-industry-government (UIG) collaborations from a project management perspective.

iii) To examine how the themes identified impact on the collaboration outcome, either positively or negatively, drawing on collaboration theory.

iv) To develop a research-informed framework to assist in the management of university-industry-government (UIG) project collaborations.

The first objective has been partly answered through the literature review and will be further developed in the qualitative results. To answer the remaining questions, the key objectives will be considered through an examination of the quantitative and qualitative results concurrently. The implications of these results are further developed in the discussion sections of chapters **five** and **six**, and in the conclusion section.

The quantitative tests and qualitative analysis used to answer the key objectives are listed in Table 4.1.

Table 4.1. Quantitative tests and qualitative codes mapped against research objectives:

	Quantitative	Qualitative
Research objective 1 Differentiating theme identification	Rank data ● Differentiating themes in order of importance against the outcome	● Literature review for initial identification ● Extended codes from the interview analysis
Research objective 2 Differentiating themes against outcome at the data collection model level	T-Test ● Key informants and team members ANOVA ● Differentiating themes against all three sectors: University, government and industry Cross-tabulation ● Collaboration integration measure inception to completion	● Conceptual level interview responses
Research objective 3 Differentiating themes against project management perspectives and career progression	T-Test ● Project budget under and over $100K ● Project length under and over one year ● Individuals in UI projects under and over ten years Cross-tabulation ● Differentiating themes against project phases ● Differentiating themes against project constraints	● Interview responses against project management perspectives
Research objective 4 Research informed framework	Developed through chapter **five** and **six** discussion and in chapter **seven** conclusion	

4.2. Results: Questionnaire survey

4.2.1. Quantitative reliability

Reliability explains the extent to which a research instrument can replicate the same results on a continual basis (Page & Meyer, 2000). As the items used in this study are specifically included due to their relevance as proven in previous studies (Ankrah et al., 2015; Augandhavanija, 2011; Bruneel et al, 2010; Kirkland, 2010; Perkman et al., 2013; Ramli 2015; Ramos-Vielba et al., 2011; Rybnicek et al., 2018; Wilson, 2012), the criterion was used to confirm value rather than dismiss items and rank them in order of importance.

To summarise and compare the ranking of the individual differentiating themes, a comparable means test was used to provide a potential weight of importance within the scale as a whole. This is also done on the study outcomes, which are both measured in relationship to project success. Comparable means were calculated by changing the group means into percentages to improve ease of comparison and interpretation. Table 4.2. provides the means, minimum and maximum values, and standard deviations for the 16 differentiating themes in the study, and the outcome variables, together with their comparable means shown as percentages.

Table 4.2. Descriptive statistics of differentiating themes and outcome variables

Ibv	Variable	Comparable mean %	Minimum	Maximum	Mean	Standard deviation
Differentiating themes	Differences in project governance	63.57	1	7	4.45	1.31
	Differences in completion goal	62.00	1	7	4.34	1.38
	Differences in subject matter experts	61.71	1	7	4.32	1.29
	Differences in funder priorities	61.14	1	7	4.28	1.48
	Differences in timescale uniformity	61.14	1	7	4.28	1.4
	Differences in leadership	61.00	1	7	4.27	1.42
	Differences in scientific review	60.86	1	7	4.26	1.44
	Differences in intellectual property	60.71	1	7	4.25	1.45
	Differences in project ownership	60.57	1	7	4.24	1.38
	Differences in outcome goal	60.00	1	7	4.2	1.52
	Differences in career aspiration	60.00	1	7	4.2	1.32
	Differences in career focus	59.86	1	7	4.19	1.36
	Differences in team collaboration	59.57	1	7	4.17	1.38
	Differences in project justification	59.29	1	7	4.15	1.5
	Differences in collegiality	59.14	1	7	4.14	1.47
	Differences in ethics requirements	58.00	1	7	4.06	1.49
	Differences in project streams	56.57	1	7	3.96	1.41
Outcome variables	Perceived ongoing relationships	67.43	1	7	4.72	1.37
	Perceived broadening of views	67.29	1	7	4.71	1.24
	Perceived measure of collaboration	67.14	1	7	4.7	1.15
	Perceived future of research stream	66.00	1	7	4.62	1.21
	Perceived outcome effectiveness	65.86	1	7	4.61	1.12
	Perceived increase in quality of working relationships	65.00	1	7	4.55	1.37
	Perceived increase in power relationships	63.71	1	7	4.46	1.26
	Perceived increase in network density	63.29	1	7	4.43	1.25

Some provisional observations pertinent to this study can be revealed from these findings; for instance, the order of comparable means shows the potential importance of the individual factors as they relate to project success. *Project governance, completion goals,* and *subject matter experts* are shown to be slightly more important than the other factors in the survey data, whereas *project streams, ethics* and *collegiality* measure as less important to overall success.

Similarly, when we look at the outcome measures, which are the dependent variables of the study, some interesting tentative observations can be made. The order of means show that all outcome measures are perceived to be important, specifically to the outcomes of an *ongoing relationship, broadening of views* and the *measure of success in the collaboration*. Those that showed least importance are an *increase in network density, power relationships,* and *quality of working relationships*. These results in themselves are interesting and will be explored further in the following sections.

Together with the project factors and project outcomes, this study also measures the differentiating themes against the following:

- the data collection model
- project perspectives of the project life cycle
- project constraints
- build at project inception
- build at project completion

As this study primarily uses non-parametric tests, cross-tabulation can also be used to explore the frequency for each category; for example, the importance of the independent variables across the project life cycle.

To this end, there is also an advantage of using single-item measures, which are often viewed as having increased face validity (Wanous, Reichers, & Hudy, 1997). The use of a single item measure allows us to test more holistic thorough models of relations among constructs (Voydanoff, 2007), as in this study with a set of core constructs of interest.

4.3. Quantitative demographic Information

This section describes the key characteristics of the participants who responded to the questionnaire, followed by the demographics of those who were interviewed. The information is displayed using frequency distributions in tables and figures with the primary purpose of describing, summarising and presenting the data in a graphical format (Pandey, Manivannan, Nov, Satterthwaite, & Bertini, 2014).

4.3.1. Survey respondent data

As noted in the study participants Section 3.6.1., the questionnaires were distributed to the universities, industry, and government research entities that responded to the initial call for participation. The questionnaire was distributed via email using a Qualtrics link to gain access to the questionnaire. The initial distribution was by the Qualtrics email system between November 2016 and February 2017, with follow up requests between March and June 2017. The date of the receipt of responses was captured in the online system used to ensure that the findings from the questionnaire had an accurate depiction across the views of research staff and organisational types as developed in the thematic framework.

Demographic variables were derived and calculated from section one of the instrument. The following table contains the breakdown of the questionnaire responses, including country of the participant, primary sector, length of career involvement in this type of project work, length of the project, and total funding for the project. As noted in section 3.6.1.1., there were 98 samples in total, 77 from Australia and 21 from New Zealand.

Table 4.3. Demographics of survey participants

Country	
Australia	78%
New Zealand	22%
Business Categories	
Education - Universities	28%
ICT - Information and Communication Technology	21%
Financial and Insurance Services	14%
Government and Health care	7%
Science and Knowledge Intensive services	17%
Others	13%
Length involved in UI Collaboration	
< 1 year	44%
1 - 4 years	19%
5 – 9 years	11%
10 +	12%
20 +	13%
How long was the collaboration	
< 1 year	40%
1 – 4 years	49%
5 – 9 years	7%
10 +	4%
Funding totals	
< $100K	50%
$100-$499	23%
$500-$1M	12%
$1-2M	7%
$2-5M	1%

>$5M	8%

Table 4.3 shows the majority of the respondents are from Australia, being 78% compared to 22% from New Zealand. This can be contributed to the difference in population size and therefore the number of research collaborations within each country (Australia has a population of 25 million versus New Zealand at five million). However, we cannot assess whether these figures are proportionate to the participating organisations as, while staff figures currently working on research projects is known, there are no figures available for whether this research is collaborative in nature between different organisation entities or individual researcher projects.

To attain an accurate set of demographic split, respondents were asked to supply data regarding their business research sector, the length of time they have been involved in collaborative research, the length of their most recent collaborative project, and the amount of funding the project received. A full set of business categories was supplied in the survey using the New Zealand Sectors report produced by the Ministry of Business, Innovation and Employment (MBIE, 2016). The responses to this section have been summarised into the higher-level business categories shown in the report to improve ease of use and are reported in Table 4.4 producing a spread of responses across industry, government and university which are the three areas under concern in the study. These have been amalgamated for reporting. The data for the length time respondents have spent in collaborative projects also shows a spread of respondents across all timeframes, with the majority (44%) having involvement of under one year. Similarly, half of the projects reported were small, involving less than $100,000 dollars. The split in both length and funding is explored further in the results and discussion sections to add understanding to project types.

Table 4.4. shows the breakdown of the project funders who are also an important element to the research as they show the organisational context in which the collaboration sits. Funders are split evenly across the study, with 65% of projects being individually funded across university, industry and government funders. Dual (24%) and tri-party (12%) funding is still significant.

Table 4.4. Primary funders

Who were the primary funders	
University	26%
Industry	18%
Government	21%
University / industry	15%
University / government	9%
University / industry / government	12%

Both project lead staff and team members within the collaborative research projects were investigated to look at the similarities or differences in their response to the differentiators under investigation, with the roles of the participants being reported in Table 4.5. The study respondents are distributed between leadership and team members, but there was no leadership response within the government collaborator.

Table 4.5. Participant roles on the collaborative project

Role on the project	
Industry lead	13%
University lead	15%
Team member	54%
Researcher	10%
Graduate	9%

To add to the understanding of the survey data, a question was also included that investigated the spread of researchers from university, industry and government, with similar distribution levels between university, industry, and government staff across all levels of participation. The majority of projects (31%) had one staff member. The number of projects with more staff involved dropped as the project participation levels grew, with the largest teams of 20 or more team members accounting for 7% of projects. Between two and 10 team members the percentages stayed similar, with 16% of projects having two team members, 15% of projects having three team members, 16% of projects having four team members, and 14% of projects between five and ten team members.

Funding spread was another important aspect for the collaborative project types. Figure 4.1 shows the funding source, together with the spread of funding both under and over $100,000. There are however, no respondents in the category of industry and government joint funding. The spread of funding on projects was split quite closely, with 52% of the projects being funded at under $100,000 and much of this funding being from individual bodies. Project funding over $100,000 constitutes a more even spread.

However, for individually funded projects it can be seen that, while industry and government show similar levels, university funding is split much more evenly with the majority of their funds being to smaller projects under $100K, with only a small percentage gaining access to larger levels of funding.

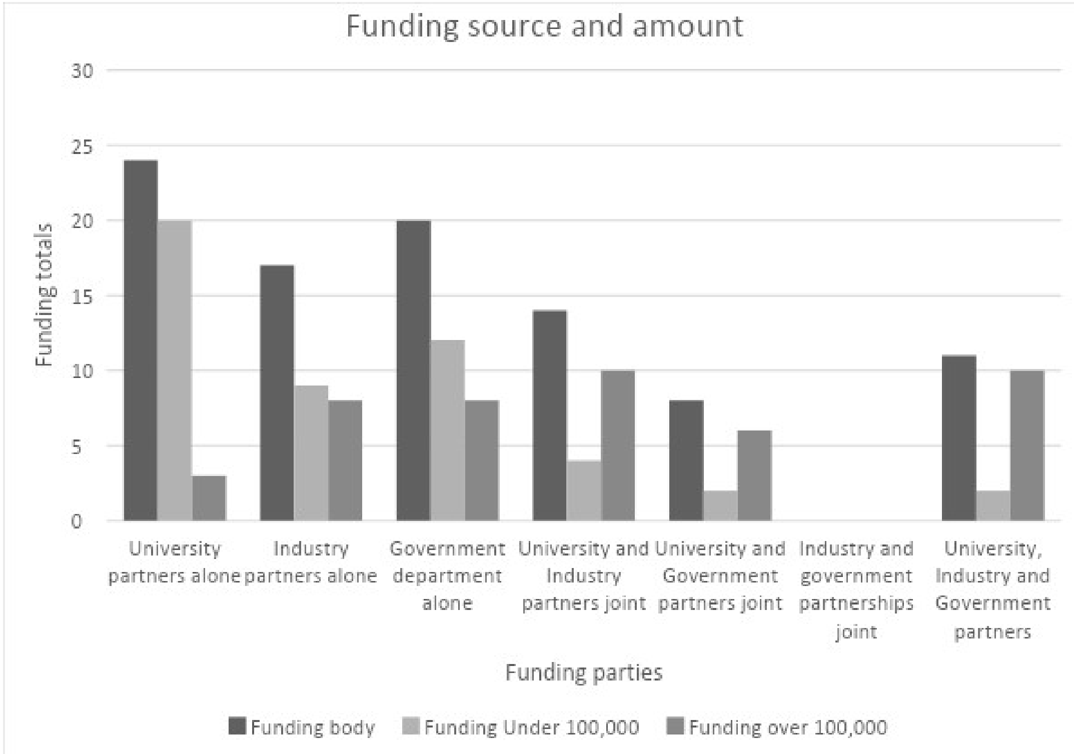

Figure 4.1. Funding source, funding amount and team role.

These results, together with the interview results that follow provide a spread of data that adds to the reliability of the overall study data.

4.4. Qualitative demographic information

4.4.1. Interview respondent data

This section reports the qualitative results from the interviews with key informants and team members and continues to follow the research framework of the quantitative method, drawing participants from the three sectors of university, government and industry and from both key informant and team member participant levels.

Demographic information for the interview participants was gathered during the interviews. Gaining the views of both key informants and team members within collaborative research projects enables a comparison between the two groups looking at the similarities or differences in their response to the differentiating themes under investigation.

Twenty interviews were conducted with eleven key informants and nine team members across the three organisation types over two months. The interviews involved five key informants and three project team members from universities, three key informants and three team members from industry, and three key informants and three team members from government research entities. Table 4.6. contains the demographic breakdown of the participants, along with their length of experience in this project type.

Table 4.6. Demographics of interview participants

Business type	Staff type	Years of experience
University New Zealand	Key informant	10+ years
University New Zealand	Key informant	30+ years
University New Zealand	Key informant	33+ years
University New Zealand	Key informant	30+ years
University Australia	Key informant	20+ years
University Australia	Team member	2 years
University Australia	Team member	6 months
University Australia	Team member	10 years
Industry New Zealand	Key informant	8 years
Industry New Zealand	Key informant	27 years
Industry New Zealand	Key informant	25 years
Industry New Zealand	Team member	2 years
Industry New Zealand	Team member	4 years
Industry Australia	Team member	6 months

Government New Zealand	Key informant	15+ years
Government New Zealand	Key informant	20+ years
Government New Zealand	Key informant	20+ years
Government New Zealand	Team member	5 years
Government New Zealand	Team member	4 years
Government New Zealand	Team member	6 years

The average length of involvement for key informants was 21.63 years, and the average length of involvement for team members was five years.

4.4.2. Coding

This stage involved using the coding from the original framework, together with abductive inference, a means of interpreting and redescribing different components / aspects from hypothetical frameworks and theories. Within this research, the framework was compared and integrated, shaping the research design by studying both the existing and original ideas and relevant critiques (alexander 1996; Lupton, 1997). As a result, relevant critiques were integrated as part of the interview guide.

Therefore, pre-coding was developed in an iterative process that involved highlighting or pulling out words or sections of text that appeared significant both to the original framework, and to consider original exploration. It can be argued that pre-coding employs abductive inference because it allows the researcher to identify findings external to the original theoretical lens for further exploration and interpretation of the data, and gives rise to provisional codes that are subsequently validated by ongoing data collection and analysis and were eventually adopted as core codes and categories. In this sense emerging data that was not in keeping with the original framework but was not overlooked.

The responses from the qualitative interviews were coded into the preliminary 16 differentiation themes and sub-themes constructed from the literature review. Following this initial categorisation, the data was ready for more detailed analysis in fulfilment of the research aims. The relative frequency of each theme in this initial categorisation is presented in Table 4.7, together with the new differentiation themes and sub-themes generated through the coding process. New themes developed and produced an additional five main themes and five sub-themes, which together comprise a new extended framework.

Table 4.7. Extended differentiation theme framework showing the hierarchical frequency distribution

Main differentiating themes	**(n)**	**Sub-themes**	**(n)**
1. Career	86	1a. Subject matter experts / career credentials	42
		1b. Career aspirations	19
		1c. Career focus	16
2. Funding	84	2a. Asset distinction	28
		2b. Funder priorities	8
3. Collaboration (new)	63	3a. Trust (new)	8
4. Project management methodology (new)	57	4a. Contract management (new)	29
		4b. Task segregation (new)	19
5. Project ownership	55	5a. Project stream	19
		5b. Project justification	11
		5c. Profitability (new)	10
		5d. Governance	9

6. Completion	54	6a. Timescale uniformity	35
		6b. Completion goal	16
7. Teamwork	36	7a. Collegiality	16
		7b. Team collaboration process	4
8. Intellectual property	27	8a. Influencing (new)	3
9. Communication (new)	24		
10. Leadership	21		
11. Scientific endeavour	19		
12. Internationalism (new)	16		
13. Ethics	9		
14. Project mishaps (new)	9		

Table 4.7. includes five new main themes: collaboration, project management methodology, communication, internationalism, and project mishaps. In addition, it includes five new sub-themes: trust, contract management, task segregation, profitability, and influencing

As with the quantitative results, the qualitative results provide patterns of interest around each of the differentiating themes, indicating the importance and weight given to each by the research participants. The results are presented collectively to provide a fuller understanding of their impact. During further analysis, the themes are observed from the perspective of each of the specified sectors, the participant views and finally their influence on the project management concepts as follows:

1. Section 4.5 discusses the themes individually against the findings of the literature review or as new themes discovered through the qualitative findings. New themes have been integrated into this section rather than reported separately, as some were found to be discussed more frequently than those previously found in the literature. This

section also reports the themes individually to assess their global influence on the UIG collaborative project.

2. Section 4.6 is reported in two sub-sections. Section 4.6.1 discusses the themes as they relate to the data collection model with specific regard to differences between the three sectors of university, industry and government and the two levels of participants both key informant and team member levels, and against staff longevity in this style of collaboration. This is reported separately as there are researchers in the study that stayed at staff level rather than moving into management roles, but who have many years of practical experience and provide another perspective within the topic. The themes in this section are reported primarily to evaluate the differences between groups.

Section 4.6.2 continues by discussing the impact of the themes, presenting them here against the project management perspectives used in the study, which include project budget, length, phases, and constraints, both at the start and at the end of the project.

In both sub-sections of Section 4.6, the themes are also evaluated against the perspectives of the outcome measures.

4.5. Individual theme analysis

4.5.1. Career

The central theme of *career* also includes the sub-themes of *subject matter experts/career credentials, career aspirations,* and *career focus* and considers researchers across all sectors. In industry and government, most of the researchers' roles were in pure research, whereas in universities, there was a mix of staff mainly doing teaching and research roles, with fewer doing only research. The role of project managers similarly spans all three sectors and, as such, has no specific sector alignment. The theme of *career* was the most frequently discussed theme in the qualitative data.

Bayney (2009) noted the similarities in management paths in all three sectors and reflected the findings that there was no specific sector alignment. A research path and specifically a university academic path is acknowledged as a different direction, however, as discussed in a study done by the University of Oxford (2011), according to which the unique nature of the path allows academics the freedom of choice in their research, which is not found in other sectors. Unlike the role of managers, researchers were more definitively aligned to a specific sector which heavily relies on their knowledge of the subject, as noted by Calderhead (2002). This difference reflects in their career goals. Industry careers are measured for their wealth creation, and university careers are measured for their knowledge creation; both goals drive career output and both careers are driven by and rewarded according to these goals. As Kenny (2002) stated, this brings conflict between the two approaches of classical project management and independent academic professionals. This cultural gap is a known phenomenon and was first reported by Simon (1967), but this misalignment is still apparent with companies emphasising concrete tasks and measurable results, and universities discussing matters at a more abstract level (Pohjola, Puusa & Iskanius, 2015), with few studies to underpin academic engagement (Perkmann, et al., 2013). The findings in the literature are also reflected in the importance of this theme in the research and demonstrate the cultural gaps previously found:

> High profile researchers want to stay as academic researchers. Highly skilled researchers still need to be in a strategy that works for all. Recognition of researchers is high, and the institute itself also brings people to us.
>
> (University key informant 5)

> Some academics are connected well in their area of industry; others are connected well scholarly but not with industries. We lead people together to see what ideas may bubble to the surface. However, if an academic doesn't want to work with the organisation, they don't have to.
>
> (University key informant 1)

Government key informant one explained that "our scientists move around within industry, but they don't usually go through to universities."

4.5.1.1. Subject matter experts / credentials

Lavin et al (2007), says that *subject matter expertise* is the main credentials that academic researchers bring with them to industry, but is also the area of interest on which most managers and researchers outside of academia base their careers. Being a *subject matter expert,* therefore brings with it an individual's *career credentials*, a subject that is also discussed within the theme of *intellectual property* which is an output of most UIG collaborations, but also a precursor to the collaboration. As noted by Alexander et al. (2010), it is possibly the most important aspect as it will dictate the viability of the project. The university researcher requires the ability to publish results as part of their *career credentials*; the organisation needs the ability to produce a commercially viable output; and the government want to optimise the economic return of the research done (Marcos & Denyer, 2012).

While most researchers are *subject matter experts*, not all are given the ability to follow the research path they would like to focus on in their career. As Etzkowitz (2008) noted, this is usually only possible to the academic researcher whose science is primarily conducted for the pursuit of knowledge; both commercial sciences for marketable products and government sciences for public enterprise or economic guidance are dictated by company strategy and political agenda. Knowledge creation may follow similar methods, but it follows a different set of rules (Shmaefsky, 2002). However, *subject matter experts* are seen as one of the essential aspects when considering who to collaborate with and are the foundation of the Triple Helix theory (Etzkovitz & Leydesdorff, 2000). *Subject matter experts* are reported as necessary to both the research topic and the research management:

> The breakthrough was discovered through invention in a lab and the deep knowledge of the specialists.
>
> We found the leaders we wanted and went out to them. We identified the work first, then the people and then contracted through the universities.
>
> (Industry team member 2)

> One outside job we were asked to do was to look at 'chatbots' for a company who had no expertise in this area. The job came completely out of the blue, but as we have the highest level of data scientists in New Zealand, they came to us first. We only have one specialist in this area, but it's still more than most.
>
> (Industry key informant 2)

> We have a case at the moment, a project which is in data technology and data analytics in a centre, and we have nine different groups and a national body.
>
> We've just put some money into it from a strategic fund, and we have specifically told the PI that they will use part of the money for a project manager. As a director within the group who will control the major funding

> bid which we have taken to the government which needs to be recast, they need to set up financial protocols, the governance arrangements, and all other areas and we need a funded project manager/director throughout. If we look at the national science challenges, they all have executive directors as do the centres of research excellence. Most have at least a full-time dedicated administrator.
>
> (University key informant 2)

University key informant 5 explained that "industry relies on the credibility of the university as an independent scientific advisor."

Research projects usually dictate the need for *subject matter experts*, and at this level of specialisation there are also fewer experts in any given subject field. This situation gives rise to inherent collaboration as researchers in the same fields often know other through similar past projects. Gratton (2007) noted the ability to capitalise on these pre-existing or heritage relationships to increase the chances of project success:

> We needed a specialist physician for the trial and found one I had faith in and knew him from our community group. They wanted to use a colleague, and the team grew organically.
>
> (Industry team member 2)

4.5.1.2. Aspirations

Career aspirations were talked about less than credentials but are important as they inform the choice of collaborative endeavour. In the case of many researchers, their pursuit of research will continue throughout their career, either in the same or a related area of research. The research stream leadership competencies were identified in an initial study by Muller and Turner (2007) and confirmed in a follow- on study in 2010 as providing a direct correlation to success.

Researchers reported two main directions: continuing as researchers or transferring into managerial roles. Academic researchers were slightly different as their research roles often included teaching. The benchmark for academic research is widely understood: employment in an institute that encourages and rewards research (Oxford, 2011), whereas industry and government careers are rewarded by fulfilling the needs of the business and budget plan (Bayney, 2009), providing a different set of *career aspirations* to those involved in a collaboration as can be seen by these two descriptions:

> Different sets of expectations with different areas and ranges for scientists. We have a stream for science and a stream for general staff, and we don't mix the two. Within science, there is a technology stream and a science stream.
>
> (Government key informant 1)

> Scientists need to go down a management route if they want to get to the top of the organisation, we don't have scientists as high as managers. Scientists tend to stay on their path; the management is more fluid. Although in this industry, there is not much new blood, it more shuffles around.
>
> (Industry key informant 1)

4.5.1.3. Focus

Focus was talked about on an equal basis with *aspirations* and dictates the alignment of a researcher in terms of organisational type. There were distinct differences in the discussion on *focus* between academic researchers and non-academic researchers. Specifically, academic researchers could, for the most part, choose the research area they want to be involved in, whereas non-academic researchers were more aligned to their business sector or government policy decisions. This difference in *career focus* puts the collaboration leaders on quite different paths, and this can be seen as a cause for tension (Hughes, 2008) when collaborating, as noted by the following comment:

> Industry is used to more incremental research, small improvement, less risky, more sure research. Generally, academic research is more disruptive and riskier.
>
> University key informant 3

4.5.2. Funding

The main theme of *funding* also includes the sub-themes of *asset distinction, funder priorities*, and *funding availability*, and was the second most frequently discussed topic in the qualitative data. This theme considers all forms of *funding* available whether from an external *funding* agency or the mix of the collaborators in the project, and also takes into account *funding* availability and competition. Current literature reported the main issue as being the change in the funder environment from a relatively friendly and informal relationship that governs joint projects to a more formal legal one, in which universities have onerous obligations to deliver against contracts with stringent ethical requirements (Kirkland, 2010). The literature shows this by highlighting an ongoing trend of university research being increasingly funded by private companies while the share of basic *funding* for universities is decreasing. Most empirical studies also show that external sponsors give more money to institutions which have high-quality researchers (Kohrman et al 2008). Applied research is most frequently undertaken by universities and government subsidised research centres, both to serve the direct needs of industry without direct collaboration, and to contribute solutions to social and economic issues (Harman, 2006).

The *funding* theme also takes into account funder behaviour. As shown from the literature, the collaborative model has separate *funding* scenarios providing for a fundamental difference in the way the research is funded for each partner. With funders being the main driver of the research goals, the fund holder has stronger weight on what they may be. The quantitative analysis showed the primary funders to be universities, which account for 26% of those reported, followed by the government with 21%, and industry *funding* at 18%. These indicate that single party *funding* was still making up the majority of the budget for collaborative projects, simplifying the ownership structure, which generally comes from the funder. Looking at collaborations that are funded by dual parties, 15% were from university/ industry, and 9% by a university/government mix. Twelve percent came from the tri-party agreement of university/ industry and government, which means having to accommodate multiple funder behaviour scenarios and further complicates the bid for *funding*. Another point of interest was size of *funding*: in both industry and government there was a relatively similar split of project *funding* under and over $100K, whereas university had the majority of their *funding* (83%) aimed at smaller projects under $100K, with much less (17%) being given to larger, long-term projects. There were no discussions around the proportioning of funds, but this is possibly due to the number of research active staff within universities, given that this is an intrinsic part of the role. It is, therefore, a necessity for universities to provide a wider spread of funding. Securing *funding* is a constant endeavour and can be hard to attain:

> Funding from Universities takes time and hasn't been available for whatever reasons. It's too slow, so we've been using contracts. Haven't been able to plan out far enough to get funding help from Universities, even with long lead times on clinical trials.
>
> Fundraising is continuous, and we farm out some of our fundraising and pitching needs. No hard and fast rules as long as we get funding.
>
> We have used crowdfunding, industry groups, and angel groups. We have also had some pro-bono from professional bodies for some of the work.
>
> (Industry team member 2)

The constant need for *funding* necessitates a secondary collaborative relationship with the funder to secure *funding,* and this has necessitated the need for expert bidding staff. This *task segregation* was noted by Kirkland (2010), and is reflected by participant comments:

> The funder relationship is more important than collaborator relationships, and they aren't always the ones you want to collaborate with.
>
> Often the bidding person is not the science person, which means that the delivery team might deliver a project that they have not necessarily been involved in for either planning or milestones.
>
> (Government key informant 2)

It was also noted that both the speed of *funding* and the additional efforts needed to gain it cause friction:

> Industry still has an expectation of getting something for nothing. If we get a grant from MBIE and it gives 60% of the cost of the project which means we have to go to industry to get the other 40% we often have to sell the project to the industry by saying they are actually getting 60% of the development cost of the research free. So, it's a sales process.
>
> (University key informant 4)

> I've talked to the three main universities in Auckland, and they all have a lack of understanding for commercial settings. There is a significant disconnect between academic importance and business need. Interns prove extremely important at bridging the gap.
>
> (Industry key informant 2)

The competition for *funding* causes further contention, which was presented in several conversations. Many collaborations rely on the availability of *funding*, and external *funding* is mainly gained under competition:

> It's a lot about who is competing for the same funding. There are specialist organisations that get the majority of the work. In NZ Fletchers get a lot of government-funded work, but have a 60% turnover in staff, and do not have enough professional project managers, they are mainly construction managers.
>
> (Government team member 1)

> Once you have the collaboration and you have a common goal, and you're starting to go for funding together, it's easier. It's more competitive to get the upfront money, and it's not individually led, so it's competitive. You

> need to have enough time to generate enough person-to-person collaborations and relationships.
>
> (Government key informant 1)

4.5.2.1. Asset distinction

Assets are distinctly different for each collaborative sector, with industry being driven through a return on investment; academic organisations primarily that of the public good; and government organisations by public enterprise while providing aid between academic and industry entities. Although they all work within the same principles of research, they follow different sets of rules (Shmaefsky, 2002). The principles of scientific research methodologies do not differ, however, and while many academic managers still contend that their environment is 'unique' and not amenable to generic project management models and techniques (Liberatore, 2009), there are many methods and techniques which are used within project frameworks. A framework is a meta-level (a higher level of abstraction), through which methods and techniques are integrated. While some sectors are particular, others are general, and this reflects in their *asset* criteria in that those that were more general in their *asset* criteria tended to be working on return on investment as their core *asset* driver rather than the public good. This core *asset* driver brings with it a core competence inherent in industry and government that is not present in university:

> Most of the CRI's assets are built around a single discipline; universities are not, so there is an immediate disadvantage for them to collaborate and send research elsewhere.
>
> (University key informant 1)

4.5.2.2. Funder priorities

Participants talked less about *funder priorities* than *assets*, but their discussion underlined the strong influence that funders have as drivers of research goals. It is not surprising, therefore, that universities would want to grow these relationships as this is where the majority of their research funding is gained (Harman, 2010):

> Time and cost are the main decisions around go-no-go, usually because the client has a time-bound decision of their own, and it's usually around how it fits into the current business.
>
> When there is a clear commercial change of direction, and the research team don't want to accept it that can be discouraging for all involved. We then just try to get the researchers to understand that from a customer's viewpoint the world might change quickly, and although the research might be useful the customer does not want to pay for it, so it has to go on hold until we find a different way to get it paid for.
>
> (University key informant 1)

However, many researchers would still follow their research interests regardless of funding availability and would do whatever was necessary to keep their projects going through personal passion for the subject:

> Getting the government involved and engaged is not easy, ministerial agendas change. Also, how research infrastructure is aligned to research strategy slips, or facilities change, or resources are diverted. For instance, we have research in the Antarctic, which is not currently being supported; we might need to get a philanthropist or go to the Chinese or the US for funding.

(University key informant 2)

4.5.3. Collaboration

Collaboration is a new theme that was not included in the original theme list; a *collaboration* framework was used to measure outcome in the quantitative study; in the qualitative research, however, *collaboration* was discussed in a much broader context than pure outcome. This wider context warrants the inclusion of *collaboration* as part of the initial framework.

As the collaborative process starts with interaction and negotiation of autonomous actors (Thomson et al., 2014), inherent in this definition are process-related activities such as joint governance decisions and the creation of effective support systems to arrive at a mutually beneficial relationship (Thomson et al, 2014). *Collaboration* is shown as a theme that has an influence before and throughout the UIG project, not just at its end.

Collaboration was the third most discussed topic in the qualitative data. Inherently, collaborators have a mutually beneficial and well-defined relationship into which they have entered to achieve common goals. The relationship includes commitments on several levels: to mutual relationships and goals; to a jointly developed structure; and to shared responsibility, mutual authority and accountability for success; as well as sharing of resources and rewards, (Mattesich, Murray-Close, & Monsey, 2001). The effort and time involved to set up, develop and maintain *collaborations* was a primary topic, and the main issues identified by collaborators was a lack of understanding towards the effort needed to pursue and manage such collaborative networks:

> Collaboration also helps to build up good relationships, but you need to keep them going. In industry keeping relationships going is harder, for

> example, I spent 60 hours helping to build a case for a royal society catalyst feeding fund which we didn't get – this has to come out of personal time.
>
> They can also have negative effects if collaborators are going for the same funding, the competition can also stop scientists collaborating together.
>
> (Government key informant 2)

> Collaboration is also an issue. In many universities, even interdepartmental collaborations are ZIP (none existent). Company collaborations are similar, although smaller companies are better collaborators than bigger companies. Last time we worked in a commercial/academic environment, it took too much management, so we ended up doing our research.
>
> (Industry key informant 3)

Collaboration was also discussed in the view of individual relationships. To gain and maintain a collaborative relationship, it is important to ensure that all associates realise a reasonable level of proprietary gain from the partnership even if the nature of their involvement in the project is subject to change. As stated in Section 4.5.1. a track record of successful collaborative research may also be an academic driver, capitalising on these pre-existing or heritage relationships increasing the chances of project success (Gratton, 2007):

> We have found that regardless of what happens in the business world, collaborations keep going, even in the case where an organisation was taken over, and the accountants came in to tighten up the work, the collaboration still keeps going.

> The human element needs to be taking into account more than the company. The human element is the most important. Collaborations are important, but they are with the person, not the institution.
>
> (Industry key informant 3)

4.5.3.1. Trust

Trust in this study was identified as a new sub-theme not previously identified as a contributing theme in the literature. Although the discussion was not prevalent, *trust* was reported as an inherent part of the *collaboration* and it was reported to gain impetus the more a *collaboration* continues. Heritage relationships, as they are known, are built on the basis of *trust*, which is necessary for a successful *collaboration*. Forming teams that capitalise on pre-existing, or heritage relationships increase the chances of project success, while new teams, particularly those with a high proportion of members who were strangers at the time of formation, find it more difficult to collaborate than those with established relationships. Newly formed teams are forced to invest significant time and effort in building trusting relationships before performing well (Gratton, 2007).

Along with many of the other human themes in the study, *trust* is an important theme and takes longevity to build, with Harris (2007) noting that variable levels of commitment and the failure to establish *trust* are reasons for the failure of collaborative research. The following two participants reflect this finding and also note that *trust* levels also lead to repeat *collaborations*:

> The most important theme for the team is trust. Success with a positive culture comes down to trust in the project. Kiwis have an old culture and are risk averse. They tend to be slower to innovate and conservative in the South Island, I think the North Island is a little better.

(Government team member 1)

> Once we have this, we tend to get repeat work. We have a company that we work with in Texas who told another third party that we are trustworthy and that we understand their work well, we work on win-win situations.

(University key informant 4)

4.5.4. Project management methodology

Project management methodology, together with *contract management* and *task segregation,* are all new themes identified through the qualitative research in this study. *Project management methodology* is also differentiated from the *scientific method,* which is concerned with the method performed to provide repeatable science. *Project management methodology* was the fourth most frequently discussed in the qualitative data, but this theme was not explicitly identified as a differentiating theme in the literature, and consequently, no quantitative data was gathered.

As noted by Liberatore (2009), there is still contention by many academic managers that they are in a 'unique environment' (p.1328) which is not amenable to traditional project management techniques. There is, however, an increasing understanding that research management will need to imitate the processes of project management to realise the protection of intellectual property that comes through controlled contract management practices, together with customer satisfaction and the broader dissemination of project results that are performed through the differentiated channels of *task segregation* as noted by Kirkland (2010).

Research by Ankrah and Tabbaa (2015) showed that applying any form of project management impacts the perceived successful operation of knowledge and technology exchange. The study also found that themes identified as either facilitating or inhibiting the perceived successful operation if correctly managed all had a positive effect, and those that were neglected or mismanaged tended to have a corresponding negative impact.

Interviewees in this study also noted *project management methodology* as the broader management of the research project and as a perceived benefit to their endeavours as shown in the following statement:

> The government puts the impact of research excellence first as the key goals in their project with a fund, and it's up to us to pull a project management framework around it to facilitate it. The project management side on collaborative projects is seen as a necessary service function.
>
> (University key informant 2)

It was also noted that researchers do not usually receive project methodology training, which is more likely to be needed on collaborative projects, and a difference was also noted between the research methodology training that most researchers receive:

> Not many get project management training on a degree but those that do use it. Research methodology teaches keeping your documentation well, but it's not oversight around communication and finance, or meeting the requirements of the project as it was set down.
>
> Once we have collaborations that sit outside the university, we are much more likely to have a project manager. Although an external funder with large amounts of our staff would still be wondering whether we need someone to do the oversight.
>
> (University key informant 2)

4.5.4.1. Contract management

Contract management was discussed as a sub-function of *project management methodology* and typically done by specialist staff not directly related to the UIG project, being either contract managers or legal professionals. Kirkland (2010) notes the change in funder environment from a relatively friendly and informal relationship that governs such joint projects to a more formal legal one, in which universities have onerous obligations to deliver against *contracts* with stringent ethical requirements (Kirkland, 2010). Many interviewees noted this regulation in their environment, as well as the need for specialist staff to fulfil these demands. The specialist staff manage the documentation, not the actual work. and are often removed from the project. In theory, the *contracts* are owned at a managerial level; in reality, they are more aligned with the researchers:

> We like to get all contractual items agreed before we begin including who's doing what about publications, we do contract variations for the changes. When it's a change of research, this can be inconsistently applied. The contract is the university's not the individual academic's, although contracts often follow academics or researchers. We should be able to replace them with a researcher in the same area but were not always allowed to.
>
> (University key informant 4)

> We manage the governance, not the work, and this is done through a contract which usually consists of service agreements and appropriate payments. Our job is to take the politics out. We do also help develop the programmes, get funding and work out the contracts and milestones. We don't work without it.

(Industry key informant 1)

4.5.4.2. Task segregation

Funding being gained by expert bidding staff, *project management methodology* overseen by project managers, *contract management* overseen by contract specialist and intellectual property lawyers, and researchers running the *scientific research* leads to teams where *task segregation* becomes normal. This complicated landscape has introduced several roles that will not be directly involved in actual collaborative work. *Task segregation* was noted within the purview of *project management methodology* and was also noted by some interviewees, specifically the research bid, often meaning that the collaborators are not a party to the work until the project is negotiated. This process takes the researcher out of collaborative development entirely and, in some cases, to the detriment of the project, because "More than one person writing bids for the same team causes issues, and sometimes we have to say no to the research" (Government key informant 2)

> In our environment, the segregation of research and operations has been consistent in both large and small organisations. We also have segregation around running and configuring the machines (hardware) and software where I work.

(Industry key informant 2)

When collaboration generates multiple ongoing projects, there is a perception that formal relationships need to be nurtured by business development staff. Once they have gained the contacts within the network, however, researchers will continue to collaborate with a less formal model, continuing to build heritage relationships as noted in Section 4.5.1.1. *career credentials*:

> We do have collaborative partners, and the best is the repeat sale. Many of which are years long, and we have ongoing conversations of what else we can do. The business developers will keep the relationship going and look after them as a customer, keeping them happy and satisfied and looking for other opportunities, they are tasked with this job although researcher will often do it too.
>
> (University key informant 1)

4.5.5. Project ownership

The theme of *project ownership* also includes the sub-themes of *governance, profitability,* which was a new code, *project justification,* and *project streams*. This theme considers the rationale behind the project and its inherent need, including the governance structure which ultimately owns the project, and how it fits into ongoing research streams. *Project ownership* was the fifth most frequently discussed theme in the qualitative data. However, the interview discussions did not reflect the measured importance in the quantitative analysis, which showed this theme as having only minimal impact on the project when compared to other themes. Alexander, et al. (2010) noted that contracts help to prevent any unnecessary uncertainty or disputes regarding ownership in government and university research. Industry tends to cover this through employment contracts allocating ownership to the organisation, which has alleviated some of the tensions around ownership issues.

Ownership is, however, fundamentally diverse. It is viewed as both monetary and intellectual input, and as such, the owners of these collaborations often differ in their justification for the research, and therefore, these ownership differentiation drivers need to be considered. In industry, a short-term completion view was noted in a survey by the McKinsey group (2017), which suggests that pressure to deliver short-term results continue to increase. In comparison, university academics follow streams of similar projects which are strung together, either to explore a subject or different facet of a topic, which involves taking a much longer view of the subject. Barbolla and Corredera (2009) noted this longevity as a primary key to success. Government, however, may only see projects undertaken during their governance term (Harrison & Callan, 2013). Indeed, the ownership of a project has an impact on the project environment, particularly with timescales of individual projects and ongoing work streams which need to be continuous in industry and government, but not in university:

> Most of our scientists, including myself, would have projects starting and stopping at different times so ongoing work. I do know some academics that have a couple that might stop altogether and then think about what next. In Crown Research Institutes (CRI), there are continuous opportunities and projects coming through all the time.
>
> Commercial projects tend to be shorter than government-funded projects. Commercial projects are often one year but not always, they can also run multiple years. A lot of government-funded projects are over a year; four years would, however, be a long project.
>
> (Government team member 1)

4.5.5.1. Project stream

Project stream looks at the continuation of the research into follow-on projects creating the opportunity to develop the work further with a natural forward flow and is associated with both researchers and organisations. University researcher employment contracts often have the continued extension of their research field written in (Manchester University, 2011), with an expectation that researchers will extend their research into related topics. Industry projects, however, are defined as more temporary endeavours undertaken to create a unique product, service, or result, with a definite end deliverable, and are not generally ongoing (Sa Couto, 2008). Government projects being dictated by policy and economics can fall into either ongoing streams or temporary endeavours (Harrison et al., 2013), meaning the definite end of an industry project is in direct opposition to the continuing remit of academic projects. Manchester University (2011) and Kirkland (2010) also noted the growing desire of governments for more accountability from universities through research outcomes which are driving them in a similar manner to industry measurements (Muller & Turner, 2007).

The study results show that *project stream* is regarded as necessary to build up a primary ability of expertise which in turn brings in an income stream, rather than a discrete project approach and is an important addition to collaboration. Both of these aspects are demonstrated by the following participant:

> A stream of research often has commercial and intellectual property which we can either be developed or licensed as a new or existing company. From there we are often asked to develop it or take it to the next generation.
>
> (University key informant 2)

4.5.5.2. Project justification

Project justification was significant to any form of project and aligned with either organisational strategy or a future research strategy in most cases. This need was reflected by the study's participants:

> As a scientist, I'm always trying to align what I want to do with what the organisation and the national body wants to do, and trying to align all the

> strategies, that's where you can maximise resources into your project and provide benefits into the national strategies.
>
> (Government key informant 1)

This need was further highlighted by Government key informant 1, who explained "We have a strategy internally so that we can connect funding requests back to our strategy.

University research has always had a more open remit, which is mainly justified through the funding decision. As Hammerstedt (2011) pointed out, a faculty member in most instances can study any area of interest provided they have the skill set and connections to raise the necessary funds. Government agencies such as MIS are moving the focus away from pure government funding towards industry funding where academics who require funding for their proposed research cannot have the same freedom. These contrasting views frequently co-occur, with University key informant 1 explaining that, "If an academic doesn't want to work with the organisation they don't have to. Our job is to help make them more successful." Government representatives point out that there are benefits for universities in collaboration. Government key informant 1, for example pointed out that "Universities should see us as someone to collaborate with as we are looking at major outcomes for the country".

4.5.5.3. Profitability

As noted in the theme *project stream,* industry projects are tightly defined to create a unique product, service, or result (Sa Couto, 2008). Industry is generally viewed as being profit-seeking, yet the strong drive for *profitability* as an output was not noted in the literature. *Profitability* was, however, discussed as frequently as *project justification* by participants and warrants inclusion as a new code. *Profitability* for the purpose of this study is interpreted as gains made from the project in monetary or intellectual terms. Traditional traits of commercial viability and *profitability* often seen as industry outcomes are now becoming more of an agenda in collaborative research:

> It’s hard to say no to the research; at present, I am booked at 109% with more research coming in. As a researcher, I don’t like to say no, but managers do not want us doing extra work for no money.
>
> (Government key informant 2)

> They measure financial outcome and have too many accountants in control – bean counters are killing businesses. They also work more on sticks than carrots. The business still runs on the bottom line.
>
> (Government team member 1)

4.5.5.4. Governance

Governance was discussed from the view of project *governance*, not organisational *governance*, which on smaller projects was carried out by the primary researcher. However, on more extensive collaboration’s *governance* became a complex scenario with large consultative panels controlling the project delivery in a similar way to corporate *governance*. In this realm the suppliers of finance act to assure themselves of a return on their investment through rules, contracts, relationship management practices, ranking systems, and other coordinating mechanisms that oversee performance at a project organisational level. Leisyte, Enders, and Boer, (2009) discussed how these new policies are moving the role of academics, as shown by the following two university participants:

> The project is a large clinical trial run jointly with a significant multinational. It's NZ$50 million and a five-year project. The industry partner is very focused and engaged with those costs. Although they don't fully direct the work, but we have a trial consultative panel, half are from the industry partner half from the research groups, and we meet every two to three months to keep on track.

(University key informant 1)

> Whoever is the head contractor runs the project for all the parties as well as subcontractors, this is the entity that holds the funds. We do collaborative discussions initially to formalise relationships and contractual agreements, including all the usual items like milestones and intellectual property.

(University key informant 4)

4.5.6. Completion

The theme of *completion* includes sub-themes of *completion goal* and *timescale* while considering the interpretation of *completion*, and specifically the goal and timescale from the perspective of collaborators and stakeholders both inside and outside of the project. *Completion* outcomes are often viewed as the most crucial part of the project. Where possible, they are defined at the beginning and, as noted by Schindler and Eppler (2003), this repeatedly means that the end of a project is consequently the end of collective learning, especially where expectations do not flow into a research work stream. The goal of the project may be the same for all of the multiple stakeholders on a project in a collaborative UIG project, but the format of the outputs aligned with the goals can differ considerably for each of them. The outputs may, for example, be in the form of marketable products, or services with which to make a profit for industry. They may also be in the form of policy guidelines for government participants, or knowledge and capability extension such as new teaching material of peer-reviewed research publications for university

Deliverables in innovation are not always immediately quantifiable, but it has been reported that these outcomes are most possible in collaboration with industry when the outcomes are being driven by traditional project pay-off models which are not used in university. This approach will also guide the completion agenda, which may be relatively short term and superficial. Satisfying all the necessary outputs that align with the actual goal of a project needs to be negotiated to benefit all parties, which includes looking back at the initial drivers for the research, and may involve a staggered approach to completion as demonstrated by these comments:

> People want to get to completion so it would be rare to have a project stopped, they would find a way through problems. I have had one project stopped by a commercial partner who decided they were no longer interested in that outcome. They simply decided it was not the outcome for them anymore. I don't think that's particularly common. Generally, even internally we would want to get to the output stage, even if only a publication or report so that we can get something out of it."
>
> (Government key informant 1)

> Sometimes we have a longer publication time depending on the outcome, as we might have to delay due to the importance of the product to the company. In some cases, we also aren't allowed to publish company names. There's a lot of education around taking a longer-term view of the research.

> Once we have a scope, we then look at cost and time, and if it's prohibitive then we'll either look at how we can do the same work for less, or how we can phase it across multiple years to get the same outcomes that we have already decided we need.
>
> (Government key informant 3)

4.5.6.1. Timescale uniformity

Timescale uniformity is a characteristic issue in all projects and one defined as a boundary in the traditional project constraint model denoted as the Iron Triangle in Figure 2.3., which depicts a tight equilibrium between the time, cost, scope and quality of a project. Given the understanding that all project work is new and therefore timescales are often more flexible than initially understood, adding more complexity with multiple party deliverables can guarantee differences in understanding. This is a theme that has been understood for some time. Barnes, Pashby and Gibbons (2002) studied the collaborative project and noted that university, specifically academic researchers, raised concerns that the industrial partner's short-term focus and desire for quick results were being satisfied at the expense of academic progress. *Timescale* is still noted as a long-standing concern by the study participants; the three following comments are typical of the concerns shown:

> Timescales are the first difference that I saw when working with Universities in the late '80s and this hasn't changed. Academics just don't have the urgency. It gets picked up relatively quickly with missed milestones and the academics focusing on something else, and then the academics wondering why it isn't working. It only takes one event like this for a corporate to stop working with the academics.

(Industry key informant 3)

> Because sales is an entirely different area to data analysis in our organisation, timescales are never realistic. In a recent project with a large university, it took one year to negotiate the contract once the contract was negotiated; it took me one day to do the work. In many cases, timeframes are wildly incorrect.

(Industry key informant 2)

From a government perspective, “they (Industry) tend to want to explore the more known research, short term with predictable outcomes” (Government key informant 3)

4.5.6.2. Completion goal

Completion goal was the sixth most frequently discussed theme in the qualitative data; however, in the quantitative analysis, it was reported as the most significant difference. Jordan et al (2005) and Kirkland (2010) noted that one-size does not fit all. The *completion goals* of innovative projects such as those likely to be delivered by collaboration are problematic by definition, with no common language around the deliverables these projects produce. Completion goals in this type of project are a significant point of contention and are driven by the factors that surround the researchers, such as differing performance measures:

> Yes, our environment differs in the way we react. Universities are different being led by their PBRF performance reviews; our performance reviews are different.

(Government key informant 2)

> Our industry partners are pushy; they need to be linearly connected to an outcome. Each move needs to prove that we are one step closer to the outcome, whereas we trust ourselves to progress.
>
> (Government key informant 3)

4.5.7. Teamwork

Teamwork as a theme includes the sub-themes of *collegiality* and the *team collaboration process*. It was the seventh most frequently discussed topic in the quantitative data, and in the qualitative data was ranked similarly. It is a topic of interest both in and out of project work, especially in relation to the speed at which project teams need to start working cohesively due to the collaborative style of work. Jordan et al (2005) suggests that complex teams best accomplish radical advances such as those in research and innovation as the scope of expertise may reach across more than one organisation. The longevity of teams for project success, however, is a subject with very little reported research as this contrasts with the more traditional project frameworks where teams disperse upon completion as shown in Figure. 2.5. whereas streams of work provide longevity in teams, especially in the university setting where research streams are considered an intrinsic part of subject matter expertise. Barbolla and Corredera (2009) also postulated that previous collaborative relationships leading to collegiality appeared to produce better results and that the continuation of the team is a key component. How well the individuals work together as a team is an essential aspect of collective work and was reflected by the research participants:

> Where people are doesn't make a big difference, it's more about how they interact with each other than the location. We've had some very closely

> located projects that haven’t worked as well as dispersed ones that have worked really well. The individuals are more important than the work.
>
> (University key informant 1)

> It’s also important to keep the teams where they are comfortable, not necessarily in the corporate headquarters. Teams don’t have to be co-located; it's often unproductive. If we only get together to focus on the work, we do better.
>
> (Industry key informant 3)

4.5.7.1. Collegiality

Collegiality looks at how these teams share authority and responsibility and come with the shared interest teams have in the work. *Collegiality* was discussed less than teamwork and was seen as much less important than collaboration. As postulated by Barbolla and Corredera (2009), however, previous collaborative relationships leading to collegiality appear to produce better results, and longevity becomes paramount. The continuity of relationships needed for *collegiality* was seen as an essential theme in this research:

> As a team, we collaborate really well; we all work well together and are all continually learning. I have six teams that I meet up with around town, and there is always somebody here on a conference.
>
> (Industry key informant 2)

> There are different types and styles of collaborators in every sector…., but it does come down to the people, the level of trust and their track record. People look closely at track record to see how well they collaborated in the

> past and what they've been able to achieve in the past. Track record is quite important.
>
> (Government key informant 1)

4.5.7.2. Team collaboration process

Team collaboration is associated with working towards a common goal, an important aspect in project work, and newly formed teams need to invest significant time and effort to build relationships before performing well (Gratton, 2007). Forming teams that capitalise on pre-existing or heritage relationships increases the chances of success. The importance of collaborations was highlighted by Industry key informant 3, "the human elements need to be taken into account more than the company, being the most important element. Collaborations are important, but they are with the person, not the institution." The use of pre-existing collaborations was also an important aspect when building a team that needed subject matter experts, "we needed a specialist physician for the trial and found one that I had faith in as I knew him for our community group. He wanted to use a colleague, and the team grew organically" (Industry team member 2)

The high-stress environments of projects are well documented and discussed (Hoegl, Ernst & Proserpio, 2007). The tensions of creating a team while innovating for each new project entered into is also reported as a known tension of UIG collaborations.

4.5.8. Intellectual property

The theme of *intellectual property* includes a new sub-theme of *influencing*. *Intellectual property* within this environment looks at who owns the outcomes of the project. A secondary theme presented itself in the qualitative interviews of the study, that of the influence of the *intellectual property. Intellectual property* was the eighth most frequently discussed theme in the quantitative data, with a similar position in the qualitative data. However, the discussions around *intellectual property* still produced many different perspectives. Ownership of *intellectual property* is of concern to most projects and is complicated in a collaboration as there may be multiple owners and this can be either collaborative leaders or company's owners to whom the project leader reports.

What constitutes *intellectual property* and its use is primarily negotiated as part of the initial contract phase and was seen as the most crucial process to dictate the viability of a project from the ability to publish results as part of a researcher's career credentials, or the organisational needs to produce a commercially viable output, or the optimisation of economic return, a deciding aspect to many when choosing a partner. Industry team member 2 explained that "We looked at the USA for universities but came back to NZ because the USA wanted to keep the IP." The importance of intellectual property was also highlighted by Industry key informant 3, "Intellectual property is also an issue. We have stopped doing work with universities as we haven't been able to easily define who gets the IP from the beginning."

Intellectual property was also seen as important by university participants, with University key informant 1 underlining that "We have rules around the intellectual property, but they are pretty straightforward. The initiators are the ones that hold the intellectual property the other groups participate."

4.5.8.1. Influencing

Influencing was a new sub-theme for this study and not found against the literature on the topic. This is not, however, a new topic for universities where research impact and influence is seen as a primary agenda of research. *Influencing* has also been gathering momentum from the funders of research and is concerned with getting value-for-money from research spending together with the need to ensure that research is making a difference (Sumner et al., 2009).

Managerial tensions around risk, time, and size of possible payoff depending on the mix of scientific and technological research have also been identified as an area that needs a clearer definition (Jordan et al., 2005). The need for influencing was seen by the participants as a necessary part of research outcomes and an important factor to include when measuring risk. The need for influencing is seen as a newer aspect of research work, as explained by University key informant 5 “influencing is newer and needs to be done more by universities. Key researchers are prominent on committees, IPC panels, and as lead authors”. Influencing was also seen as a way to develop collaborations and gain funding, “We are trying more to write key position papers to let industry know what issues we are looking at; we need to get industry on board to get funding.” (University key informant 3).

4.5.9. Communication

Communication was identified from the qualitative analysis as a new theme and was not included in the original theme list; however, *communication* was discussed similarly to *collaboration*, in that it was a pervasive topic rather than being in a specific context. This broader concern warrants the inclusion of *communication* as part of a framework and, similarly to *collaboration*, it starts with the first interaction and continues throughout the life span of the *collaboration*. As Kapsali (2011) noted, where the outcomes of project activities are less than predictable (uncertainty), and activities involve multiple stakeholders across many boundaries (*communication*), both flexibility and boundary management become very significant to success.

Communication, therefore, addresses all forms from media used for discussion or to convey information about the project, to informal discussions while passing in the hallway, and circumstances where teams are co-located or in a distributed model. *Communication* is also documented as the second stage of *collaboration* in many academic texts, with examples such as the seven stages of collaboration (Fray, 2006) and the networking levels of integration partnering model (Gaida, 2004). It also features in this study as one of the outcome themes in the SAFAR framework (Gajda, 2004), which looks at the level of interpersonal and communication integration across a project. *Communication* as a subject is an inescapable issue in any form of contact, and it may be this lack of specificity that causes it to be noted more generically. The PMI (2013) suggests a project manager should spend as much as 90% of their time communicating, which poses particular challenges in this style of specialist project and was reflected in the discussions:

> You have to take time and efforts to get in touch with someone in Moscow whereas passing someone in the corridor it's easier just to say "how about this". Technology use is variable, we try to use every available technology, but we recognise face-to-face is hugely valuable. As a general trend though, the technology is good when things are going well; when things aren't going well face-to-face is better, and this includes in negotiations.
>
> (University key informant 1)

> We do a lot of Skype conversations and video conferencing. Sweden is challenging because of the 12-hour difference as with all European countries. Communication depends on the project's needs, depending on

> how closely monitored we need to be and the level of trust between the parties, real trust that is built, not that is written into the contract.
>
> (Government key informant 1)

Success or failure is often measured through the understanding built within and around the project, and *communication* levels of staff can promote either of these:

> The biggest issue I would find in collaborative research is the perception or reality of non-delivery, and that then comes back to degrees of communication. Poor communication leads to not being sure what's happening, and you don't actually get what you expect.
>
> (University key informant 1)

> We are more interested in management and communication skills. I would be judging those first before scientific familiarity with the area. It's a bonus if they have familiarity with the area, it would be an advantage but not necessary.
>
> (University key informant 2)

4.5.10. Leadership

Leadership can mean the project leader in the university, government or industry organisation or a defined project manager, and of those interviewed 55% were in leadership positions and 45% were in team member roles across the three sectors. From the quantitative review, 18% were in leadership roles split between industry and university as no government leads responded.

Anantatmula (2010) reported the need for *leadership* to define project processes and roles as an essential first step to create clarity, communication expectations and consistent processes, and also found that leadership roles helped to establish the trust that enabled communication, knowledge sharing and team development. Collaboration *leadership* is defined through the organisation, an in the case of universities the leader is often the project owner and has a pragmatic scientific approach used with a focus on academic, and research excellence, whereas both industry and government leaders are not usually the owners. Industry leaders are focused on the commercial outputs, and government leaders on economic potential and growth. The leadership role needs to manage the needs of all parties, such as the academic right to publish and the industry right to a patent. The results show a level of understanding in the differences in leadership perspectives between partners, but not always reported in a positive manner:

> There is also some dependency on who is running the research, universities are science for science sake, whereas we are looking at practical science and tech transfer, and the managers are looking for popular science first and then scientific papers last.
>
> (Government key informant 2)

This brought with it an inherent lack of trust which in turn meant covering leadership by including leaders from each of the collaborative partners:

> The designated principal investigator is the lead on the project. If you're working across organisations, there is usually a similar person in the other place or organisation in joint leadership.
>
> (University key informant 3)

There were also discussions about the need to separate the different styles of leadership needed on a project, although these ideas were less well developed. How to define what style of leadership was needed, and where the leader should focus their efforts is an ongoing debate, with some organisations trying to provide a definition as with the following example:

> We have two types of leader, a project leader who focuses on the project, and project deliverables, and a team leader who focuses on the team and keeping them happy and working – some leaders are both, but it's usually either one or the other as each has a different focus. We've found that this works best, as there are two different skill sets, and we let the researchers decide which role they would like to take/try rather than allocate them. We're getting better at listening to our staff, if they don't want to leave the lab, they don't have to, but there is ample opportunity if they want to do some management.
>
> (Government key informant 3)

4.5.11. Scientific endeavour

Scientific endeavour refers to the way project work is completed, incorporating robust processes that are answerable to peer review. As Boronico (2011) stated, peer review is a quintessential idiom in science and requires the initial work to follow rigorous scientific methods. *Scientific endeavour* was not highly noted in this research but is of significance as one of the main facets that form the work of this collaborative style. Two of the main causes for conversation and concern were scientific review points and essential documentation requirements, which inevitably produce extended timescales or specific phases required for scientific project reviews. The importance of understanding the need to incorporate these requirements into a broader framework cannot be underestimated. Boeme (2002) wrote that any guidelines produced need to align to their host organisation, while noting that a generalised set of guidelines could be developed for the effective management of collaborative research and development projects for the universities and tailored to suit the project under development. The literature acknowledges the time and documentation requirements for scientific rigour which presents contention in such projects; however, the participants in this study accepted it as a necessity for both validation and credibility of the project, as can be seen by the following statements from two key informants:

> Scientific research methodology is more important than management reports.
>
> We do see ourselves as an independent research provider, so we won't take shortcuts. We will be thorough, and we will stand behind the results. That can sometimes be a problem for others who just want to focus on particular elements.
>
> (Industry key informant 1)
>
> Our science is really important, and we have to be able to prove our results, so we always use a scientific research methodology, and we won't work with companies that want to go down a route of working without it.
>
> (Government key informant 3)

4.5.12. Internationalism

Internationalism, which looks at cultural and regulatory differences in the global economy, emerged as another new theme. Again, this is not a new topic to UIG collaborative projects, as in many cases projects and teams have been working globally for some time, but the topic was not found in direct relationship to this project type. Challenges also covered competing measures of collaborations across countries and within industries. An academic example of this is the PBRF process which measures researchers in New Zealand but is not a requirement for collaborators in other countries. Culture and competition were the main concerns of international research and for smaller economies such as New Zealand are seen as essential:

> I've worked across the UK, Germany, Hong Kong, Sweden, and the USA and the academic view of time is the same. The USA is slightly more aggressive, but there is less altruism there. More altruistic behaviour is apparent in the UK and NZ.
>
> (Industry key informant 3)

As Government key informant 2 noted, "International collaborations are essential, NZ collaborations are easier and more flexible and have gotten easier over the last ten years including with NZ Universities", however international differences have also stopped collaborations from forming, with participants citing rules and culture as the main barriers to collaboration:

> When I look at international commercial projects I tend to find that you're the provider of services rather than a partner, especially with the USA where they see it as their intellectual property, so they are good at soaking up knowledge but not as good at sending it back.
>
> (University key informant 3)

4.5.13. Ethics

Ethics within the collaborative research environment looks at the ethical processes under which collaborative projects in this space operate. Research, specifically in the university and government settings, is subject to stringent ethical requirements that are not always followed in industry research and development projects.

While many industries in the private sector have specific guidelines for ethical operation, the private sector remains under-regulated (Stranger, 2009). Even when specific guidelines for ethical operations exist, not all industries are obliged to follow them. To ensure that ethical requirements are met in collaborative projects, UIG practice is covered by a formal legal approach with onerous obligations to deliver against contracts that have stringent ethical requirements (Kirkland, 2010). This results in closer regulation of the activities of individual staff and the research teams who deliver the research. Therefore, while ethical consideration is an absolute for academic practice, it can cause problems for other parties and was also reported as an area that can stop research partnerships from forming. It is, however, also seen as one of the main points for contribution:

> Ethics is part of our terms and conditions, so we won't do anything or contract anything without ethics. If it's a game breaker, we won't contribute. Invariably it comes later on when they try and do shortcuts.
>
> (University key informant 1)

This point was reiterated by Government key informant 3 "Same as our scientific research methodology, we won't do anything to jeopardise ethics as it's reputational."

4.5.14. Project mishaps

The theme of *project mishaps* was the last theme to be discussed, and as it was new, there was no quantitative data available. This theme looks at collaborative projects where unexpected issues may occur; in a traditional project this might be qualified as project risk, an inherent part of project endeavours. PMI (2013) defines risk as "an uncertain event or condition that if it occurs, has a positive or negative effect on one or more project objectives", and, similarly to *collaboration* and *communication,* it was a pervasive topic rather than being in a specific context. This wider context warrants the inclusion of *project mishaps* as part of the original framework. In a similar manner to *collaboration* and *communication*, this theme was seen as something that is present with the first interaction and that continues throughout the life span of the *collaboration*. *Project mishaps* are related to risks: they are, however, likely to be unexpected; whereas risks are identified in the formal risk identification appraisal process. The areas for both risk and mishaps were reported as similar in a project environment and include personnel, costs and technical details. University key informant 1 told of an occasion, "I can think of one instance where the project wasn't working out, and we were asked to change researchers, and we had to start again". Other participants reported related situations that have caused issues on project:

> When we partner with Industry, the staff are more likely to change. We have had a project run off the rail when an industry leader takes another role, or the industry were working with goes broke or is taken over by another company – all these scenarios can cause issues.
>
> (University key informant 5)

> We have had stalled projects on delivery of service types, less so in the collaboration space and that's usually more technical where staff might have a lot of work on and getting people to prioritise can sometimes be a problem.
>
> (Government key informant 1)

4.5.15. Conclusion

This section looked at the themes individually against the findings of the literature review directly relating to the UIG collaborative project, or as new themes where they emerged through the qualitative findings, and which have been integrated and reported from a universal project perspective. The new themes have not been given significant credence in the extant UIG literature although four of the new themes, being *collaboration, project management methodology, communication,* and *internationalism*, were more frequently discussed than several of those found in the literature, with only *project mishaps* being less frequently discussed. Similarly, the five new subcategories of *trust, contract management, task segregation, profitability,* and *influencing* were more often discussed than many of the previously found themes, adding insight into the need for their inclusion.

The following section looks at the impact of these themes on the data collection model, specifically regarding the differences between the three sectors of university, industry and government and the two levels of participants, both key informants and team members. It also looks at the importance of staff longevity in this style of collaboration, as well as concept level views on the outcome measures. Following this is a separate section looking at the impact of the themes, but with regard to the project level concepts.

However, there are limitations in this reporting as neither the new themes nor the subthemes have quantitative data against which they can be assessed. They can only be determined through the qualitative comments and frequency of discussion.

4.6. Comparison of differentiation themes against the data collection model and project perspectives

Section 4.6.1. examines the themes from the data collection model level developed in this study and incorporates the views of key participants and team members across the three sectors of university, industry and government. The study also takes into consideration the perspectives of staff, looking at their longevity in this collaborative project style, as well as the differences noted across both differentiating themes and outcome measures. The effects of these themes are explored using a range of ANOVAs, T-Tests and Cross-tabulations, utilising the data collected from the quantitative research. Alpha levels of 0.05 are used for most statistical tests giving a 95% confidence level but, as this is a purposive group, they are also reported when close to a 0.1 alpha level, still giving a 90% confidence level in the data, which means that they are also of interest to the study. Qualitative results are reported in cases where discussions describe any differences in themes under the perspectives being examined.

Following on from this Section, 4.6.2. examines the themes from the project levels of budget, length, phase, constraint, and at the beginning and end of the project, and again from the view where they differ.

4.6.1. Data collection model perspectives

This section, therefore, presents the findings of the study from the data collection model perspectives of key informant and team members, sector, and longevity in this research project type.

4.6.1.1. Key informants and team members

A set of paired-sample t-tests were conducted to compare the sixteen project themes and the eight outcome variables under the condition of key informants and team members to look at the effects this condition had on the themes.

Significant effects were found in five of the sixteen project themes and seven of the eight outcome goals. Each of the five project themes was found to be more significant to the team members than to the key informants, and the seven outcome variables were found to be more significant to the key informants than to the team members. Those reported are mostly at 95% significance, although some are reported at a lower significance as they are of interest to the study. The t-tests that follow are in order from the most important difference to the least important difference.

There was a significant difference in the scores for team leaders (M=3.15, SD=1.592) and team members (M=4.30, SD=1.417) conditions t(94)=-3.409, p=0.001 against *project ethics* project theme.

There was a significant difference in the scores for team leaders (M=5.35, SD=1.129) and team members (M=4.34, SD=1.328) conditions t(94)=3.417, p=0.001 against the *perceived measure of ongoing relationships* outcome variable.

There was a significant difference in the scores for team leaders (M=5.12, SD=1.211) and team members (M=4.26, SD=1.270) conditions t(94)=2.978, p=0.004 against the *perceived measure of the increase in quality of working relationships* outcome variable.

There was a significant difference in the scores for team leaders (M=5.12, SD=1.143) and team members (M=4.44, SD=1.199) conditions t(94)=2.472, p=0.015 against the *perceived measure of broadening of views* outcome variable.

There was a significant difference in the scores for team leaders (M=3.62, SD=1.416) and team members (M=4.31, SD=1.389) conditions t(94)=-2.180, p=0.032 against the *project career focus* project theme

There was a significant difference in the scores for team leaders (M=4.81, SD=1.201) and team members (M=4.26, SD=1.188) conditions t(94)=2.012, p=0.047 against the *perceived measure of the increase in network density* outcome variable.

There was a significant difference in the scores for team leaders (M=3.65, SD=1.441) and team members (M=4.26, SD=1.369) conditions t(94)=-1.892, p=0.062 against the *project career aspirations* project theme.

There was a significant difference in the scores for team leaders (M=4.88, SD=0.993) and team members (M=4.43, SD=1.084) conditions t(94)=1.872, p=0.064 against the *perceived measure of the effectiveness* of outcome variable.

There was a significant difference in the scores for team leaders (M=3.69, SD=1.569) and team members (M=4.30, SD=1.468) conditions t(94)=-1.769, p=0.080 against project *scientific review* project theme.

There was a significant difference in the scores for team leaders (M=4.88, SD=1.177) and team members (M=4.44, SD=1.163) conditions t(94)=1.649, p=0.103 against the *perceived measure of future of research streams* outcome variable.

There was a significant difference in the scores for team leaders (M=3.50, SD=1.749) and team members (M=4.00, SD=1.383) conditions t(94)=-1.462, p=0.147 against *project streams* project theme.

There was a significant difference in the scores for team leaders (M=4.85, SD=1.120) and team members (M=4.50, SD=1.100) conditions t(94)=1.363, p=0.176 against the *perceived measure of collaboration* outcome variable.

Key informants and project team members differed on the relative importance of several project themes and showed disagreement in all outcome goals except the outcome goal of power relationships. Where differences are shown, they are split between the two groups. With all of the differentiating themes where differences occur, the project team members saw these as more important than the key informants. With all of the outcome measures, the key informants say these as more important than the team members. An overview of these results is shown in Figure 4.2.

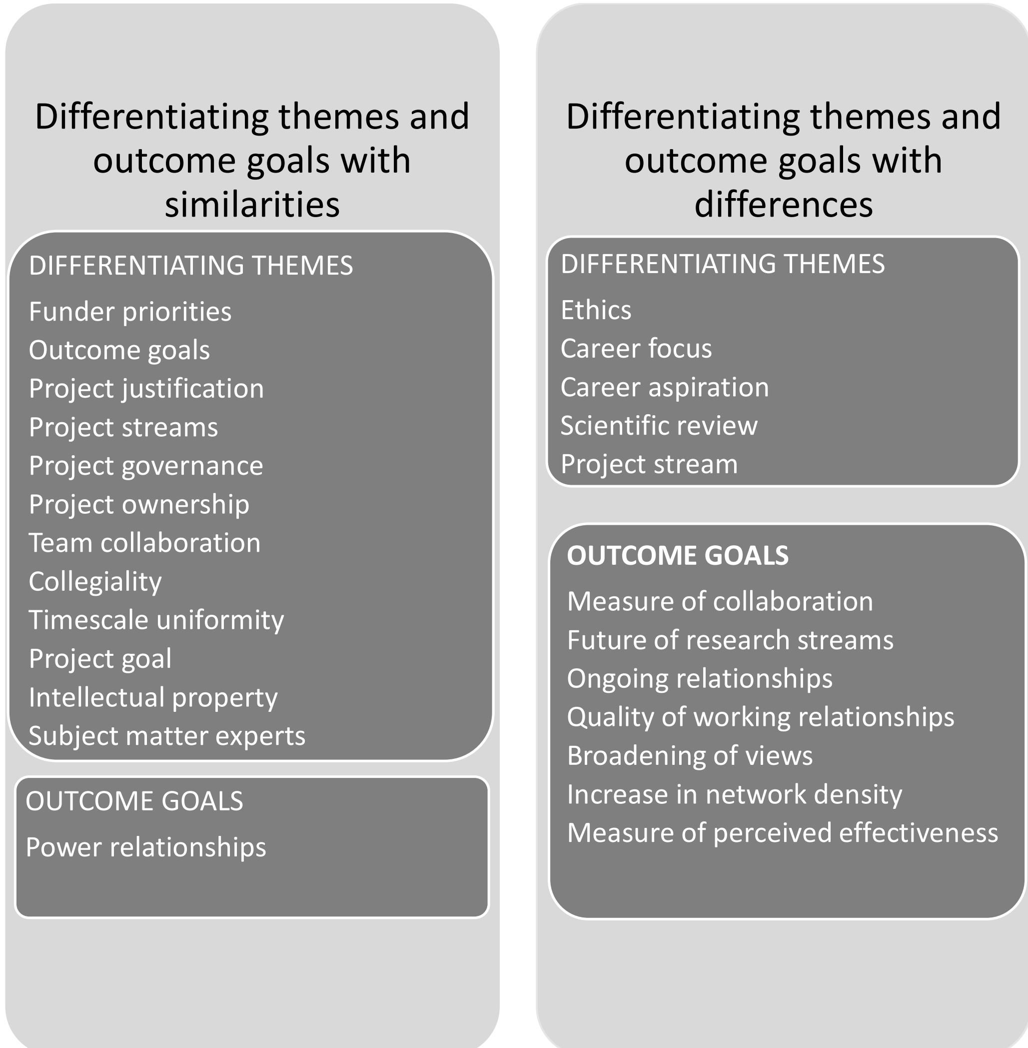

Figure 4.2. Similarities and differences shown between key informants and team members in differentiating themes and outcome measures.

The effects of the differences between key informants and team members in both the differentiating themes and the perceived outcomes were also apparent in the discussions throughout the qualitative interviews. Examples have been drawn from the comments made in both the qualitative and quantitative results. Project level differentiating theme differences are reported first, with outcome goals second.

4.6.1.1.1. Project level theme differences.

As noted above, each of the five differentiating themes which presented with differences between the two groups of team members and key informants was found to be more critical to the team members, which in itself is an important finding showing that team members are more focused on project themes. The project themes showing a different level of importance to the team members were the themes of *ethics, career focus, career aspiration, scientific review* and *project stream*, each of which is discussed in the following section. The results here report on conversations with the interviewees to explore these differences:

i. Ethics

Ethics in the study was perceived as a stipulation by all staff and as such was discussed more from the view of a requirement within UIG project work. Although ethics are seen as a necessity, of more importance was the need to go through the process to gain peer review, which was in turn viewed as the more important outcome providing an opportunity to validate findings. As Boeme (2002) noted, the case for research ethics should be easy to justify, as more stringent requirements help to safeguard the success of a project. Team members perceived *ethics* to be more important than key informants as having a direct effect on their work, with Industry team member 2 stating, for example, that "ethics are a must and have been done in NZ."

ii. Career focus

Careers and *credentials* were the most highly ranked and discussed theme in the study. As noted by Hughes (2008) the credibility of an academic from the point of view of practice is not necessarily in place as a precondition; it has to be earned, and this point would be relevant for all early career participants. It is therefore understandable that team members who are looking to attain credibility through their *career focus* would find this theme to be more important than key informants whose career paths and inherent credibility would be more developed. *Career focus* was also viewed as quite separate by most of those interviewed, seeing project management as a business role and researchers as technical roles as illustrated by the following two comments:

> High profile researchers want to stay as researchers. Highly skilled researchers still need to be in a strategy that works for all. Recognition of researchers is high; the institute itself also brings people to us.
>
> (University key informant 5)

> Scientists need to go down a management route if they want to get to the top of the organisation, we don't have scientists as high as managers. Scientists tend to stay on their path; the management is more fluid. Although in this industry, there is not much new blood, it more shuffles around.
>
> (Industry key informant 1)

iii. Career aspiration

Career aspirations for most researchers is to continue in the same pursuit throughout their career in some form of research, and usually in the same or a related area of research. However, there were also researchers who wanted to move into management. As team members' *career aspirations* were still developing, *career aspirations* were seen as more important to this group than to key informants whose careers were better developed. *Career aspiration* which is led by the individual's desire is however viewed as separate to *career progression* which is often dictated by the organisation being worked in:

> Career aspirations are interesting… when I started out, I was in a financial services organisation, and they asked me to do the year 2000 coding and I became an expert in their system looking at processes that took them eight hours traditionally, I managed to get these down to 16 minutes per run. From here, they gave me a program manager role looking across US$400 million of projects, but that is not where I wanted to be, so I soon went back into data analysis.
>
> (Industry team member 1)

iv. Scientific review

Scientific review points, documentation and extended timeframes or phases needed for *scientific review,* while potentially onerous, provide a complete understanding of the project as viewed by all parties, and their inclusion affects the project work. These practices are embedded in scientific research, and their effect was reported as having significantly more importance to the team members who saw the *scientific review* as an important theme for both results validation and project continuity. Comments from participants were relatively similar in that there is no science without review. Government team member 1 for example emphasised that “Without the scientific review, there is no overlap should the PM leave to pick up the pieces”. Also, as an important part of the integrity of many collaborative projects as noted previously by Government key informant 3 “we won’t work with companies that want to go down a route of working without it”, many companies won’t do a project without a scientific review process.

v. Project stream

A *project stream* is often how a researcher will establish and extend their research field and can be the basis for the researcher to run their research group and develop productive collaborations (Manchester University, 2011). Team members viewed this as more important than key informants as this is where team members are working. If a *project stream* stops, it can also be the impetus for researchers to move organisations to a new stream of work, whereas key informants tend to be across many streams and so are less concerned if a particular stream stops. Key informants expressed this by explaining for example, that “If the government decides not to fund it and there are no other streams of work the researchers have said that were out of here” (University key informant 2). This viewpoint was further emphasised by University key informant 1:

> A lot of our research is a stream of research both in policy and commercialisation, a piece of research often has commercial or intellectual property, which we can develop or license as a new or existing company. Often, we are asked to develop research or take it to the next generation, so it keeps developing.
>
> (University key informant 1)

4.6.1.1.2. Outcome goal differences.

Conversely to project level differentiating themes, which were reported as more critical to team members, outcome goals reported higher for key informants. Each of the seven outcome measures showed as more important to the key informants, this was again an important finding, showing that key informants were more focused on the outcome and future goals than on current project level concerns. The outcome measures showing as more important to the key informants were those of *measure of collaboration, future of research streams, ongoing relationships, quality of working relationships, broadening* *of views, increase in network density* and *measure of perceived effectiveness,* each of which is discussed in the following section:

i. Measure of collaboration

While *collaboration* and its application in practice are still being defined, Sullivan and Skelchers (2002) defined *collaboration* as a state that gives practitioners and researchers room to permeate organisational and scholarly boundaries to spur inter-organisational, sectoral or inter-governmental partnership through vertical and horizontal engagement, which aligns with the UIG collaborative philosophy. With this extensive sphere of activity, it is understandable that the key informants view collaborative outcomes as of more ongoing importance that team members who are engaged at the project level. *Collaboration* was seen as an important endeavour both at an organisational and at a personal level and one that takes time and experience to develop and is reflected in the following comments by a key informant:

> Once you have the collaboration and you have a common goal, and you're starting to go for funding together it's easier. It's more competitive to get the upfront money, and it's not individually led. You need to collaborate enough to build person-to-person collaborations and relationships. I encourage people to present at conferences as it helps to start a conversation.
>
> International relationships and collaborations are built over the researchers' career; they are all like-minded people and get on well together. I'm not sure how much you can force that.
>
> We do have some organisation to organisation collaborations but in the main they are person-to-person.

(Government key informant 1)

ii. Perception of ongoing relationships

Ongoing relationships were seen as important and again, more so with key informants. This theme was also ranked in the quantitative instrument as the most important outcome and related to the measure of collaboration above. Gajda (2004) argued that groups will pass from lower to higher stages of collaboration before they can be effective and again this shows the need for *ongoing relationships* which take both time and effort to maintain. Ongoing relationships are also a source of work in the future, as they involve "collaborative partners, and the best is the repeat sale, many of which are years old, and we have ongoing conversations of what else we can do", (University key informant 1). The importance of ongoing relationships was further highlighted by other key informants, with University key informant 2, for example emphasising that "Ongoing collaboration is dependent on the people, one of our largest construction firms and our engineering school currently completed a collaboration and the development was working so well, so they decided to get together again to do the next phase".

There are obvious benefits to collaborative styles of work; however, as in all relationship types, collaborations can be prone to conflict, many of which are around ownership, as one of the quantitative survey industry participants put it "Disagreements between researchers and the industry partner over the business model for commercialising the outcome arose at the end of the project. This has hampered further collaborations".

The complexity of the UIG collaborative style of research also means that some relationships, such as those with the funders, have to be developed due to their importance to the endeavour, even if they have no interest beyond funding. The funder relationship is recognised widely for its necessity as an ongoing source of funds, “the funder relationship is more important than collaborator relationships, and they aren’t always the ones you want to collaborate with,” (Government key informant 2).

iii. Perception of broadening of views

Broadening perspectives and mutual learning as noted by Jung, Kudo and Choi, (2012) is seen as a clear advantage of collaboration and was again found to be of importance to all of the participants in this study but more important to the key informant group. *Broadening of views* was discussed from both a national and a multinational perspective in New Zealand and Australia. As with many specialist collaborations researchers are collaborating outside of their home country for knowledge gain. Inherent culture also appears to dictate who to collaborate with from an international perspective:

> Although I have limited experience internationally, of those, I have been to Belgium, and the Netherlands do a much closer collaboration. In Australia, Melbourne and Victoria collaborate quite well. I think the problems we have in New Zealand are because of the spread of our population.
>
> Israel is a country that has few natural resources and has the ability to use their people resources in a collaborative way to produce a knowledge nation, and we are behind them.
>
> Universities in Europe appear to make collaboration easier, the culture is different, and we need to share better.
>
> Universities in NZ also don’t have a good reputation for collaboration as they all run on a Humboldt model (tell the masses and do not collaborate

> with industry for teaching) instead of a 3rd generation model where university and industry collaborate in their learning programmes.*"*
>
> (Government team member 1)

> It's more about knowledge transfer and getting student internships and profile raising, and lots of cool stuff, not just about making money.
>
> (University key informant 2)

Similar to the complexity found with *ongoing relationships*, collaborator views do not necessarily align and expectations can be challenging to manage:

> There are also issues if you have two partners with opposing views who interpret the data and recommendations differently, especially if those recommendations can potentially close down a business.
>
> *Industry key informant 1*

iv. Perception of the future of research streams

The *future of a research stream* was discussed as being led by a specific individual's expertise in an area. All participants found this to be an important theme, but from the perspective of key informants, the future of their research stream would mean longevity in the subject. This leads to the ability to continue work in their subject field over many years, and is how many research institutes are formed:

> We have two or three research institutes where there is a single outstanding individual, and we are currently working to see how we can back those up to provide succession.
>
> (University key informant 2)

> *"*While the research was successful, and more will continue, this is mainly because the university leads are specialists in their area and therefore highly sought-after individuals. The choices for industry to partner with on this particular subject are not many.*"*
>
> (Quantitative survey industry participant)

v. Measure of perceived effectiveness

Efficiency effectiveness and output-oriented cultures have become increasingly important and are transforming the role of the academic (Agion, 2008; Leisyte, 2009). In line with this trend is a direct correlation between the success of effective outputs and the autonomy given to the university. *Perceived effectiveness* was important to both levels of participants but was of more importance to key informants. The assessment of effectiveness in the three sectors of university, industry and government is measured from quite different perspectives. The measures for key informants in industry are high level and involve being in business. Key informants in government see effectiveness as ongoing research informing policy; and universities see it as gaining a higher profile. Interestingly even though these differences are noted when measured at participant levels, the same difference was not measured between sectors although this difference can be seen through the following statements reporting across sectors:

> Our feedback mechanism to say if we were successful is just by being in business, we have been in business for a long time, so we know what is successful. We are not good at getting feedback or project basis.
>
> (Industry key informant 2)

> Really our outcomes are our most important theme, and far outweigh cost and time. We're looking at how NZ will be mapped in our sectors in 40 to

> 50 years, and we're just starting to get some of our collaborators …… to do the same. In industry we're lucky if they get past their five-year plan.
>
> (Government key informant 3)

It was also recognised that the profile of the individuals involved can be a potential source of success, as University key informant 2 said "the collaborator themselves also bring success with them; more research is gained through higher profiles".

vi. Perception of quality of working relationships

Quality of working relationships was seen as an essential outcome. The collaborative relationships in the UIG are governed by processes of formal and informal negotiation, joint rule creation and structures governing their relationships (Thomson et al., 2014), which all affect working relationship quality. The management complexity of these relationships was of more importance to the key informant participant group, who were more actively tasked in maintaining relationships on both a personal and an institutional level:

> We are currently scoping our partners to look at how we can collaborate better with them. We have a full mapping exercise going on at the moment, starting with some of our smaller customers. A large customer will be next, but it will take some time as it's a large organisation.
>
> (Government key informant 3)

> Collaboration also helps to build up good relationships, but you need to keep them going. In industry keeping relationships going is harder, for example, I spent 60 hours helping to build a case for a royal society catalyst

> feeding fund which we didn't get – this has to come out of personal time. Personal relationships make a big difference in how projects work.
>
> (Government key informant 2)

vii. Perception of increase in network density

Substantial collaborative networks (Oxford, 2011) are a necessary part of a senior investigator's portfolio. The increase in *network density* comes through developing collaborations which increase over time and experience. Although the study showed a difference between levels of participants, *network density* was important to all, showing as more important to key informants who may have had more time to develop their network. Discussions on this topic enveloped cultural differences when building networks as well as the importance of *communication*, and the need to justify collaborative activities such as conference attendance which are difficult to quantify:

> Some of our scientists want to travel more to find more collaborators and there is no substitute for face-to-face to begin a collaboration. Some already have the network and don't need to go anywhere. There is a lot more travel now than they used to be and there are a lot of people coming and going. There is definitely more skyping, but this isn't stopping us travelling. You have to sit down and go through the relationship building, and in some cultures, it's incredibly important. Māori is an obvious one, China is another one, you have to go through the ritual first, and you can't do that on the Skype, but there are other cultures where you don't need to meet such as the USA.
>
> The hardest part is the upfront piece to justify the conference and meet a whole lot of people and network.

(Government key informant 1)

The study also noted the importance of different primary measures, and the way that they can influence researchers' collaboration. New Zealand, for example, measures an individual researcher in the PBRF system whereas Australia measures research by higher education institute in the more collaborative ERA assessment:

> Collaborators do network at conferences and with university partners and federal government etc. In Australia, we use university rankings, not individual rankings; there is no PBRF. Universities are fields of research-based.

(Industry key informant 1)

4.6.1.2. Government university and industry sector

A one-way between subject ANOVA was conducted to compare the sixteen differentiating themes and the eight outcome measures under the condition of sector type, which referred to university, government and industry. The purpose of this investigation was to look at the effect this condition had on the differentiating themes.

Significant effects were found in eight of the sixteen themes, and in two of the eight outcome goals. Some of these effects were reported at 95% significance, although there are some reported at a lower significance as they are of interest to the study. A summary of the results is shown in Table 4.8 and then reported in order from the most significant difference to the least significant difference.

Table 4.8. Significance differences in project themes and outcome goals against sector type

Significant difference in differentiating themes between sectors	Non-significant difference in differentiating themes between sectors	Significant difference in outcome goals between sectors	Non-significant difference in outcome goals between sectors
• Completion goal • Project stream • Collegiality • Scientific review • Project ownership • Funder priorities • Outcome goal • Project driver	• Ethics requirements • Project justification • Team collaboration • Career focus • Career aspiration • Intellectual property • Timescale uniformity • Subject matter experts • Project governance	• Future of research stream • Increase in power relations	• Ongoing relationships • Broadening of views • Measure of collaboration • Outcome effectiveness • Quality of working relationships • Increase in network density

There was a significant effect on sector type for *completion goal* at the $p<.05$ level for the three conditions [$F(2, 93) = 3.805$, $p = 0.026$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the university ($M = 3.60$, $SD = 1.354$) was significantly different from the industry ($M = 4.59$, $SD = 1.544$). However, the government ($M = 4.17$, $SD = 1.697$) did not significantly differ from the industry. Taken together, these results suggest that both the government and industry sectors perceive that *completion goals* have more of an effect on the overall project than the university sector.

There was a significant effect on sector type for *project streams* at the $p<.05$ level for the three conditions [$F(2, 93) = 3.390$, $p = 0.038$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the university ($M = 3.48$, $SD = 1.327$) was significantly different than the industry ($M = 4.32$, $SD = 1.357$). However, the government ($M = 4.25$, $SD = 1.545$) did not significantly differ from the industry. Taken together, these results suggest that both the industry and government sectors perceive that *project streams* have more of an effect on the overall project than the university sector.

There was a significant effect on sector type for *collegiality* at the $p<.05$ level for the three conditions [$F(2, 93) = 3.334$, $p = 0.040$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the university ($M = 3.60$, $SD = 1.190$) was significantly different than the industry ($M = 4.46$, $SD = 1.442$). However, the government ($M = 4.17$, $SD = 1.528$) did not significantly differ from the industry. Taken together, these results suggest that both the industry and government sectors perceive that *collegiality* has more of an effect on the overall project than the university sector.

There was a significant effect on sector type for *perceived future of research streams* at the $p<.1$ level for the three conditions [$F(2, 93) = 2.433$, $p = 0.093$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the industry ($M = 4.20$, $SD = 1.256$) was significantly different than the government (M = 4.92, SD = 1.165). However, the university (M = 4.64, SD = 1.036) did not significantly differ from the government. Taken together, these results suggest that both the university and government sectors perceive that *future of research streams* has more of an effect on the overall project than the industry sector.

There was a significant effect on sector type for *scientific review* at the $p<.1$ level for the three conditions [$F(2, 93) = 2.536$, $p = 0.093$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the university (M = 3.44, SD = 1.261) was significantly different than the industry (M = 4.25, SD = 1.646). However, the government (M = 4.17, SD = 1.697) did not significantly differ from the industry. Taken together, these results suggest that both the industry and government sectors perceive that *scientific review* has more of an effect on the overall project than the university sector.

There was a significant effect on sector type for *project ownership* at the $p<.1$ level for the three conditions [$F(2, 93) = 2.344$, $p = 0.102$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the university (M = 3.68, SD = 1.376) was significantly different than the government (M = 4.67, SD = 1.231). However, the industry (M = 4.31, SD = 1.534) did not significantly differ from the government. Taken together, these results suggest that both the government and industry sectors perceive that the *project owner* has more of an effect on the overall project than the university sector.

There was a significant effect on sector type for the *perceived increase in power relationships* at the $p<.1$ level for the three conditions [$F(2, 93) = 2.172$, $p = 0.120$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the government (M = 5.17, SD = 1.337) was significantly different than the university (M = 4.32, SD = 0.945). However, the industry (M = 4.54, SD = 1.208) did not significantly differ from the university. Taken together, these results suggest that both the government sector perceive that *increase in power relationships* has more of an effect on the overall project than either the university or industry sector.

There was a significant effect on sector type for *funder priorities* at the $p<.1$ level for the three conditions [$F(2, 93) = 2.092$, $p = 0.129$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the university ($M = 3.52$, $SD = 1.388$) was significantly different than the industry ($M = 4.27$, $SD = 1.617$). However, the government ($M = 4.17$, $SD = 1.528$) did not significantly differ from the industry. Taken together, these results suggest that both the government and industry sectors perceive that *funder priorities* have more of an effect on the overall project than the university sector.

There was a significant effect on sector type for *outcome goal* at the $p<.1$ level for the three conditions [$F(2, 93) = 1.786$, $p = 0.173$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the university ($M = 3.56$, $SD = 1.502$) was significantly different than the industry ($M = 4.25$, $SD = 1.549$). However, the government ($M = 4.25$, $SD = 1.865$) was the same as the industry. Taken together, these results suggest that both the government and industry sectors perceive that *outcome goal* has more of an effect on the overall project than the university sector.

There was a significant effect on sector type for *project drivers* at the $p<.1$ level for the three conditions [$F (2, 93) = 1.719$, $p = 0.185$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the university ($M = 3.68$, $SD = 1.314$) was significantly different than the government ($M = 4.33$, $SD = 1.557$). However, the industry ($M = 4.29$, $SD = 1.441$) did not significantly differ from the government. Taken together, these results suggest that both the government and industry sectors perceive that *project drivers* have more of an effect on the overall project than the university sector.

A summary of the results is shown in Figure 4.3. and then reported in order from the most significant difference to the least significant difference.

SECTORS THAT VIEW DIFFERENTIATING THEMES AND OUTCOMES TO BE LESS IMPORTANT	MEASURE	SECTORS THAT VIEW DIFFERENTIATING THEMES AND OUCOMES TO BE MORE IMPORTANT
• University	• Completion goals • Project streams • Collegiality • Scientific review • Project ownership • Funder priorities • Outcome goals • Project drivers	• Industry and Government
• Industry	• Perceived future of research streams	• University and Government
• University and Industry	• Increase in power relationships	• Government

Figure 4.3. Differences between sectors shown in differentiating themes and outcome goals

Of the eight differentiating themes and two outcome goals that showed significant differences within the three sectors, all of the differentiating themes measured as less important for the university sector than for the other two sectors of industry and government. For the outcome goals, industry reported the outcome of *perceived future of research streams* to be less crucial than university or government, and for the outcome goal of *increase in power relationships*, the government sector saw this as more important than both industry and university participants.

This is an important finding in that university and government are aligned with a need for future research streams, showing a focus on more long-term endeavours. In the more currently focused differentiators, however, government and industry are aligned. Government is the only sector that assigns higher priority to all of the measures that are perceived as important.

Of the ten differences noted between sectors, there are three that were also reported as differences between key informants and team members; these were the themes of *scientific review* and *project stream,* and the outcome variable of *perceived future of research streams.*

The effects of the differences between sectors in both the differentiating themes and the perceived outcomes were also apparent in the discussions throughout the qualitative interviews, and examples have been drawn from the comments made in both the qualitative and quantitative results. Differentiating theme differences are reported first with outcome goals reported second.

4.6.1.2.1. Differentiating theme differences.

As noted above, each of the eight differentiating themes was found to be less critical to the university sector, which in itself is an important finding in that both industry and government, therefore, view these as more important. The themes showing as less important to the university sector were the themes of *completion goals, project streams, collegiality, scientific review, project ownership, funder priorities, outcome goals* and *project drivers.*

i. Completion goals

Significant differences were found between the three sectors when it came to the effect of *completion goals* on the project. Both government and industry sectors perceive that the *completion goal* had more of an effect on the overall project than the university sector.

It has been speculated that this may be because publications and patents are an accepted measure of progress and deliverables for research projects in the science-oriented organisation, while other organisations measure their projects against a different set of deliverables (Kirkland, 2010). The completion of innovative projects is by definition problematic, with no common language around the deliverables these projects produce. The following comments point out some of the differences noted between sectors, and the importance of the *completion goals:*

> An industry partner may need a pragmatic result that goes into production, but the researcher might say, 'if I look at this, it might be really interesting.' Industry objectives are more linear; if industry finds that the discovery is possibly more interesting they might go down that route, and that is ideal and not uncommon for an industry partner to agree to do that for three months, but in many cases, they just want to stick to the project and explore the areas of interest after.
>
> (University key informant 2)

> There is also some dependency on who is running the research, universities are science for science sake, whereas we are looking at practical science and tech transfer, and the managers are looking for popular science first and then scientific papers last.
>
> (Government key informant 2)

ii. Project streams

Project streams were found to be less important for the university sector than for either the government or industry sectors, yet it was an important theme for key informants. However, in the literature, a career in academic research is signified by a flowing or connected set of research and often becomes a career research stream run by a dedicated academic. The commercial projects, on the other hand, are defined as a temporary endeavour undertaken to create a unique product, service or result and as such projects are not on-going efforts and should be finite (Sa Couto, 2008).

The research project definition does not match the description proffered for commercial projects, and the research stream is unrestricted. This distinction between the longer-term research streams in the academic field and the intentions of industry is also noted by observing who owns the outcome and can ultimately continue with its development. In some situations, “If a researcher leaves the organisation, they cannot take the IP that they created, but they can take the research team and future direction of it with them to continue elsewhere”, (University key informant 1)

iii. Collegiality

The study showed *Collegiality* to be less important in the university sector than in either industry or government sectors This finding is of interest of interest as the literature reports university teams as being more collegial than industry teams whose structure is reported as being more unequal. There is little if any need for *collegiality* in the industry project team, with team members often being disbanded upon completion as shown in Figure 2.5., whereas university researchers have a propensity to keep collegiality in their team with a view to future project endeavours together. Barbolla and Corredera (2009) also postulated that previous collaborative relationships leading to *collegiality* appeared to produce better results and, that this longevity is a key component of success. It could, therefore, be hypothesised that, because collaboration and ultimately *collegiality* in the university setting are commonplace, it is deemed less important, whereas the other sectors consider it more critical as they find it harder to attain:

> The main aspect that is easier with proximity is when the work is highly ambiguous, and you're brainstorming ideas and roots that you may follow. The right people casually crashing into each other can often generate quite important things that become good threads to follow. It happens less through email or phone calls or trips around the world.
>
> (University key informant 1)

> Personal relationships make a big difference in how projects work and the rules at each organisation. We are not very formal in our approach, for instance, if you know a researcher and they have a PhD student who needs the training, an email is enough to secure an industry-based placement – unofficially we're allowed to do it.
>
> (Government key informant 2)

iv. Scientific review

Significant differences were found at different participant levels between the three sectors when it came to the effect of *scientific review* on the project. Both government and industry sectors perceive *scientific review* to be more critical for the overall project than the university sector, and within these sectors, team members found *scientific review* more important than key informants.

This reflects the opinion that *scientific review* is important generally. As stated by Boronico (2011), *scientific review,* especially in the form of peer review, is an essential difference in collaboration between industry and academia and is a quintessential idiom in science. When credibility is needed, both industry and government sectors seek out partners from the university, and as previously noted by Government key informant 3 “we have to be able to prove our results, so we always use a scientific research methodology”.

v. Project ownership

From the quantitative study, 65% of projects are still individually funded regardless of who collaborates on them, with universities accounting for 26% of individual funds, government 21%, and industry 18%. Funding is the primary determinant of ownership, and in ownership terms single party ownership is easier to develop and define than multi party ownership.

Project ownership was seen as more important for industry and government sectors. This may be because of the inherent sharing of ownership, which is still weighted more heavily towards individualized university funding, making universities more assured of it. UIG projects are controlled by contracts written around intellectual property ownership and knowledge building; the question of ownership of intellectual property is a key component of research and a researcher’s credibility. Within industry, ownership of various forms of intellectual property are assigned through employment contracts to the company (Alexander et al., 2010) in order to produce intelligence that helps towards staying ahead of the market and staying in business. For government, this intelligence is used to inform policy and create future recognition. All sectors have a similar view of ownership, “If we pay for a project, we own the IP”, (Industry key informant 1). Finance often dictates ownership of the *intellectual property*; however it can also be seen to have a negative influence:

> They measure financial outcome and have too many accountants in control – bean counters are killing business. They also work more on sticks than carrots.
>
> The business still runs on the bottom line. We did a project with a bonus structure for the industry company, giving a NZ$50K bonus on a NZ$50M project, and the incentive created better collaboration.
>
> (Government staff member 1)

vi. Funder priorities

Funding was found to be the second most important theme in the study, having a similar level of discussion to *career*. Significant differences were found between the three sectors when it came to the effect of *funder priorities* on the project, with both government and industry sectors perceiving that *funder priorities* have more of an impact on the overall project than the university sector.

Government funding of research and development in both academic and commercial environments has been focused on fostering collaboration but is primarily reliant on the choices of profit-seeking corporations. Such companies rarely allow freedom of research as their goals are the strategic direction of the company with goals of increased revenue and decreased expenses (Tomczyk, 2005). Hammerstedt (2011) pointed out that an academic faculty member in most instances can study any area of interest or “follow their nose" provided they have the skill set and connections to raise funds necessary to support that research.

The industrial research fit has therefore primarily been driven by the need to justify projects against strategic goals or criteria, which essentially means self-funding. Academic research, on the other hand, is mainly justified through the funding decision; although research is dictated as part of the university researcher's role, it can be progressed unfunded with less of an impact on business survival. The viewpoints and priorities in funding from different sectors, and the importance of the *funder priorities* can be seen in the following two comments:

> In Australia, industries struggle to find research funding. Two of the larger schemes we use are ARC at AUS$800M for blue sky research and one for partners, where industry get quite a lot of the funding.
>
> (University key informant 5)

> Funding and drivers say when we get involved, and this is not always at the planning stage. They can also have negative effects if collaborators are going for the same funding, the competition can stop scientists collaborating.
>
> (Government key informant 2)

vii. Outcome goals

Outcome goals are another area of difference between the three sectors and again seen as more important to industry and government than to universities. This may be due to the more fluid nature of university researchers, who extend their thoughts into future work based on the current project in a way which is divergent to the industry and government team who were focused on the short-term completion of the project, with the end of their project being the end of collective learning (Shindler & Eppler, 2003). Many industry projects are disbanded before project documentation is complete; the parts of the process that industry collaborators are least interested in are quite possibly the parts of the process that are of most importance to the university collaborators. This ultimately leads to a difference in expectations and a difference in their idea of *project completion* and *outcome goals*. The following statements give differential perspectives from each of included sectors in the study:

> Unless a peer-reviewed article is in the funding agreement, it's not commercially viable, but we are asked to PLEASE write a peer-reviewed article by our organisation. I find papers get written at the weekend.
>
> (Government key informant 2)

> We don't advocate for our partners, regardless of what they may want us to do, we do objective research and will report what we find. We have had companies who don't like the results we come up with, but we doesn't change them.
>
> CRI is more focused on an outcome that universities. Research outputs and publications are insufficient as one of our main goals is to make an impact.
>
> (University key informant 4)

> We have internal feedback presentations, post product in-house presentation, but the client is not involved in this. We might speak to sales, but we would not speak to the client.

> In many cases, the result of our research is a presentation PowerPoint slides for the report so the information is already stale when it's complete and updates can be done regularly.
>
> (Industry key informant 2)

viii. Project drivers

The theme of *project drivers* is the final differentiating theme reflecting differences between the sectors. Similarly, to other differentiating themes, this was seen as more significant to industry and government than university. Funding is a primary driver, and even a necessity, for most projects; however, there is more of a push towards industry collaboration with control coming away from academics. While businesses are usually the primary funders of their commissioned collaborative projects, spending between 3% and 15% of annual turnover on research each year, the Ministry of Science and Research Technology (MORST, 2006) academic project funds come mainly from external bodies or external business. The central driver of any project and a precursor to funding, however, is the desired output or the expectations of the project which is often tied back to strategy. The connection between drivers and outputs was highlighted by Industry key informant 1, who explained that, "we have a research strategy internally so that we can connect funding requests back to our strategy". Although not all drivers are the same as University key informant 4 explained, "we are driven by a need to have better transparency and to some extent, what we think industry needs".

As shown by these two statements and noted in the previous section on *outcome goals*, the strategy for each of the sectors is quite differently driven: commercial organisations' strategic focus is on a return on investment; the academic organisation focuses on the public good; and the government organisation - while primarily being driven by public enterprise – proposes to aid collaboration between academic and industry entities.

4.6.1.2.2. Outcome level differences.

As noted above, only two of the outcome variables showed differences: the *perceived future of research streams* was reported as more important for both the government and university sectors than for the industry sectors, and the *perceived increase in power relationships* was reported as more important to the government sector than to university or government sectors.

i. Perceived future of research streams

Significant differences were found between the three sectors when it came to the *perceived future of research streams* at the staff levels of key informants and team members. Both university and government sectors view the *research streams* to be more important to the overall project than the industry sector. Within these sectors, key informants found the *perceived future of research streams* more important than team members.

From the perspective of industry, the future of their *research stream* would mean more longevity in the subject which was less of a concern. This longevity is important both to university researchers, who are often subject specific, and to government sectors, which have long term policy changes in mind. This was evidenced through conversations, which reflected the researchers' wish to continue work in their subject field over many years, whereas industry saw less of a need to collaborate and extend the subject:

> They (Industry) tend to want to explore the more known research, short term with predictable outcomes. One business is just beginning to get into

> trust mode after about ten years of working with them and starting to look at the long term – being five to ten-year outcomes.
>
> (Government key informant 3)

> We do have collaborative partners, but we're just as happy looking for new organisations to work with; whatever works best. We have no need for longevity of collaboration. We have one long-term collaborator, but we will use whatever delivers.
>
> (Industry key informant 1)

ii. The perceived increase in power relationships

Power has been seen as central to the pessimist perspective of collaboration theory (Emerson, 1962) for a long time, and it is interesting in this study that this perception is accorded more importance by the government sector than by either the university of the industry sector. This perspective noted that the motivation for collaboration hinges on the political economy for securing both current and future valued resources (Sullivan & Skelcher, 2002).The realist perspective takes a more pragmatic approach, recognising the optimistic view of altruistic motivation, while realising that influences of change on collaboration is capable of swaying collaborators to either side of the spectrum from altruistic motivations to resource and power motivations. While all sectors see a perceived increase in *power relationships* as important, it is however of most importance to the government sector. As can be seen by the following statement, research can provide powerful positive incentives:

> The immunisation advisory service in the country is run by us. It's one of our business units. It started as a research team looking at how to improve the immunisation rates for young kids under school age. When work started

> 10 to 15 years ago immunisation was around 50% for new kids to school, so we did some research on how to influence the right choice, and we were then asked to implement it. Now the immunisation rate is 95%, so process and policy have been changed. That work was born in research, and the following research is around how effective that is by not effecting parents working life from being at home with sick children, so it's monitoring health and well-being.
>
> (University key informant 1)

4.6.1.3. Individuals with less than ten years or and more than ten years in UIG collaborations

T-Tests were conducted to compare the sixteen differentiating themes and the eight outcome variables under the condition of the length of time (less than ten years, and more than ten years) within UIG collaborations, in order to look at the effect this condition had on the differentiating themes.

Significant effects were found in three of the sixteen differentiating themes and four of the eight outcome goals. Some of these effects were reported at 95% significance, although there are some reported at a lower significance as they are of interest to the study. A summary of the results is shown in Table 4.9 and then reported in order from the most significant difference to the least significant difference.

Table 4.9: Differences in differentiating themes and outcome measures by length of project experience being under ten years and over ten years

Differentiating themes that are more important for participants involved for less than ten years	Outcome measures that are more important for participants involved for more than ten years
● Project ownership ● Project ethics ● Project justification	● Quality of working relationship ● Network density ● Ongoing relationships ● Measure of collaboration

In the quantitative study for the individual length of involvement in UIG collaborations, 25% of respondents had been in this style of work longer than ten years, which also equates to key informants who similarly found outcome variables to be more important than team members.

There was a significant difference in the scores for under ten years (M=4.33, SD=1.225) and over ten years (M=5.00, SD=1.446) conditions t(94)=-2.192, p=0.031 against the perceived measure of the *quality of working relationships* outcome variable.

There was a significant difference in the scores for under ten years (M=4.34, SD=1.407) and over ten years (M=3.70, SD=1.636) conditions t(94)=1.848, p=0.068 against *project ownership* differentiating theme.

There was a significant difference in the scores for under ten years (M=4.15, SD=1.479) and over ten years (M=3.48, SD=1.675) conditions t(93)=1.843, p=0.068 against *project ethics* differentiating theme.

There was a significant difference in the scores for under ten years (M=4.22, SD=1.502) and over ten years (M=3.57, SD=1.701) conditions t(94)=1.763, p=0.081 against *project justification* differentiating theme.

There was a significant difference in the scores for under ten years (M=4.3, SD=1.102) and over ten years (M=4.74, SD=1.484) conditions t(94)=-1.523, p=0.131 against the *perceived measure of network density* outcome variable.

There was a significant difference in the scores for under ten years (M=4.51, SD=1.237) and over ten years (M=4.96, SD=1.637) conditions t(94)=-1.402, p=0.164 against the *perceived measure of ongoing relationships* outcome variable.

There was a significant difference in the scores for under ten years (M=4.51, SD=1.015) and over ten years (M=4.87, SD=1.359) conditions t(94)=-1.372, p=0.173 against the *perceived measure of the collaboration* outcome variable.

Of the differences found for length of involvement, the three differentiating themes of *project ownership, ethics* and *project justification* were all more important for those who have been in the UIG project area for less than ten years. Only *ethics* were shown as more important to team members than key informants with both *project justification* and *project ownership* showing no differences for participant levels; and *project ownership* and *justification* showing to be equally important to both participant levels, and participants with less than 10 years' experience. *Ethics* have measured as more important to both team members and participants with less than 10 years' experience, possibly due to these participants having more of a project focus and therefore more affected by *ethics*. The outcome variables of *quality of working relationships, network density, ongoing relationships* and *measure of collaboration* showed differences, however, for those who had been in the UIG project area for more than ten years, and similarly for key informants.

For the two themes measuring as more important to the participants with less than ten years of involvement being *justification* and *ownership, ownership* also showed significant differences between sectors; however, *justification* was equally important. Looking at the initial framework, *justification* is a sub-theme of *ownership,* and *ownership* as a subject was the fifth most frequently discussed specifically for researchers with less experience as they were less likely to have built up a stream of research that enabled them to justify their research projects. This was expressed by Government key informant 1 in these words, "It's hard for new people coming along. You have a choice you can get new exuberance or somebody that's tried-and-true".

4.6.2. Project management perspectives

This section presents the findings of the study at the project level perspectives of budget, length, phases and constraints, measured traditionally as the 'Iron triangle' shown in Figure 2.4. Both budget and duration have been reported to determine the effects of the themes and outcomes on small and large, as well as short and long, projects, and these differences provide a split in the detailed results in each measure. The quantitative results reported 50% of the projects as being small in nature, with budgets of less than NZ/AUS$100,000 dollars, and as such this provides a natural split to assess any differences found against the themes and outcomes. For project length the quantitative results showed that 40% of projects were up to one year long and this also provides a split to assess any differences whilst still being significant in each category.

4.6.2.1. Project budgets under NZ/AUS$100K and project budgets over NZ/AUS$100K

T-Tests were conducted to compare the sixteen differentiating themes and the eight outcome measures under the condition of project budgets split between under NZ/AUS$100,000 and over NZ/AUS$100,000 to look at the possible effects. Significant effects were found in three of the sixteen differentiating themes and one of the eight outcome goals. Some of these are reported at 95% significance, although some are reported at a lower significance as they are of interest to the study. The three themes of *intellectual property, timescale uniformity* and *project streams;* and the one outcome, a *measure of collaboration*, in cases where differences were shown, were all more important to the larger projects budgeted at over NZ/AUS$100K.

There was a significant difference in the scores for under NZ/AUS$100K (M=3.82, SD=1.548) and over $100K (M=4.35, SD=1.538) conditions t(94)=-1.674, p=0.097 against *intellectual property* differentiating theme.

There was a significant difference in the scores for under NZ/AUS$100K (M=4.00, SD=1.604) and over $100K (M=4.46, SD=1.277) conditions t(94)=-1.534, p=0.128 against *timescale uniformity* differentiating theme.

There was a significant difference in the scores for under NZ/AUS$100K (M=4.08, SD=1.664) and over $100K (M=4.54, SD=1.295) conditions t(94)=-1.514, p=0.133 against *project streams* differentiating theme.

There was a significant difference in the scores for under NZ/AUS$100K (M=4.42, SD=1.416) and over $100K (M=4.83, SD=1.253) conditions t(94)=-1.483, p=0.141 against the *perceived measure of the collaboration* outcome measure.

Of the differences found for budget, both the differentiating theme of *project streams* and the outcome measure of *measure of collaboration* showed differences for team members and key informants. Team members found the *project stream* to be more important than key informants, and key informants found the *measure of collaboration* to be more important than team members as did the participants with more than ten years of experience. There were no differences noted between sectors for any of the differences found due to funding. This reflects the previous findings where differences were noted, showing that team members found differentiating themes to be more important than key informants, and key informants found outcome measures to be more important than differentiating themes.

4.6.2.2. Projects under one year long and projects over one year long

T-Tests were conducted to compare the sixteen differentiating themes and the eight outcome measures under the condition of projects under one year long and over one year long to look at their effect. Significant effects were found in two of the sixteen differentiating themes being *ethics* and *career aspirations*; however, no significant results were found in outcome measures.

There was a significant difference in the scores for under one year (M=4.33, SD=1.562) and over one year (M=3.64, SD=1.466) conditions $t(94)=-0.220$, $p=0.028$ against *project ethics* differentiating theme.

There was a significant difference in the scores for under one year (M=4.35, SD=1.494) and over one year (M=3.83, SD=1.274) conditions $t(94)=1.822$, $p=0.072$ against *career aspiration* differentiating theme.

Both of these themes were of more importance to the shorter projects under one year long. They also showed differences for team members and key informants, with team members finding both themes more important than key informants, again reflecting previous findings of team members measuring differentiating themes as more important than outcome measures. Participants with less than ten years' experience also found *ethics* to be of more importance than those with longevity in this area, reflecting the same results. There were, however, no differences noted between sectors for either *ethics* or *career aspirations*.

4.6.2.3. Cross-tabulation of differentiating themes against project phases

Cross-tabulations were conducted to compare the sixteen differentiating themes under the conditions of project phases. The study used the traditional five project phases of conceptualisation and initiation, definition and planning, execution, performance and control, to look at the effect the phases had on the themes.

The primary purpose of this data set is to look at the effect of the sixteen themes on each of the project phases and to understand their impact within the project setting, the results of which are presented in Table 4.10. followed by a discussion of the results from both the quantitative and qualitative data.

Table 4.10. Cross-tabulation of the importance of themes against project phases

Differentiating themes						% across phase
	Conceptualisation and initiation	Definition and planning	Execution	Performance and control	Closure	
Completion goal	21	9	16	18	22	10.05%
Outcome goal	14	18	18	16	17	9.70%
Funder priorities	23	17	14	16	5	8.76%
Team collaboration	13	15	16	15	11	8.18%
Project justification	15	19	7	6	13	7.01%
Project ownership	8	14	11	15	11	6.89%
Project drivers	10	9	12	15	9	6.43%
Scientific review	14	7	11	10	13	6.43%
Timescale uniformity	12	12	9	12	8	6.19%
Career focus	9	7	11	11	12	5.84%
Intellectual property	10	12	8	8	7	5.26%

Subject matter experts	11	12	7	8	7	5.26%
Career aspiration	7	10	7	5	6	4.09%
Ethics requirements	6	5	6	10	6	3.86%
Project streams	8	9	6	7	2	3.74%
Collegiality	4	4	4	3	5	2.34%
TOTAL	185	179	163	175	154	

The initial investigation of the outcome measures reveals provisional observations that show the importance of specific themes as they relate to project phases. Across all phases, the conceptualisation and initiation phase were measured as the most critical phase with the closure phase being the least important phase. The themes of *completion goals, outcome goal, funder priorities* and *team collaboration* are shown to be slightly more important than the other themes in the survey data, whereas *collegiality, project streams, ethics requirements* and *career aspirations* are seen to be slightly less important across phases. The most important themes at the conceptualisation and initiation phase are *funder priorities* and *completion goal*, and this was closely followed by the *completion goal* in the closure phase. Eleven themes are reported as being more important as the project progresses rather than in the conceptualisation and initiation phase: *outcome goal, team collaboration, project justification, ownership, project drivers, career focus, intellectual property, subject matter experts, career aspirations, ethics* and *project streams*. There are also five themes that are more important in the closure phase than in the conceptualisation and initiation phase: *completion goal, outcome goal, project ownership, career focus* and *collegiality*. The project phases are discussed in order, conceptualisation and initiation, definition and planning, execution, performance and control and closure.

i. Conceptualisation and initiation importance

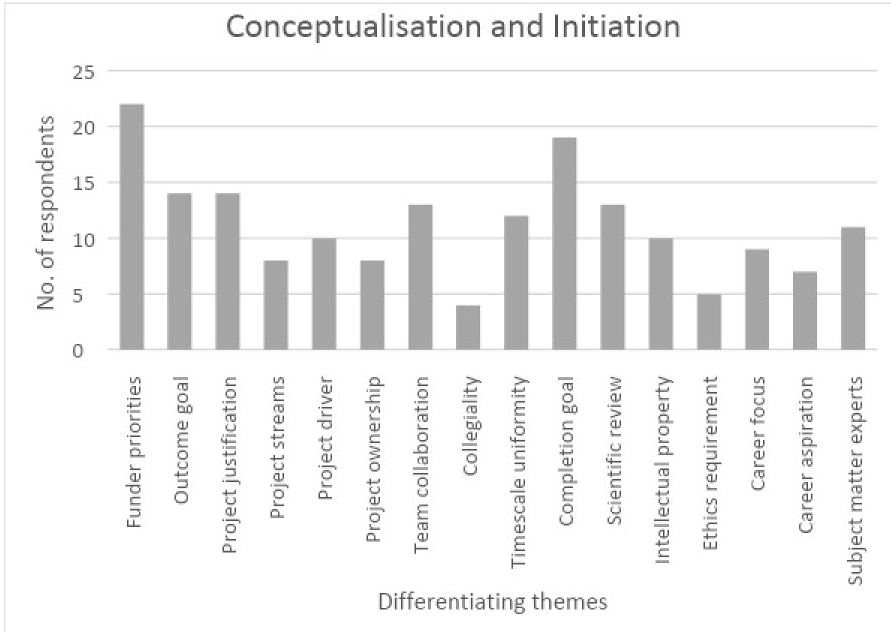

Figure 4.4. Theme impact in the conceptualisation and initiation phase

In the conceptualisation phase, respondents reported differences in *funder priorities* and *differences in completion goals* as the most significant themes, and *differences in collegiality* and *ethics* requirements as the least significant themes. *Funder priorities* and *completion goals* were also themes that both key informants and team members agree as being important; these were also themes that were significant between sectors, with both government and industry seeing these themes as more important than the university sector. When looking at these themes from a constraint view, they also show as being the most important. The following three comments reflect the importance of the conceptualisation and initiation phase and also reflect the time a project can take to formalise:

> The setup phase is especially important with people you don't know who can be a problem. The front end of the project is harder than the backend if everything has been monitored along the way we just slide through the end.

(Government key informant 1)

> We had to be aware of the different priorities - academic with ongoing progression of research while commercial priorities were focused on more immediate application.

(Industry key respondent quantitative)

> The project contract took a long time to work through. There was a one-year period before the project could begin talking through intellectual property ownership and who would benefit if the project was successful, and what percentage gains would be given to each of the three parties on the project.

(Government key respondent quantitative)

ii. Definition and planning

Figure 4.5. Theme impact in the definition and planning phase

In the definition and planning phase respondents reported *project justification* and *outcome goals* as the most significant themes, while *collegiality* and *ethics requirement*s were the least significant themes as in the conceptualisation and initiation phase. *Outcome goals* and *project justification* were themes that both key informants and team members agree on as being important, and the *outcome goal* was a theme that showed a significant difference between sectors with both government and industry seeing this theme as more important than the university sector. *Project justification* also showed a significant difference in the length of involvement in UIG projects; those with less than ten years' involvement saw this theme as more important than those with over ten years' experience. *Project outcome* was in the top three most important themes against the project constraints, and *project justification* was the only theme seen as equally important across all the constraints of cost, scope, time and quality. Comments mirrored the importance of the definition and planning phase and also indicated the time a project can take to understand in this phase:

> Time frames of commercial projects are crucial, while a high dose of flexibility is often allowed with academic projects; the use of resources must be very well planned and monitored during the time of the project.
>
> (University key respondent)

> In many ways, the differences in the timelines result from differences in the motivation for doing a research project. Commercial market research is often conducted to answer a specific business question, which means the research has to be conducted within the timeline required by the business question, which is typically rapid.
>
> (Government key respondent)

iii. Execution

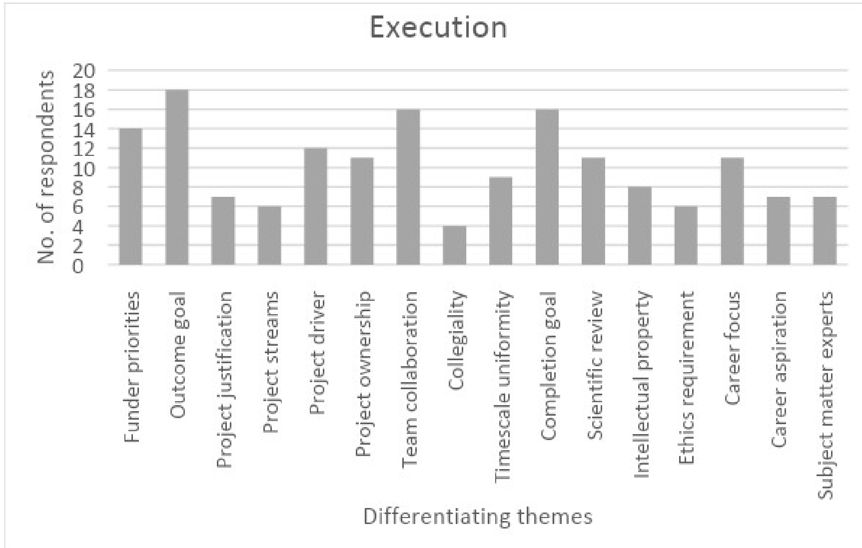

Figure 4.6. Theme impact in the execution phase

In the execution phase, respondents reported differences in *outcome goal, team collaboration, outcome goal* and *funder priorities* as the most significant themes, with the least significant theme being *differences in collegiality*. As shown in the previous two phases, *outcome goals* and *completion goals* were also frequently discussed and were themes that both key informants and team members agree as being important. These themes also showed significant differences between sectors, with both government and industry seeing these themes as more important than the university sector. *Team collaboration* was a theme considered equally important by both levels of participants and all three sectors. When looking at these themes from a constraint view, they also show as being important, with *team collaboration* being most important to the constraint of quality. Comments reflected the importance of the execution phase and the need to progress the project, but also the difference in motivation and methodology through this phase:

> While generally, the commercial partner wants to see the best science, this may not be their principal outcome, and therefore there can be some robust discussions as to the level of detail and/or rigour required to deliver a particular outcome. (i.e., the balance of how resources need to be applied to achieve the desired outcomes for all parties).
>
> (University key respondent 1)

As Government key respondent 2 noted, such projects often require flexibility from the collaborators, "The execution project phase has to be flexible in order to control the different variables to ensure that the project is completed on time and on budget."

iv. Performance and control

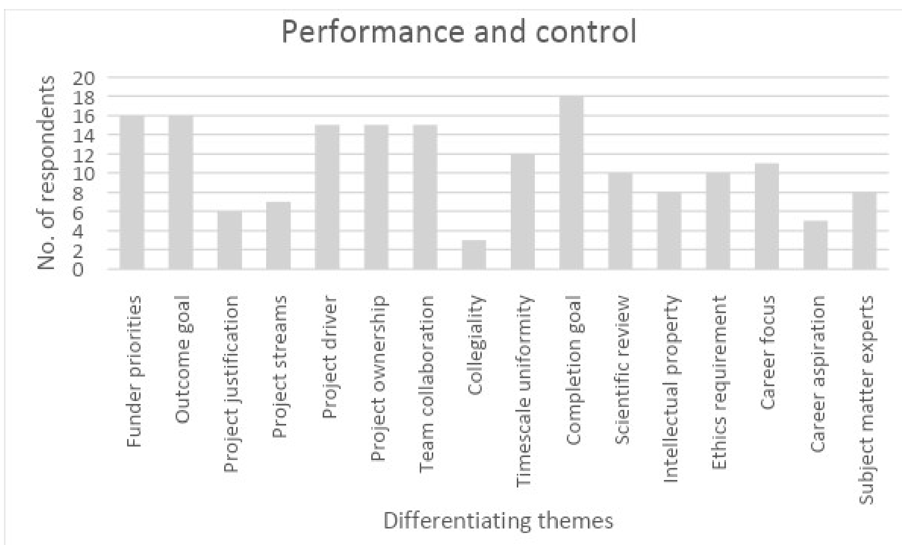

Figure 4.7. Theme impact on the performance and control phase

In the performance and control phase respondents reported *completion goals* as the most significant theme with *funder priorities* and *outcome goals* closely behind, while respondents reported differences in *collegiality* and *career aspirations* as the least significant themes. *Completion goal, outcome goal* and *funder priorities* have been a continuous trend through the phases and are no less important when looking at the performance and control of the project. Comments reflected the importance of the *timelines* and *project goals* in the performance and control phase. Participants referred to commercial projects as being, “more demanding” (University key respondent) and that they needed to be “very clear about timelines and goals, whereas academic projects are less defined”, (Industry key respondent) and speculated that this was because “the economic feasibility of the newly developed technology must be proven”. (University key respondent).

v. Closure

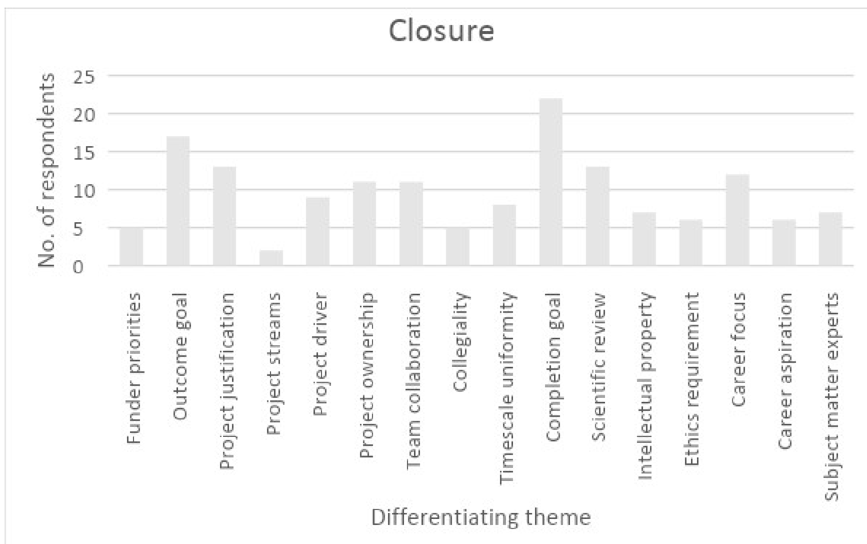

Figure 4.8. Theme impact in the closure phase

In the closure phase, respondents reported *completion goals* as the most significant theme with *outcome goals* next. *Project justification* and *scientific review* were closely behind, while respondents reported *project streams, collegiality* and *funder priorities* as the least significant themes. This is the first phase that has seen *funder priorities* moved away from being one of the most important themes to one of the least important themes, and also the first phase where *scientific review* has moved up to being one of the most important themes. Comments reflected the importance of the closure phase, showing the difference in nature between the sectors, a natural end for many industry and government projects and the ongoing nature of university projects as well as a main concern for the length of a closure phase. The following three discussions reflect these differences:

> Commercial projects come to a natural end when the problem is solved, or the team has realised that it is not going to be solved. Whereas academic projects go on without a clear end point and can be very hard to manage as the researcher will always ask for an extra month to come up with the world's first in the field.
>
> (Industry key respondent)

> The key client outcomes must be met, however frequently there is (academic) interest in further pursuing the science. During the review, this can be an opportunity to further explore whether the research can go further.
>
> (University key respondent)

> Mainly in the review stage, there were reports that needed to be complete, but once the research was complete, the academics did not do their reports quickly while industry completed much sooner.
>
> (Government key respondent)

4.6.2.4. Cross-tabulation of differentiating themes against project constraints

Cross-tabulations were conducted to compare the sixteen differentiating themes under the condition of project constraints. The study used the traditional project constraints of cost, scope, time and quality of the traditional 'Iron triangle' shown in Figure 2.4. to look at the effect they had on the themes.

The primary purpose of this data set is to look at the effect of the sixteen themes on each of the constraints and to understand their impact within the project setting, the results of which are presented in Table 4.11, followed by a discussion of the results from the quantitative and qualitative data.

Table 4.11. Cross tabulation of project constraints criteria

Contrast themes across project constraint criteria	Cost Constraint	Scope Constraint	Time Constraint	Quality Constraint	Importance across constraints
Completion goal	10	20	12	15	10.00%
Outcome goal	10	14	14	13	9.00%
Funder priorities	19	11	7	9	8.00%
Team collaboration	11	7	10	13	7.00%
Project justification	10	10	10	10	7.00%
Project ownership	7	10	11	12	7.00%
Project drivers	9	9	12	10	7.00%
Scientific review	10	11	9	8	7.00%
Timescale uniformity	2	13	17	5	6.00%
Career focus	8	8	11	9	6.00%
Intellectual property	6	12	8	9	6.00%
Subject matter experts	9	7	7	6	5.00%
Career aspiration	8	8	5	6	5.00%
Ethics requirements	3	8	6	7	4.00%
Project streams	5	3	8	2	3.00%
Collegiality	2	2	5	2	2.00%
TOTAL	129	153	152	136	

Table 4.11. shows the descriptive data for each of the constraints. An initial investigation of the outcome variables reveals provisional observations that show the potential importance of specific themes as they relate to the constraints. Across all constraints the scope and time constraints were measured as almost equally important, with the cost constraint being the least important. The themes of *completion goals, outcome goal, funder priorities* and *team collaboration* are shown to be slightly more important than the other themes in the survey data, whereas *collegiality, project streams, ethics requirements, career aspirations* and *subject matter experts* are seen to be slightly less important across the constraints, which is the same as the results found against project phases. The most important theme for scope is the *completion goal*, which was also the highest correlation within the cross-tabulation table; however, in phases the highest correlation was *funder prioritie*s in conceptualisation and initiation. This was closely followed by the importance of the cost constraint correlated with *funder priorities*. Time constraint and the theme of *timescale uniformity* showed as the third highest correlation in the table, although the theme of *timescale uniformity* does not show as being significant across all constraints.

The following section examines the effects in more detail by constraint using comments from the survey as well as discussions throughout the qualitative interviews. The constraints are discussed in order of cost, scope, time and quality.

i. Cost

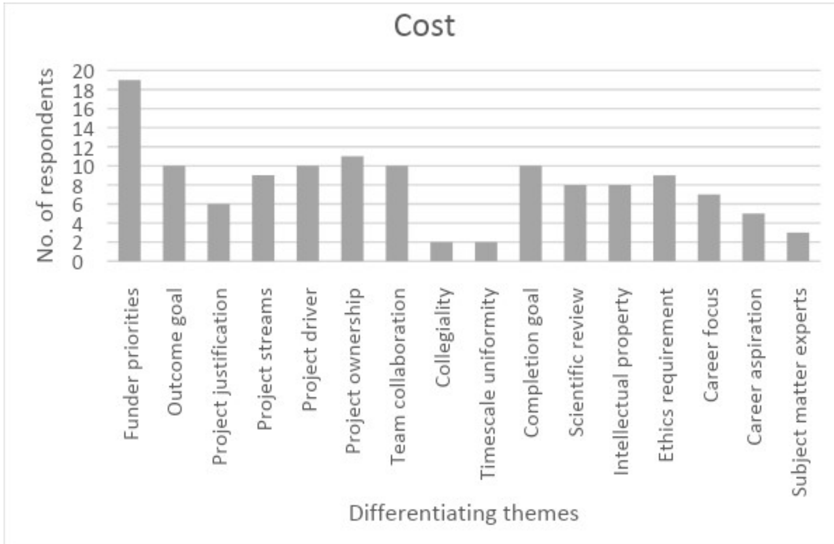

Figure 4.9. Theme impact against the cost constraint

For the cost constraint respondents reported *funder priorities* as the most significant theme, and this were also the second most important correlation shown in the table, while respondents reported *collegiality* and *timescale uniformity* as the least significant themes. *Funder priorities* were also amongst the most frequently discussed theme, and both key informants and team members agree on its importance. However, this theme showed significant differences between sectors, with both government and industry seeing *funder priorities* as more important than the university sector. The following three comments reflected the importance of the cost constraint and the differences perceived by each sector specifically to cost controls:

> Scientists often like to follow side-paths when interesting observations are made. Care needs to be taken to ensure the commercial partner is in agreement with this, and also to ensure that previously agreed outcomes are delivered first and foremost, within the agreed budget.
>
> (University key respondent)

The costing of a commercial project is more precise and restrictive. Cost was not a major constraint on this project. However, university overheads were a major cost that did not contribute directly to research.

(University key respondent)

The project is cost constrained, but tranches of funding have come along later to enable progress. As an industrial project, more cost control measures would have been implemented, I feel.

(Government key respondent)

ii. Scope

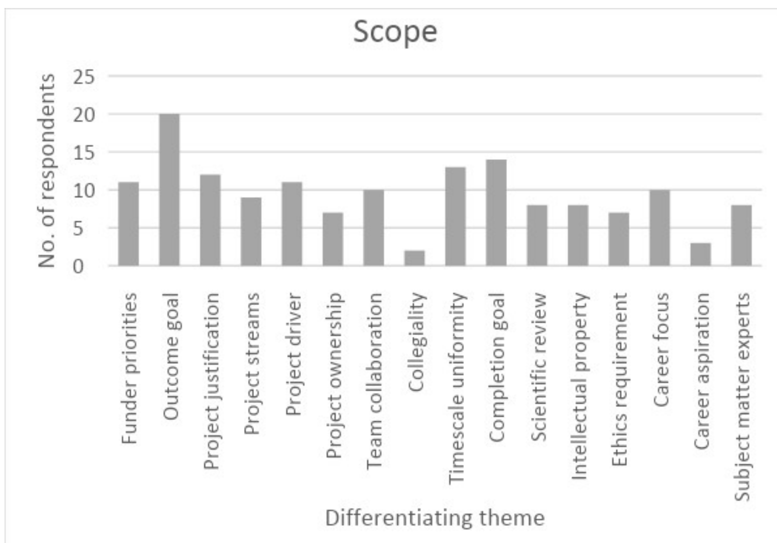

Figure 4.10. Theme impact against the scope constraint

For the scope constraint, respondents reported *outcome goal* as the most significant theme, and this was also the most important correlation shown across all constraints, while respondents reported *collegiality* and *career aspiration* as the least significant themes. *Outcome goal* was also one of the most frequently discussed, and a theme that both key informants and team members agree as being important. This was also a theme where significant differences were found between sectors, with both government and industry seeing this theme as more important than the university sector. The following comment reflected the importance of the scope constraint and also indicated the difference between sectors:

> Industry projects tend to be narrow, focus and aimed at a quick guaranteed win. Academic projects are broad, amorphous and with less closely defined terms for success (aka blue-sky thinking). Therefore, scope creep is anathema to industry and almost guaranteed for academia.
>
> (University key respondent)

The discussions also considered the connection between scope and cost and their direct relationship. As one University key respondent noted "Project scope was agreed at the start but constrained by government funding for the project to both industry and university collaborators". How much cost can affect scope can also depend on the sector, "The response to cost constraint has partly been to de-scope the project. This would have been negotiated much more severely had the project had a traditional commercial customer", (Government key respondent).

iii. Time

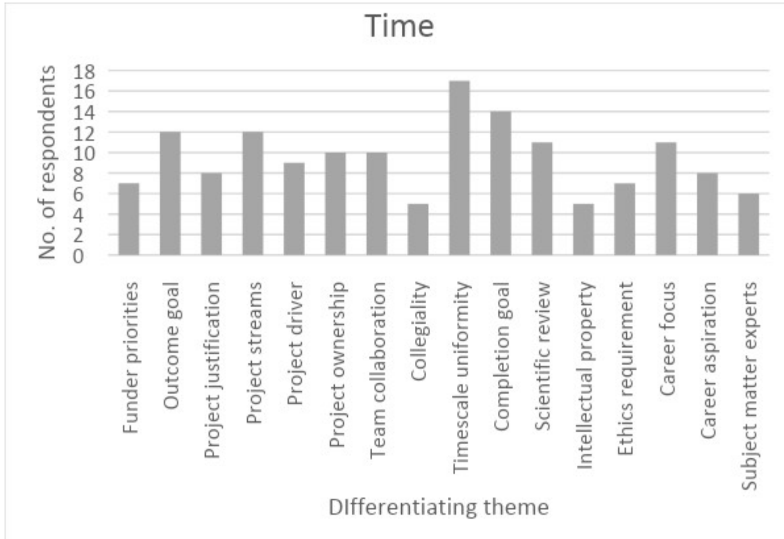

Figure 4.11. Theme impact against the time constraint

For the time constraint respondents reported *timescale uniformity* as the most significant theme, while respondents reported *collegiality* and *intellectual property* requirements as the least significant themes. *Timescale uniformity* was only reported as a significant theme in the *project funding* criteria where projects over NZ/AUS$100K found *timescale uniformity* to be more important than projects under NZ/AUSNZ/AUS $100K. The larger projects were also ones who tended to have multiple funders. *Timescale uniformity* is not reported as either one of the most important or one of the least important themes and showed no differences in either participant levels or industry sector type. Comments reflected the importance of the time constraints specifically when looking at the amount of science to be done across a project and what this meant for project outcomes. As one University key respondent noted “MBIE required a commercial prototype in the two-year time frame. The commercial nature of the project meant that publication was not a priority.” With projects trying to deliver more than can be expected in the funded timeframe, “the project is only three years but has ambitious science milestones which go beyond the funded cycle”, (University key respondent).

While no significant differences were measured across sectors, the comments showed notable differences between sectors, specifically regarding the perceived speed of academic researchers, with one participant noting that “time constraints are determined by commercial need, not academic pressure” (Industry key respondent). A lack of urgency can cause frustration between collaborators:

> There was no sense of urgency on the part of the academics, whereas industry leaders had a view of the time they expected to spend on the project and were expecting the timescales to be adhered to. When they were not, industry partners became frustrated.
>
> (Government key respondent)

iv. Quality

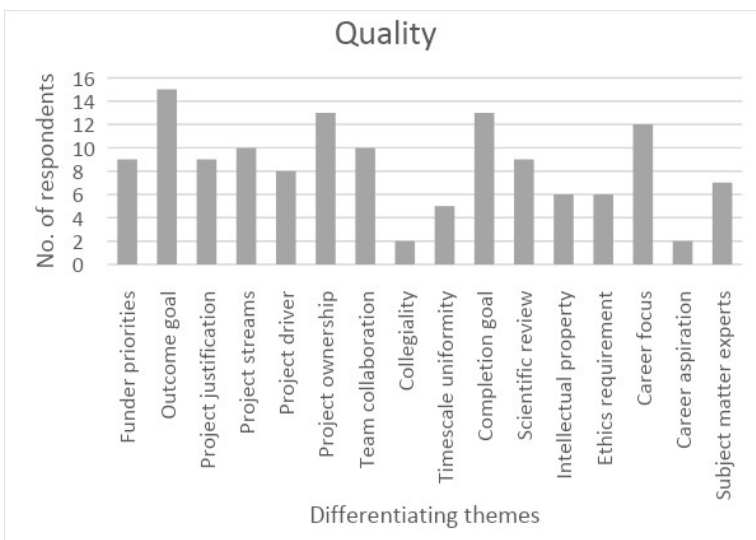

Figure 4.12. Theme impact against the quality constraint

For the quality constraint, respondents reported *outcome goal* as the most significant theme with *project ownership, completion goal* and *career focus* close behind.

Respondents reported *collegiality* and *career aspirations* as the least significant themes. *Outcome goal* and *completion goal* have been noted against both time and cost constraints; *project ownership* has not been mentioned against other constraints. *Project ownership* does, however, show as a difference between sectors where the university sector shows this as a less important theme than industry and government. This also shows as a difference between individuals with longevity in this area and those who had been in UIG for more than ten years, seeing this theme as more important than those who had been in UIG for less than ten years. The following comment reflects the importance of quality, especially with its relationship to the time available to produce quality and the availability of necessary resources:

> All partners were used to publication quality requirements, but these were the responsibility of the university and components the university had responsibility for. In the initial project design, the industry partner argued about the need to do its components such that they would be quantified and replicated adequately to meet university needs.
>
> (University key respondent)

It was also noted that “the quality of the research leading towards the final goal can be compromised in commercial projects” as a result of constraints concerning “time and resources” (University key respondent), and also that the “quality of a project will depend on whether or not you have the experts on board” (Industry key respondent).

4.6.2.5. Collaboration at inception and completion of the project

Cross-tabulations were conducted to compare the inception (beginning) and the completion (end) of the actual work of the collaboration to view and assess the effects of any changes. Integration from inception to completion of the project was measured using the SAFAR framework, as shown in Table 2.3. (strategic alliance formative assessment rubric) a measure that uses a descriptive framework to assess the levels of integration from networking through to collaborating. The five collaborative integration measures described are shown using unifying descriptor areas to provide understanding to the levels of integration from the most straightforward level to the most complex level. The descriptors used are:

- Networking
- Cooperating
- Partnering
- Merging
- Unifying

across each of four variables of:

- Project purpose
- Strategies and tasks
- Leadership and decision-making
- Interpersonal and communication.

The cross-tabulation in Table 4.12. shows the descriptive data from the cross tabulation measured across all the projects reported in the quantitative study, on a scale from 0 to 50. Those that have demonstrated a positive move towards a more collaborative style of working at project completion have been highlighted and account for 50% of the overall measures. Of the four variables listed, the greatest movement was in the project purpose followed closely by leadership and decision making. However, for project purpose the movement was away from collaboration with both merging and unifying reducing at completion, whereas in leadership and decision making, autonomy with visible leaders and a central hierarchy both made positive moves at completion.

Table 4.12. Cross-tabulation of project inception to completion descriptives.

	Inception		Completion
Project purpose			
created a web of communication	14.29	≥	9.21
work together to ensure tasks are done	35.06	≤	42.11
share resources to address common issues	19.48	≤	27.63
merge resources to create or support	20.78	≥	11.84
unification or acquisition of a single culture	10.39	≥	9.21
Strategies and tasks			
loose or no structure	8.11	≤	13.16
member links are advisory	20.27	≤	23.68
strategies and tasks developed and maintained	43.24	≥	39.47
formal structure to support strategies and tasks	22.97	≥	17.11
highly formal, legally complex	5.41	≤	6.58
Leadership and decision making			
non-hierarchical and flexible	12	≥	9.46
non-hierarchical with facilitative leaders	29.33	≥	18.92
autonomous leadership	25.33	≤	32.43
strong visible leaders	25.33	≤	28.38
central hierarchical	8	≤	10.81
Interpersonal and communication			
very little interpersonal conflict	17.11	≤	18.42
some degree of commitment and investment	32.89	≥	28.95
some interpersonal conflict	28.95	≥	27.63
high degree of commitment and investment	18.42	≤	23.68
possibility of interpersonal conflict very high	2.63	≥	1.32

Integration across the measures was also broken down by the participant levels of key participant and team member as well as the sectors of industry, university and government; this breakdown is shown in Appendix 3. The following section further analyses the levels of collaboration against the five integration measures for each descriptor looking at how the collaboration develops through the project to its completion.

i. Level of integration in project purpose against inception and completion

The first level of integration measures the project purpose across the five levels of integration, the results of which are shown in Figure 4.13. Across the whole study, both cooperating and partnering showed an increase between inception and completion while networking and merging dropped considerably across the course of the project, with unifying staying similar.

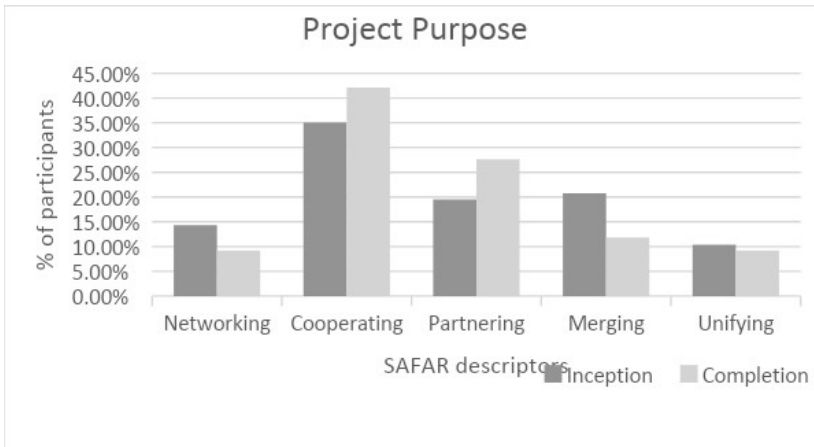

Figure 4.13. Integration of purpose at project inception and completion

Looking at the level of integration of purpose broken down by participant and industry sector, industry results did not align with the group: with the only measure that moved positively across the project being networking, they saw no positive moves in the other levels. Only the government reported a positive move in merging resources to create or support something new and no group reported unification of resources to form a single culture.

The project purpose was mainly reported from aspects of working together in the form of cooperating or partnering to ensure tasks are done and resources are shared to address common issues, both of which increase across the project as noted in the following statement:

> Ongoing collaboration is dependent on the people, an organisation working with our engineering school currently completed a collaboration and the development was working so well, they decided to get together again to do the next phase.
>
> (University key informant 2)

Merging and unifying were found to be happening to less effect and diminished across the projects.

ii. Level of integration in strategies and tasks against inception and completion

The second level of integration within the collaboration measures is project strategies and tasks across the five levels of integration, the results of which are shown in Figure 4.14. Across the whole study, networking, cooperating and unifying showed an increase between inception and completion while partnership and merging showed a drop.

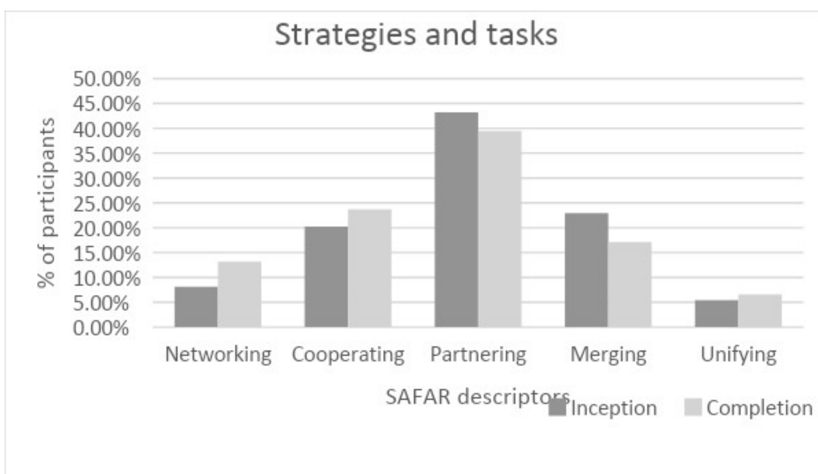

Figure 4.14. Integration of strategies and tasks at project inception and completion

Looking at the level of integration for strategies and tasks broken down by participant and industry sector, only university and team members showed growth in unifying or acquisition to form a single culture. In opposition to each other, team members saw positive moves in merging and unifying, whereas key respondents saw positive moves in networking and cooperating, which are opposite ends of the collaborative framework.

Respondents reported that strategies and tasks are developed and maintained mainly through formal structures to support the beginning of the project, although both become less important as the project progresses, with advisory roles being more important towards completion. The following two comments show the need for a higher level of structural rigour with industry reporting than either university or government:

> We have standards that we use internally, but if the industry partner wants to use a specific structure, we will follow theirs. Mostly we are flexible, but after the scoping exercise, a project doesn't usually change too much.
>
> (Government key informant 3)

> Industry wants to report back into their home structures and often needs more formal project management around it. As a university, we would do a similar structure on larger projects, such as primary growth partnership projects for large MBIE projects where we might have part-time dedicated project managers. They would be separate from our researchers. This is usually milestone and budgets and is often the home school administrators.
>
> (University key informant 1)

iii. Level of integration in leadership and decision making against inception and completion.

The third level of integration measures project leadership and decision-making across the five levels of integration, the results of which are shown in Figure 4.15. Across the whole study, partnering, merging and unifying showed increases between inception and completion, which are measured at the high end of the collaboration, while networking and cooperating dropped considerably across the course of the project.

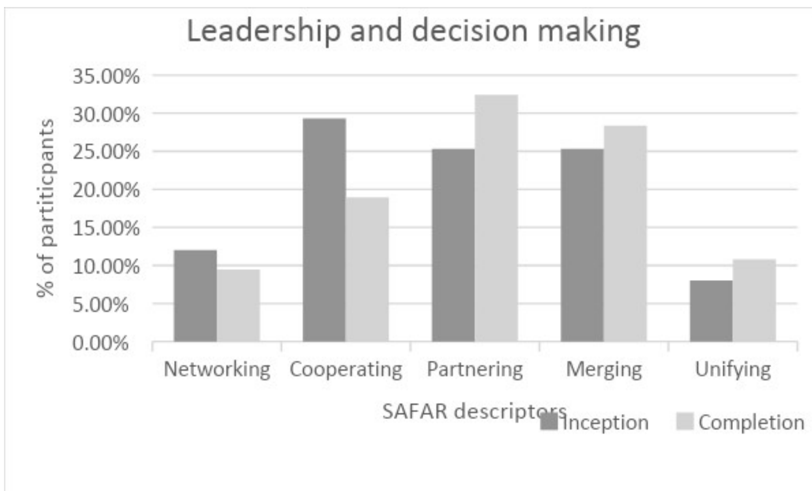

Figure 4.15. Integration of leadership and decision making at project inception and completion

Looking at the level of integration in leadership and decision making broken down by participant and industry sector, university was the only industry that did not report positively across unifying in leadership and decision-making, with levels staying the same as the project progresses.

Strong visible leaders that capitalised upon diversity and organisational strengths were reported as important across the project and became more critical at completion:

> The leadership is decided at the scoping stage, and we use the committee structure at the top of a project for reporting. It doesn't usually change during a project.
>
> (Government key informant 3)

Although joint leadership was also noted as a potential source for problems if responsibilities were not outlined well at the beginning,

> "the designated principal investigator is the lead on the project. If you're working across organisations there is usually a similar person in the other place or organisation. This is a joint leadership. Issues usually happen around delivery and understanding who is responsible for what deliverables, but this is resolved through the contract with milestones, and payments are generally around milestone delivery."
>
> (University key informant 1)

iv. Level of integration against for interpersonal and communication at inception and completion

The last level of integration within the collaboration measures project interpersonal and communication, the results of which are shown in Figure 4.16. Across the whole study, both networking and merging showed an increase between inception and completion while cooperating, partnering and unifying dropped across the course of the project.

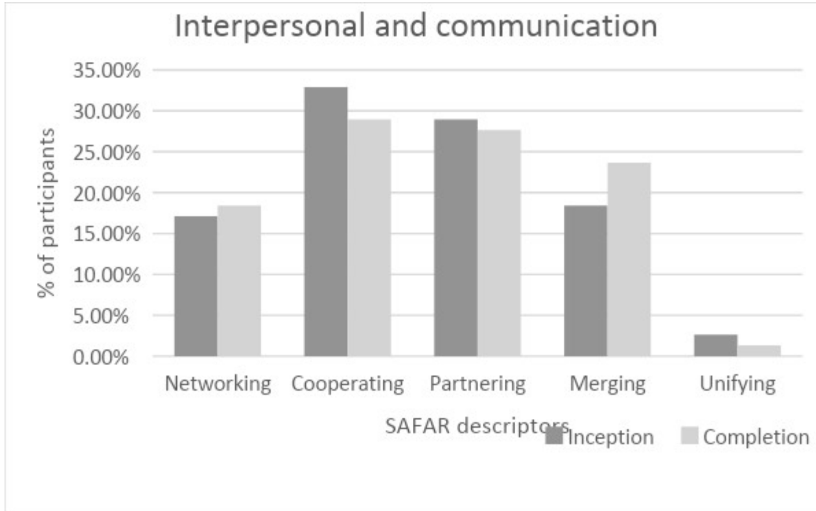

Figure 4.16. Integration of interpersonal and communication levels at project inception and completion

Looking at the level of integration across the project, with interpersonal and communication levels broken down by participant and industry sector, the main point of difference was between team members and key participants. Team members saw an increase across interpersonal and communication levels as the project progressed. Key participants, on the other hand, reported that merging was the only positive move. This stands in opposition to the level of collaboration reported across the project.

Participants reported some degree of commitment and investment throughout the collaboration, whereas a high degree of commitment and investment had become more important at completion. Interpersonal conflict was significant at the beginning of the project but became less relevant at completion. Communication was seen as an important trait in participants and an asset that cannot be measured through contract processes as can be seen in the following two statements:

> Communication depends on the projects needs depending on how closely monitored we need to be and the level of trust between the parties. Real trust that is built not that's written into the contract.
>
> (Government key informant 1)

> We are more interested in management and communication skills. I would be judging those first before scientific familiarity with the area. It's a bonus if they have familiarity with the area, it would be an advantage but not necessary.
>
> (University key informant 2)

4.7. Key findings

This chapter presents the key findings of the study and answers the main objectives of the research, an overview of which is shown in Table 4.15:

Objective one: To identify the differentiating themes for UIG collaborations that define their unique characteristics.

This was initially done through a literature search focusing on the reported areas of tension during which nine main differentiating themes and 16 sub-themes were noted, making up the original framework. The nine differentiating themes were *Funding, Project, Leadership, Teamwork, Completion, Scientific endeavour, Intellectual Property Ownership, Ethics* and *Career.* The 16 sub-themes were *Funder priorities, Asset distinction, Project justification, Project streams, Governance, Leadership, Team collaboration process, Collegiality, Timescale uniformity, Completion goal, Scientific review, Ownership of Intellectual property, Project working ethics, Career focus, Career aspiration,* and *Subject matter* *experts*. The qualitative results in this chapter added five main themes of *Collaboration, Project management methodology, Communication, Internationalism,* and *Project mishaps* and five sub-themes of *Trust, Contract management, Task segregation, Profitability* and *Influencing* to the study. These new themes and sub-themes were added to the original framework to produce a new framework, which was introduced in Section 4.4.2, and Table 4.13. and shown again here.

Table 4.13. Extended differentiation theme framework showing the hierarchical frequency distribution

Main differentiating themes	**Sub-themes**
1. Career	1a. Subject matter experts / career credentials
	1b. Career aspirations
	1c. Career focus
2. Funding	2a. Asset distinction
	2b. Funder priorities
3. Collaboration	3a. Trust
4. Project management methodology	4a. Contract management
	4b. Task segregation
5. Project ownership	5a. Project stream
	5b. Project justification
	5c. Profitability
	5d. Governance

6. Completion	6a. Timescale uniformity
	6b. Completion goal
7. Teamwork	7a. Collegiality
	7b. Team collaboration process
8. Intellectual property	8a. Influencing
9. Communication	
10. Leadership	
11. Scientific endeavour	
12. Internationalism	
13. Ethics	
14. Project mishaps	

Objective two: To examine the challenges these recognised differences may present to the UIG collaboration from a project management perspective.

The initial differentiating themes were measured in the survey instrument and then developed through the qualitative interviews. While all themes were reported as significant to the collaboration, twelve of the differentiating themes reported challenges within the data collection model level, namely *Career focus, Career aspiration, Funder priorities, Asset distinction, Project justification, Project* *stream, Timescale uniformity, Completion goal, Collegiality, Intellectual property ownership, Scientific review* and *Project working ethics*. Only four were reported without challenges which were, *Subject matter experts, Governance, Team collaboration process* and *Leadership*. New themes were not measured through the survey instrument, although each new theme and sub-theme was reported as a challenge in the collaborative space and depending on the amount of discussion for each of the new themes were positioned in order of individual ranking rather than by category.

The relative importance showed the most important theme being *career* across the measures, with *funding* and *team collaboration* also measured with high importance. The only theme with an influence that did not balance across the quantitative and qualitative measures was that of *funding* which was discussed as being of high importance to the study participants but did not measure highly in the quantitative study, possibly because participants were asked to focus on a project recently completed and as such were not reflecting on the funding process. Challenges were also reported across all concept and project levels. The hierarchical table for the themes is shown below.

Table 4.14. Differentiation themes shown in a hierarchical ranking order from most important to least important

1. Career
2. Funding
3. Collaboration
4. Project management methodology
5. Project ownership
6. Completion

7. Subject matter experts / career credentials
8. Teamwork
9. Timescale uniformity
10. Contract management
11. Asset distinction
12. Intellectual property
13. Communication
14. Leadership
15. Scientific endeavour
16. Career aspirations
17. Task segregation
18. Project stream
19. Internationalism
20. Career focus
21. Completion goal
22. Collegiality
23. Project justification
24. Profitability
25. Ethics
26. Project mishaps
27. Governance
28. Funder priorities
29. Trust
30. Team collaboration process
31. Influencing

Objective three: To examine how the differentiating themes impact on the collaboration outcome, either positively or negatively.

The collaborative measure outcomes used were those documented in the SAFAR framework, and all outcomes reported challenges. The outcome showing the most challenges was the *perceived measure of collaboration*, however, and all other outcome measures showed challenges in either one or two of the conceptual level groups.

Looking across the groups that were used to assess the differentiating themes and outcome measures, the themes showing the most challenges were *project justification, project streams, intellectual property ownership* and *ethics*, showing the difference in three of the grouping variables. *Funder priorities, timescale uniformity, completion goal, scientific method,* and *career aspirations* reported challenges in two of the grouping variables, and *asset distinction, collegiality* and *career focus* reported challenges in one of the grouping variables.

A summary of the challenges reported against grouping variables and outcome measures is shown in Table 4.15., ranked in order of reported importance, and in order to present key areas for discussion.

Table 4.15. Themes measured against grouping variables and collaborative outcomes ranked in order of importance.

Theme measures in the quantitative study		**Grouping variables in the quantitative study**						
Theme	**Sub-theme**	**Difference in sectors**	**Difference between team leaders and team members**	**Difference over and under $100K**	**Difference under and over 1 year long**	**Difference under and over 10 years involvement**	**Difference between project phases**	**Difference between project constraints**
1. Career	a. Career focus		X					
	b. Career aspiration		X		X			
	c. Subject matter experts							
2. Funding	d. Funder priorities	X						X
	e. Asset distinction	X						
3. Collaboration	New theme							
4. Project management methodology	New theme							
5. Project Ownership	f. Project justification	X				X		X
	g. Project streams	X	X	X				
	h. Governance							
6. Completion	i. Timescale uniformity			X				X
	j. Completion goal	X						X
7. Teamwork	k. Team collaboration/process							
	l. Collegiality	X						

8. Intellectual property ownership	m. Ownership of the projects Intellectual property			X		X		X
9. Communication	New theme							
10. Leadership	n. Leadership							
11. Scientific endeavour	o. Scientific Review	X	X					
12. Internationalism	New theme							
13. Ethics	p. Project working ethics		X		X	X		
14. Project mishaps	New theme							
Collaborative outcomes in the quantitative study								
1. Perceived measure of collaboration			X	X		X		
2. Perceived measure of future of research streams		X	X					
3. Perceived measure of ongoing relationships			X			X		
4. Perceived measure of working relationships			X			X		
5. Perceived measure of measure of network density			X			X		
6. Perceived measure of increase in power relationships		X						
7. Perceived measure of broadening of views			X					
8. Perceived measure of measure of effectiveness			X					

4.8. Chapter summary

The results show a complicated collaborative endeavour with multiple themes that need to be taken into consideration, many of which show challenges both within and surrounding the project environment. Each differentiating theme also displays a contributory effect on the outcomes of the collaboration, with different degrees of challenge measured dependent on the conceptual and project level measures. These key findings, outlined in Table 4.15, form the basis of the discussion in the next chapter.

CHAPTER FIVE

DISCUSSION

5.1. Introduction

The primary goal of this study was to identify themes that affect the UIG collaborative project environment, and to evaluate their impact both across the length of the project and within the project using the traditional project phases and constraints model. A data collection model was used to ensure the perspectives of the sectors, participants and project specific variables were considered across a range of projects. The research was underpinned with collaboration theory to develop an understanding of the collaborative lifecycle. The perceived success of the collaboration was also assessed using the eight outcome measures of:

- Perceived measure of collaboration
- Perceived measure of future of research streams
- Perceived measure of ongoing relationships
- Perceived measure of working relationships
- Perceived measure of measure of network density
- Perceived measure of power relationships
- Perceived measure of broadening of views
- Perceived measure of effectiveness

This chapter discusses the results and key findings from chapter **four** and explores them from the view of the current project and collaboration knowledge, and also as unique attributes to the collaborative UIG project. Differentiating themes are discussed first, including the themes identified through both qualitative and quantitative analyses. These themes are then integrated with the introduction of an extended framework. Following this, the discussion introduces the view of the themes from the perspective of the study design, showing where they impact the framework. Finally, the discussion evaluates the level of integration across the project using the SAFAR framework as its measures and finally looks at the themes against the outcome measures.

5.2. The relative importance of themes

In chapter **two**, the literature review focused on topics within the UIG collaboration that were identified as either controversial or crucial for success. The topics found were amalgamated into main themes, and into subthemes where they related to the main theme. All themes were then presented in a framework to provide an overview of the effect of each theme and subtheme by sector. The quantitative results of this study confirmed the importance of each of the original framework themes, showing that all themes measured as having a significant effect on the project.

The results showed a similar level of importance in most cases for themes and subthemes in both the qualitative and quantitative results, providing some triangulation to the study, the results of which are shown in Table 4.13. which summarises the results. The three most important main themes were *career*, *project ownership* and *team collaboration. Career* also includes the subthemes of *career focus, career aspirations,* and *subject matter expertise*. Only the theme of *funding* weighed differently across the survey and questionnaire measures: it did not measure as highly important in the quantitative results but was discussed as being highly important through the interview process.

A difference between the measures for the *funding* theme could be accounted for by the premise of the measure. In addition, the survey participants were asked to focus on either a recently completed or current project rather than the external environment, and as such did not include the funding process. When *funding* was discussed in the interviews, it was found to have a significant effect across all sectors, and it was seen as a significant constraint in the development of a project. There were also several themes that were reported as being significant in the quantitative results which were discussed as having less impact within the qualitative results. These were *ethics, collegiality, project justification, outcome goal* and *intellectual property.*

The original framework themes (excluding the new themes identified through the qualitative study) were ranked by the importance of their effect on the collaboration and its outcome. If we look only at the main themes, the six highest rankings themes were: *project ownership, completion, career, funding, scientific endeavour* and *intellectual property.* However, if we take the themes individually without main themes and subthemes, the view changes and shows that several of the subthemes were ranked individually as more important than some of these main themes. Expressly, *subject matter expertise, timescale uniformity,* and *asset distinction* were all ranked higher than *scientific endeavour*. This is an important finding for discussions on the impact of the themes within the wider framework. It is addressed by ranking the main themes in order, together with their associated subthemes, to simplify the framework's complexity.

To contextualise these three subthemes, *subject matter expert* ranked as more important than eight of the main themes, showing its importance to the framework. Moreover, *timescale uniformity, contract management* and *asset distinction* each ranked higher than seven of the main themes, which is again significant when we look at where our efforts should be focused within the framework.

5.3. Specific attributes of UIG collaborations

The results in chapter **four** presented the themes individually from both the qualitative and quantitative results and reviewed the findings. The following discussion presents the impact of each of these themes on UIG development and practice. The original themes found through the literature review are discussed first within their groupings of main theme and subtheme together under Section 5.3.1. New themes are then discussed individually in Section 5.3.2. and are noted as either main themes or subthemes.

5.3.1. Original themes

5.3.1.1. Career

Description: Career path of an individual which aligns to the sector in which they work: university to teach and research within a topic area; industry to develop within a wider business area possibly within research but not teaching; and government where careers tend to be not standardised.

As shown in Section 4.5.1. *career focus* was the main topic of discussion in the study, and while the choice of the sector may be different, *career* in each case shared certain similarities. In each case, research required *subject matter experts* (Calderhead, 2002), using *scientific methodologies* (Boronico, 2011), with outputs of *intellectual property* (Kirkland, 2010). These similarities are the central premise of the Triple Helix model proffered by Etzkowitz and Leydesdorff, (1995), and this study found them to be the main drivers for collaborative work.

The themes involved in a UIG collaboration have been investigated in several studies (Ankrah et al, 2015; Bruneel et al, 2010; Eom et al, 2010; Garousi et al, 2016; Perkman et al, 2013; Primas, 2012; Ramli, 2015; Ramos et al, 2011; Rybnicek et al, 2018; Sugandhavanija et al, 2011; Wilson, 2012), including this one, but the importance of an individual's *career focus* and therefore career choice has been explored mainly through their incompatibility. The most noted difference has been the academic's ability to lead their research direction, producing a fundamentally different set of drivers and measures compared to those of both industry and government. The differences of an individual's *career* focus constitute a significant impact on the formation of cross-sector collaboration but were not the focus of this study. *Career focus* as a precursor to collaboration needs both acknowledgement and further research.

As well as the overall weight given to *career focus*, team members saw the theme as more important than key informants in all sectors, which was conceivably due to the different stage of their career which is still being established. *Career focus* showed as their most important theme and again, as a strong driver of team members' actions. The only theme that showed a wider gap between team members and team leaders was *project ethics,* which reflects the importance of ethics within the projects that provide current success for team members and their career. *Career aspirations* changed as staff became more senior and developed more credibility, regardless of changes between roles and regardless of sector; however, the *career focus* did not change.

As previously noted, *subject matter experts* are equally important in all sectors, and this scarce resource was the primary driver for inter-sector collaborations, with the sharing of this limited resource being the main focus of models such as the Triple

Helix (Calderhead, 2002; Lavin et al, 2007). While being recognised as a primary driver, the specific need for university *subject matter experts* was to add their research credentials to the findings, which is an inherent part of their role. However, it was found that university experts were only sought if the expert knowledge could not be found within the initiating sector, and if scientific credentials and *scientific research* were needed to validate results. The difficulty of finding the right individual and the scarcity of resources where novel approaches and innovation are needed is a fact that is understood in project settings generally and not specific to this project type, which gives more weight to the *career focus* of the individual.

5.3.1.2. Funding

Description: The funding model describes where capital is gained, either through internal funding or external grants.

As mentioned above, *funding* was the only theme that was not significant in both samples, measuring low in importance across the survey but highly relevant through the interview process. The survey focused on current projects and, as the results showed, cost was mainly essential concerning *funder priorities* for the project, whereas gaining *funding* was the focus for interview participants. When *funding* was discussed in the interviews, it was found to have a significant effect across all sectors and as a major barrier to the initiation of a project.

Research projects progress business goals, and the process of gaining *funding* through the business strategic planning process means that the business owns the *intellectual property*. A university researcher is likely to fulfil their own research goals, and this requires external *funding:* while they may own the *intellectual property*, the *funding* pool is contestable, and ultimately *funding* may not be available, especially when contestable *funding* means meeting the requirements of the fund holder.

The differences between sectors for the availability of *funding* was of most importance to industry and government, which saw their *funding* as being more set and restrictive, primarily through their inability to spend time filling in lengthy *funding* applications, which are seen as a part of the university researcher's role. Whether applying for *funding* was intrinsic in the role of the researcher or not, the difficulty in gaining it gives way to novel approaches, such as crowdsourcing.

Therefore, at the beginning of a collaboration, the focus is on obtaining *funding*, and much of the time is spent on developing lengthy and costly applications which have a low rate of return. This research reported *funding* as the most essential theme in the conception phase; however, a report entitled *Collaboration between Universities and Industry* (Deloitte Consulting, 2018) noted that there is "no specific grant that is linked to UIC" (p.7) in New Zealand or Australia. Therefore, in a similar manner to the first theme, *funding* as a precursor to collaboration needs both acknowledgement and further research. *Funding* was seen as a significant constraint to initiating research, once the research was underway, participants saw *funding* as the least important of the four constraints. This is where the dichotomous results are found. A loss of *funding* was the main issue at the project level, but this only served to slow project work down, not to stop it. This suggests that, once research is underway, funders are more likely to fund further research, which also reflects the benefit of a stream of research to show ongoing importance to a funder (Kohrman, 2008). Given that considerable effort is needed to develop streams of research, this is not a well-known route outside of universities.

5.3.1.3. Project ownership

Description: The owner is the initiator of the project and is often the funder, although project owners are also able to gain external funding to run their projects and still keep ownership.

The project funder is usually the project owner, which entails owning the *outcome* and *intellectual property.* Knowing that the perspectives and outcome expectations of the three sectors differ, the project owner needs to ensure that they meet the requirement of all parties to produce a successful collaboration. Multiple parties create the need for more than one *outcome* requirement: the university researcher usually requires an academic paper for instance, and - while the research found that all parties understood this requirement - the process was seen as an academic exercise without adding much value to the output. Researchers in industry and government sectors produce academic papers as part of their ongoing influence, but generally, do not get time to write during working hours. For younger and less experienced researchers, their ability to contribute and influence from their work is highly important and needs to be taken into account when developing research output needs. Future research *justification* also becomes easier with a reputation which is earned through longevity in the research or business space (Hughes, 2008) and is a primary reason to collaborate.

The research found that *streams* of research in all sectors presented advantages, including better *collegiality* as collaborators continue to work together in projects that link and create heritage relationships. The main difference is ownership of the streams: in university, this can be dictated by a single researcher; in industry and government strategic needs often do not provide continuous streams of research. However, with newer requirements on universities to provide more accountability for their research outcomes, the streams are being driven towards a more commercialised model, using similar models of measurement to industry. This has also seen streams of research with ongoing deliverables and a more agile approach. Building research relationships between sectors in the form of research expertise, research infrastructure, and expertise in product development and commercialisation did show advantages in this study and have been noted in previous studies (Sherwood et al., 2004).

5.3.1.4. Completion

Description: Completion of a collaboration is described as the achievement of all deliverables for all collaboration members.

As noted in *project ownership*, *completion* was reported as incongruent between sectors and as a constraint within the project, driven in part by career choice, but also by performance measures in the form of PBRF for university, policy influence for government, and profit for industry. The tensions this incongruence brings have been noted previously, and the results reflect the perception of other researchers such as Ankrah et al, (2015), Bruneel et al, (2010), Chin, (2011), Freitas et al, (2013), Kato, et al (2012), Rybnicek et al (2018), and Wilson, (2012). The disparity reported in this study showed an inability to provide work plans that can be adhered to, or which are unrealistic or lacking in sufficient detail. Unfortunately, industry partners, in particular, quickly lose confidence in these multi-party projects (Barnes, 2002). This study found the main control mechanisms were reported through complex contractual obligations, with less regard to developing processes for detailed planning and expectations management.

Unrealistic work plans with insufficient detail are not merely a collaboration issue: project work is notoriously fraught with unrealistic plans that lack sufficient detail to implement, especially when working with outsourced teams, and with globalisation adding another dimension to the issues. This long-standing problem in project work has given rise to many methodological approaches (Maros & Denyer, 2012) to counteract the issues. In a collaborative environment, disjointed planning exacerbates the situation, especially when collaborators such as those within the UIG come from sectors with vastly differing cultures (Jordan et al., 2005; Kirkland, 2010), where the emphasis on contractual obligations have been progressed ahead of the expectations for each party's *outcome* or *completion goal* requirements.

The lack of expectation management was not a specific topic for discussion in the study, but it was implied in many conversations. Expectations management is a large part of project work and becomes more critical within collaborations with multiple stakeholder styles. The study showed that expectations grew with more substantial projects for both *completion goals* and the adherence to agreed *timescales*. A lack of expectations management has been the cause of many project failures and has formally been recognised as an area of development within the project management field. The topic was introduced as a separate area of knowledge management within the project management profession in version 5 of the PMBOK (2016), showing the need for closer stakeholder expectation management throughout the lifespan of the project.

There are two separate issues to be addressed: the inclusion of expectation management; and controls to ensure adherence to plans. With stringent contract controls reported at the beginning of UIG projects, this calls for the inclusion of expectations management as part of these control mechanisms. Insufficient planning and non-adherence to planning, however, cannot be counteracted purely in the documentation, and this makes the justification for a project manager more significant in larger projects.

5.3.1.5. Teamwork

Description: Teamwork is the working together of all members of the collaboration as a cohesive unit.

Teamwork is an important theme in any project, and in the case of UIG collaborations *teamwork* measured equally important across all areas of the data collection model. However, due to the notable differences in the way teams participate outside of the project environment, *collaboration* and *collegiality* measured quite differently and reflected the same levels of disparity noted in *career focus*. The main difference was within the tenure of the teams and is driven both by *career focus* and by job performance criteria. Academics join or form research streams primarily with other academics in their research area, creating a specialised research community with common interests, and these *team collaborations* were viewed as a form of closed system by the other sectors, with properties of *collegiality* that overlook interactions with outside influences. The academic researcher style of work is framed to develop cooperation, open communication, intellectual rigor, and a persistence style that is traditional to the mentoring systems within universities and produces specialist *collegiality*. This style of ongoing development has been noted in the literature, mainly regarding the rapidity with which teams can work cohesively with familiar associates (Barbolla & Corredera, 2009). In addition, this style of work aids academic researchers to fulfil their primary performance criteria of research publications (Kyvik, 2012), a relatively unimportant goal for industry and government unless there is a need to provide *influencing* material with an innovation. Horowitz (2017) has noted, in this regard, that industry and government have a right to publish, whereas academics have an obligation to publish. Ongoing *collegiality* also resolves some of the planning issues noted in Section 5.3.1.4. where prior knowledge of requirements both within and on *completion* of the project means less effort needed in the planning phases. Such heritage relationships were noted in the literature review as being an advantage for success, but this advantage has also been reported as a disadvantage in the literature, specifically in collaborative *teamwork*. The current study produced similar results, with team members within collaborations in several cases reported as reverting to the siloed mentality of a closed system, and as disabling the collaborative process.

The current research also noted the bias towards ongoing relationships and the development of long-term collaborations, specifically within the academic field, where there is a culture of ongoing research within fields enabling research teams to envelop new members and create long-term and often lifelong collaborations. Collegial teams are also present in industry and government within specialist areas but, without the primary goal of publication, *outcome* and *completion goal* deliverable barriers continue to exist between sectors as is shown in Section 5.3.1.4. This finding further confirms the need for collaborative team development across borders. Models such as the Triple Helix, which indicate a need to disseminate scarce specialist resources and include greater diversity in teams, take the researchers out of their chosen path, and this study found that while the understanding of cross-sector collaborations is being progressed, the mechanisms to produce them are still in their infancy.

5.3.1.6. Intellectual property

Description: Intellectual property refers to both information brought into the collaboration by the collaborators and collaboration outputs.

Intellectual property is seen as one of the main influencing tools both for both making a difference within the subject, and for ongoing profitability of an organisation. The imperative to produce *intellectual property* in order to provide *influence* is a primary reason for undertaking research, and it is also a main research *outcome*. As such, *intellectual property* ownership was seen as an important theme in the study. In larger projects *intellectual property* presented similar issues to *project ownership* and *teamwork.* Larger projects are by their nature more complex, with multiple researchers or teams who have differing needs regarding *intellectual property*, such as the rights to publish information and conversely the rights to guard information, and these differing needs make *intellectual property* negotiations complex. For these reasons, negotiation of larger contracts of this type are often the work of specialist *intellectual property* lawyers. In both this study and the literature, the negotiation process has been known have a direct effect on *intellectual property,* both by delaying research projects (Grant et al., 2015) when parties cannot agree, and by stopping their initiation when there is a negotiation impasse on *scientific process*, *ownership* or *outcomes*. Given that negotiation involves several parties and differing goals, this area needs more attention.

Interview participants in this study also noted a disconnect in the diversity of *outcome* and *collaboration:* commercial *outcomes* take place primarily in industry, often in the form of incremental innovations; while academic researcher-led investigations take place primarily in universities and often lead to published literature. Without a change in the primary drivers, change will continue to be impeded. A major primary concern in developing collaborative work was also discussed, pointing out the inherent danger for collaborations to be stopped if there is a loss of funding or a change in corporate direction, or if a key researcher leaves, which is a part of collaborative work that is out of the control of many participants. Heritage relationships go some way to counteracting this problem, as do research groups that include industry partners. While researchers may change companies, the relationships and the research groups continue. Failed collaborations were not a focus of this study, but interviewees reported projects as far as 80% complete that were stopped and not revisited due to ongoing commitments which impinged on their ability to produce *intellectual property*, and a risk not seen as worth taking, with their main goal being *ownership* to counteract this issue. It needs to be noted that, while the study did not focus on incomplete projects, the commitment to complete research is an important barrier to collaboration.

5.3.1.7. Leadership

Description: Leadership is the collaboration leader, which may be one or more individuals depending on both the remit and requirements of the project.

The need for strong, focused *leadership* was a theme that was of equal importance across sectors and staffing levels. A secondary and possibly more interesting point related to trust however. Although all sectors and staffing levels saw the need for leadership as equally important, an inherent lack of trust between parties led to the inclusion of leaders from each of the collaborative parties, thus adding to the costs of the research, (Curlee, 2011; Drucker & Juli 2010; Toth et al, 2012). These studies also cited location of the leader as a factor that enabled ease of leadership duties and team deliverables.

Trust amongst partners was also noted by Barnet et al (2002), together with the importance of collaborative experience, commitment, continuity of personnel and corporate stability as important factors developed through the leadership. In this study, only the industry sector did not see any unity in leadership developing across the project, both government and university did which possibly relates to their level of trust within the other sectors.

The study was not designed to develop this topic, but the inclusion of a single leader accepted by all parties warrants further research. As the study by Anantatmula (2010) noted, the project leadership role defines project processes and roles and set up both the management and leadership of the project. Leadership lays the foundation to create clarity, communication, consistent, and an ultimately successful project. The leadership role establishes trust, opens communications for knowledge sharing and enables team development.

5.3.1.8. Scientific endeavour

Description: Scientific endeavour is the scientific rigour applied to the project that provides the process to be peer-reviewed, replicated if necessary, and which makes it an accepted credible piece of research.

The credibility of research is progressed through the *scientific endeavour* of these projects, mainly through the use of *scientific methodologies* that provide robustness to the work. The primary function of this credibility is the need for peer review, and it is shown in this research to be the main basis on which UIG's collaborations are formed (Boronico, 2011). *Scientific review* has always been reported as the primary project method, reducing the need for formal monitoring and controlling as it serves this purpose and enables repeatable results. However, it does not override the need for monitoring and controlling the work outside of the science in the form of both management controls and communications. These and other themes were discussed as important aspects of a more comprehensive project methodology, and as a separate task to the science aspects of a project.

In the university sector, research involves a systematic enquiry leading to the construction of new knowledge, following particular guidelines and procedures to ensure the quality of research results. This systematic scientific enquiry is an embedded part of the work, and its inherent credentials are one of the main reasons other sectors choose to collaborate (Lavin et al, 2007). This study further corroborated these findings and found that scientific research is accepted widely as an integral part of such projects. However, the use of broader project management approaches was mixed, with organisations that would not work without the use of a project management approach, and others where the project leader decided as to their need. As several of the theme results show more of an impact on larger projects where traditional project management approaches are used, there is a need for further research into this area.

5.3.1.9. Ethics requirements

Description: Scientific endeavour is the scientific rigour applied to the project that provides the process to be peer-reviewed, replicated if necessary, and which results in an accepted credible piece of research.

With the normalisation of the scientific process for credibility, e*thics* have also become a widely accepted need rather than something of concern (Bowen, 2007; Hoet, 2004), and they appear to be well understood by all study participants. There have always been issues around the time it takes to acquire ethical approvals and this research corroborated that concern. The only difference shown across the study is the impact the ethical process had on team members, who saw this as being highly important in the work they were doing, mainly due to the amount of paperwork that ensued with the process of attaining ethical approval. The speed at which ethical approval can be obtained creates concern with shorter projects, which have less time available to go through lengthy processes (Kirkland, 2010). However, fast track ethical processes for research for projects that have less of an impact on their participants have also been introduced. Apart from timing, this research found *ethics* to be an area that all sectors and participants found equally important.

The themes discussed here represent the original themes from the literature; these are now added to by new themes found from the qualitative research.

5.3.2. New Themes

The new codes are discussed from the view of their perceived importance by the participants in the qualitative research. Following this section, the themes are combined to look at their integrated effect.

It is important to note at this stage that, while the new themes were not found through the extant UIG collaboration literature, they are not unknown in other realms of project work. As such, the new themes that have been developed can be integrated into a more comprehensive framework of understanding for the field. The ten newly developed codes in the study have been assigned to five new main themes of:

1. *collaboration* (of stakeholders)

2. project management methodology (process from project inception to completion)

3. communication (between stakeholders)

4. internationalism (guidelines applicable to collaborations between countries)

5. project mishaps (problems within collaborations, traditionally termed project risk)

and five new sub-themes of:

1. trust (under the main theme of *Collaboration*, and discussed as being between stakeholders)

2. contract management (under the main theme of *Project management methodology*, and discussed as managing contract procedures between stakeholders)

3. task segregation (under the main theme of *Project management methodology*, and discussed as separation of tasks by specialism)

4. profitability (under the main theme of *Project ownership*, and discussed as all forms of profitable output from the collaboration)

5. influencing (under the main theme of *Intellectual property*, and discussed as developed through knowledge creation)

The categorisation organises their area of influence within UIG collaborations and helps to provide a complete framework for discussion.

5.3.2.1. Collaboration (added as a main theme)

Description: Collaboration is the relationship entered into by two or more organisations or individuals to achieve a common goal.

In this research, collaboration theory is used to underpin the work. However, *collaboration* was discussed extensively and as a major influencer of the UIG, as a precursor, as an ongoing necessity and as an outcome measure. The importance of this theme was shown through the amount of discussion on this topic, being third behind *career* and *funding*.

Collaboration was essential to all participants. However, few respondents saw the development of collaborative networks as a part of their job description, a point that was also noted by Perkman et al. (2013). The call for *collaboration* is marked as important but does not appear as part of either general business planning or as a performance criterion for businesses or individuals. Some accepted practices for *collaboration* were discussed for seeking partners after the initial research idea was formed, primarily when there was a need for *subject matter experts* rather than to develop research ideas. The only widespread process for creating collaborative networks was through subject-specific conferences, which were seen to be a part of training and development costs, and contestable in all organisations. However, this practice is much more accepted in the university sector. As shown in Section 4.5.7.1, previous collaborative relationships heading to *collegiality* appear to produce better results, showing that longevity becomes paramount. Forming teams that capitalise on these pre-existing heritage relationships increases the chance of success as noted in Section 4.5.7.2. However, *collaboration* was seen as future gains, and was hard to measure against the ideology of the business sector's short-term views.

Very limited strategies or methods for *collaboration* were identified: the one organisation that acknowledged a strategy for *collaboration* has made the process into a business venture with a specific department mapping current collaborative endeavours to enable future *collaboration*. In this way, it has taken the scientists away from the relationship, and is manufacturing the partnership using market development. The study revealed a lack of understanding both of how to develop *collaborations, and* of the amount of effort needed for ongoing collaboration. This shows an area that warrants future research.

5.3.2.2. Trust (added as a subtheme of collaboration)

Description: Trust is a part of collaboration that gives the team confidence to work together.

Trust was discussed as an explicit need for *collaboration* to succeed by the interview participants, as was also noted by Martin-Rodriguez et al. (2005), and as such, becomes a subtheme of *collaboration*. Indeed, in line with the findings by Gajda (2004) respondents in the current study discussed trust as developing through *collaboration*. Notably, it was distinguished as a trait that was not earned simply through having *career credentials* or being a *subject matter expert. Trust* was therefore seen more as a development born from *collaborative* endeavours in the form of repeat projects. There was also a level of intrinsic trust shown through networked contacts, where colleagues developed collaborations through extended team networks. An example of this was shown in a discussion from Industry project staff participant 2, who noted that, “we needed a specialist physician for the trial and found one that I had faith in and knew him from our community group. They wanted to use a colleague and the team grew organically”.

Trust extends wider than ongoing project development and is a precursor to collaboration. A study by Bromhan, Dinnage, and Hua (2016) of the Australian Research Council’s Discovery Programme showed that the “greater the degree of interdisciplinarity, the lower the probability of being funded,” (p684) which has an impact on collaboration development. With research showing a reduced likelihood of funding in complex collaborative projects, there needs to be a level of confidence or *trust* in the value of collaborative work before it begins.

Trust also begins during collaborative development, which takes time away from other activities and is an area with very little research attention, although there is an understanding that both the process and its measurement are problematic. A level of *trust* is needed from organisational management that collaborations are worth the time and effort they take to develop, and to allow staff the time needed to produce them. In the SAFAR model (Table 2.3.) used in this research, the first level of collaborative integration is Networking, which involves ‘identifying and creating a base of support’ as its purpose, with ‘loose or no structure’ within strategies and tasks, and ‘flexibility’ in leadership and decision making, which requires a level of *trust* that organisations need to portray to enable cross-organisational staff collaborations to develop. Correspondingly researchers need to be empowered with a level of *trust* that accepts their effort to collaborate.

5.3.2.3. Project management methodology (added as a main theme)

Description: Project management provides methodologies as well as frameworks, and tools and techniques, to provide the management, monitoring and control of project work.

The ongoing debate in the area of methodological approach has been whether the scientific approaches used in research are suitably robust methods that negate the need for *project management methodology*. However, in this study *project management methodology* was discussed as a necessary mechanism beyond *scientific research* methods to ensure projects ran smoothly. The differentiation in the theme between sectors indicate that there is a greater need for a common method from industry and government participants, as these are sectors where the use of project management staff was more prevalent (Muller, 2010). One university participant noted, “once we have collaborations that sit outside the university, we are much more likely to have a project manager”.

A *project management methodology* is usually aligned to a separate specialist role of a project manager rather than a researcher, and the discussion focused on the need for *project management methodology* on larger projects, specifically to coordinate collaborative partners and facilitate progress as a separate role, with *scientific review* providing the necessary rigour on smaller projects. Participants debated the exact size of projects that warrant both method and management, but the discussion suggests that a recommendation could be made for the need of *project management methodology* specific to project size and scope.

The decision to use specialist staff and certain methods resides with the project owner and makes this an interrelated issue. Engaging a greater number of specialist staff has the benefit of added knowledge, but their engagement also adds cost to a project and their use needs to be justified. Using research staff to provide project management to a project, however, takes them away from their primary role.

5.3.2.4. Contract management (added as a subtheme of project management)

Description: Contract management provides a legal framework negotiated at the beginning of a collaborative project and is performed by specialist staff.

Contract management is not a new theme in collaborative projects and is a set-up process used as a control mechanism and to develop project definition. This makes it a subtheme of *project management*, and, in the case of research projects as in many other collaborations, it is a task performed by specialised staff (Kirkland, 2010). In industry and government sectors, it is less common for researchers to be involved in contract negotiations as they do not own the project or its *intellectual property*, whereas university researchers are more likely to have input into contract development both for their workload and for *intellectual property* rights. The research found that although *contract management* is a prescribed format for collaborative start-ups, many contracts were formed after a collaboration began, with the relationship being seen as more important than the contract. The topic of contract processes also relates to other themes, with discussions citing the negotiation of the *method, intellectual property* and *completion goals* as areas that caused issues within their development. Contract management was not a specific topic of this research, but it was apparent that this topic needs further attention in regard to UIG collaborations.

5.3.2.5. Task segregation (added as a subtheme of project management methodology)

Description: Task segregation looks at the multitude of personnel roles being employed within collaborations.

When specialist teams are brought together, tasks are allocated to individuals with the necessary skills, and *task segregation* was discussed in many areas. Task segregation was more prevalent in larger projects, with the themes of *project management, contract management,* and *leadership* being examples where roles are specific. Specific roles also bring a level of specialisation and raised issues where lead staff were seen to be removed from key processes within the project, leading to a lack of understanding and cohesion across the project. Individual organisations had gone as far as having a department specifically tasked with developing collaborative relationships for future gains (Thompson et al., 2006), but these were found to be less common.

5.3.2.6. Communication (added as a main theme)

Description: Communication is an enabler to collaboration and allows for productive successful exchange.

Communication was not discussed extensively but is still a necessary part of any collaboration and therefore needs consideration. It was seen as especially important when team-members collaborate remotely. Methods of *communication* varied, with face-to-face with colocation of collaborators being preferred, especially in the initial stages of innovation where project work requires a more agile approach, which is a known contributor in innovative project work. There were cases where collaborators within projects had never met and worked entirely from contractual agreements, and in one particular case, this was standard practice with a negotiating team supplying *communication* between the client and the specialists. Possibly of most interest was discussion around individual *communication.* Where certain styles meant that individuals were either perceived as competent or not competent in collaborations.

5.3.2.7. Internationalism (added as a main theme)

Description: Internationalism explains the cultural and regulatory differences in the global economies in which collaborations progress.

Collaborations can cross country boundaries, requiring an understanding of international rules, regulations and cultural styles, and while the findings were not extensive, *internationalisation* is a differentiating theme that should be taken into account for UIG collaborations. The literature suggests that international research collaborations produce an increase in research quality through the ability to access and share knowledge, techniques and skills, and gain access to foreign facilities and equipment, creating broader networks (Lasthiotakis et al., 2013). Many studies also cite specific benefits from international collaborations (Hauge, Pinheiro, & Zyzak, 2016; Ito, Kaneta, & Sundstrom, 2016; Moreira, Pelissari, Parr, Wohrmeyer, & Pandolfelli, 2015; Muller, Sporri, Kroll, & Horterer, 2017).

Although UIG does not have to involve cross-border collaboration and can be cross-sector collaborations in a specific country, *internationalism* is noted for extending the initial reasons to collaborate: access to knowledge, skills and networks. It would therefore be a reasonable expectation to find international projects in this project type.

This study considered only the New Zealand and Australian landscape and looking at each country's research funding from overseas sources helps to explain the lack of discussion on international collaborations. The OECD average GDP spend on research and development is 2.38%, with both New Zealand and Australia being considerably below this figure, with 1.37% of GDP in New Zealand and 1.88% of GDP in Australia according to 2018 government statistics (Stats, NZ 2018., Stats, Aus 2018). Within these figures the overseas funding is a small proportion, with 16% of total research and development income in New Zealand, and 3.4% for Australia. Given the current levels of international collaborations in both countries, the discussions surrounding the topic were not extensive, but where conversations developed the issue has been considered, including discussion around global collaborative nations that were ahead of both New Zealand and Australia, such as Israel, a country with few natural resources, spending 4.25% of GDP on research and development.

The main concern for international collaborations was a lack of globally set rules for such engagement, especially around competing measures for researchers, such as the primary university researcher's measure in New Zealand, the PBRF system. This system accounts for research but brings in a further level of complexity in contract negotiations when accounting for collaborations (PBRF manual, 2016). An industry survey participant also noted that the Humboldt structure that New Zealand universities are based on does not provide a good reputation of collaboration. Additional to global research measures, competition for *funding* and *intellectual property rights,* and culture, were seen as differentiators that impeded international collaboration development. Similar cultures were seen as easier to collaborate with such as connections between New Zealand and Australia, and the UK, and other European countries such as Belgium and the Netherlands, whereas connections with different cultures were viewed less as collaborative partners and more as requests for service. The USA was specifically referred to as "soaking up knowledge and not sending it back" (University key informant 1). Those that had worked internationally also noted that their portion of research in collaborations was usually smaller than other parties to the collaboration and discussed this as almost tokenism on the part of the *owners*, often with no budget or time allocations to pursue the research from either the originator or their own managers.

5.3.2.8. Project mishaps (added as a main theme)

Description: Project mishaps are unexpected issues that occur within the collaboration.

Project mishap discussions reflected the inherent risk in all project work including both unforeseen events and what can potentially go wrong. The premise of most project work is that it is inherently risky; however, few unexpected mishaps were discussed within the UIG style. Those that were discussed related to what could be deemed traditional areas of risk within a project, which were personnel, cost and technical details. UIG projects tend to be of a developmental nature, and the *project mishaps* that were encountered in most cases, were overcome due to the necessity of continuity with specialist organisations and *subject matter experts* who continue to be in short supply.

Where *project mishaps* were reported, differentiators were apparent. There was a noted difference in stability between the three sectors which is seen in other themes such as *collegiality*, "industry staff are more likely to change, and projects run off the rails when an industry leader takes another role" (Industry key informant 1). The same key informant noted that issues also happened when "the industry we are working with goes broke or gets taken over by another company". Both the short supply of *subject matter experts* and the allocation of experts who proved incompatible with either the team or their work were also reported as causing issues. Overloaded specialists were cited as struggling to prioritise timing and causing project delays which were specifically reported as a difference between the sectors, with Industry key informant 3 noting:

> Timescales are the first difference that I saw when working with Universities, academics just don't have the urgency. It gets picked up relatively quickly with missed milestones and academics focusing on something else and it only takes one event like this for a corporate to stop working with the academics.
>
> (Industry key informant 3)

This opinion was also reflected within the theme of *timescale uniformity* and as a symptom recognised as a lack of project management. Poor staffing choices were also discussed and resulted in either project delays or in the worst-case scenario projects being closed, and ultimately reduced the *trust* between collaborators.

5.3.2.9. Profitability (added as a subtheme of project ownership)

Description: Profitability described the gains made in both monetary and intellectual property from the collaboration.

Profitability as a subject was discussed in relation to the ownership of the profits from the project delivery in whatever form profit is measured, which was seen as both monetary gain and intellectual gain. The disconnect in ownership between sectors was apparent in the discussions on *profitability* (Alexander, 2010) in the same context as *intellectual property* and *outcome goals*. University researchers focus on *intellectual property* gains primarily to answer questions or fill gaps in knowledge, and, while there are intellectual gains for all sectors, both industry and government include the need for profitability to be a part of the justification in the initial research proposal as well as an output. There has been far less emphasis on traditional profit models with university research. With the inclusion of several parties and individual researchers, the *profitability* of a project needs to satisfy all requirements, specifically on larger projects where the discussion around how *profitability* is attributed continues to be an issue.

5.3.2.10. Influencing (added as a subtheme of intellectual property)

Description: Influencing is described as both influence between collaborative partners and using the outcomes of the collaboration to produce influence.

Influencing is both a property and an outcome of the project and is created from the *intellectual property* of the project which is primarily gained through project *ownership*. *Influencing, intellectual property* and *profitability* are also subthemes of *ownership* in this study. There are instances where these themes and subthemes are not a part of the project owners' sphere of activity, specifically where the government sector requests collaborative project development (Harman, 2010), and as such the themes were separated regardless of the similarity of their effect.

The discussion on influencing took both a micro- and a macro- view. The micro-view of *influencing* involved individual UIG projects having outcomes that have an effect in their subject area. This view related directly to the theme of *ownership*, with the owner having influential ability over the project *outcomes*. There were also *influencing* discussions on the macro-level centred around the need for sectors to develop greater influence between each other, primarily with a view that the university sector should provide more influence to both industry and government, by becoming more prominent in order to gain industry funding. Illustrating that this was a point understood by university staff, as Industry key informant 1 said, "Influencing ... needs to be done more by universities. Key researchers are prominent on committees, IPC panels, and as lead authors." While it might be acknowledged as an issue, it is not a gap that is being bridged, as we can see from the discussions around the amount of collaborative activity reported between sectors. Government policy is aimed at promoting such activity but strategy in both university and industry sectors is still in its infancy within the study participants. There was only one participant organisation with a clear strategy in place, which belonged to the government sector. Government key informant 3 indicated that, "we are currently scoping our partners to look at how we can collaborate better with them. We have a full mapping exercise going on at the moment, starting with some of our smaller customers…" They also noted how long it can take to promote their *influence* on another business, explaining, "We've spent 10 years gaining trust of our largest collaboration…, and we're only just reaping the benefits. We can go into a discussion in an open manner, and they no longer have a them and us suspicion."

5.3.3. Individual Theme Conclusion

This section presented each theme individually, with both main and subthemes developed to look at their specific attributes and how each of the theme's characteristics affect the UIG collaboration. While the effect of the individual themes may differ in intensity, themes do not exert pressure individually, nor is their sphere of influence the same: some themes specifically affect only parts of the collaboration such as contract management, scientific endeavour and ethics which are directly related to the project processes: while others are more pervasive, covering all areas of development such as collaboration, communication and research streams. Combining both existing and new themes, we can now extend the original thematic map to get a fuller picture, as shown in Figure 5.1. Several of the themes produce more significant challenges to specific sectors, participants and project elements within the reported results, and the following Section 5.5. explores these issues further.

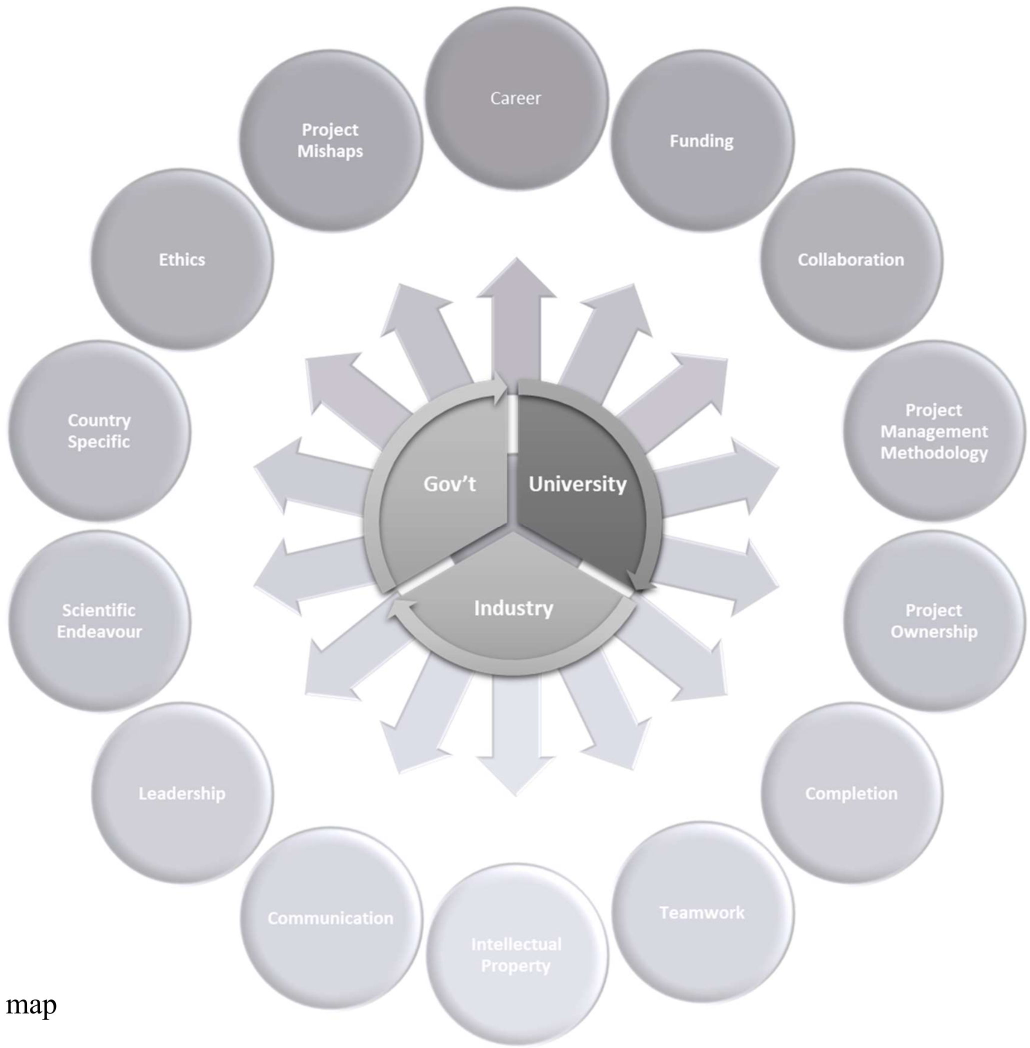

Figure 5.1. Extended thematic map

CHAPTER SIX

DISCUSSION OF THE FRAMEWORK COMPLEXITY

6.1. Introduction

Chapter **five** discussed each of the themes individually and then by their effect on the sector, participant and project, following the data collection model. This chapter looks at both the development of *collaboration* across projects and the perceived collaborative outcomes, and also discusses the framework, looking at project contributor, project influencer and project level as three levels of complexity which form a complete framework of themes that need to be considered in UIG endeavours. The chapter then looks at the primary challenges within the framework which can be considered as the primary focus areas for management to facilitate future UIG collaborations.

The framework developed from the discussion illustrates the complexity involved within the UIG collaboration project type, and the extent and level at which each of the themes impacts the collaboration. Influence on the UIG collaboration starts at a fundamental level. where the themes contribute to the nature of the actual project work, incorporating phase and constraint issues. Only one previous study was found (Plewa at al., 2013) that measured *trust* and *communication* across phases. The theme impact at the level of project influencers shows a more direct relationship to the work at the conceptual level of sector and participants. As noted by Rybnicek and Konigsgruber (2018), it is advisable, for successful UIGs, to study the environment in which the collaboration is to take place. Where participants are on their career journey, either early as team members or more developed as team leaders or key informants, influences their perception of theme influence. The same was found for sectors, where the perception of theme influence depended on the sector to which participants belong.

At the next level, themes influence how the *collaboration* and *project streams* are built, all of which impact the outcomes. The precursors to this work in the form of the study influencers and contributors have few solutions that address the inherent disparity between participants and sectors and are shown to be ongoing challenges. This study shows that, while there are challenges within the themes, the perceptions at concept level between team members and key informants, and more importantly, between sectors, can preclude the concept of *collaboration* itself.

Control mechanisms are being put in place to provide clear expectations and roles from the beginning of the project work (Barnes et al., 2002; Franco and Hasse, 2015), especially around ownership (Barnes et al., 2002; Bruneel et al., 2010). Concrete agreements and contractual safeguards provide support in this regard (Hemmert et al., 2014), many of which are placed at the practical end of the continuum. However, there are few mechanisms in place to facilitate cross-sector development.

At this stage, it is important to reflect on the purpose of the framework, which is not to produce a prescriptive piece of work. The framework is used as a supporting structure that incorporates the ideas, information and principles in the form of organised components as a reference to the UIG collaboration. It is the beginning of a tool kit from which participants can be prompted at certain junctions for requirements that need consideration, and in which case, not all parts of the framework will suit all collaborations. It is also a framework that prompts further research into the areas where information has not been found and that require further study, such as those at the level of influencers and contributors.

Many established project frameworks consider only the project work; the most widely used project framework the PMBOK developed through the PMI only introduced stakeholders as a knowledge area in Version 5 (2016). Such frameworks map the knowledge areas needed to manage projects from scope to completion without taking into account their justification or development. However, this research has taken a broader view and considered both the environment in which the UIG works and the contributing themes to both sector and participant levels that are seen as precursors to project formation. This extended framework creates a broader view of the effect of the themes found throughout the lifecycle of a UIG collaboration and can be used by practitioners as well as future researchers to explore their implications, especially where barriers are found that preclude collaboration.

The framework attempts to describe all areas that are relevant to UIG collaborations, within which the specific characteristics of the UIG collaborative forces have been assessed. As with all project types, some themes are descriptive of any project and common to all project types, and some themes are specific only to the project type under study. This study attempts to develop our understanding of the themes, and also to understand the primary challenges of difference that make this project style unique. The following section gives an overview of these difference that shows how the UIG collaborative environment is unique to other project forms.

6.2. Proposed UIG Collaborative framework

As discussed above, all themes presented in this study are important to the UIG collaborative project, but their sphere of influence differs as does their impact on the progress of the collaborative project. In order to understand these effects, they need to be placed into context. Several themes are aligned to a specific part of the collaboration and are similar for all collaborators, such as the *scientific endeavour* throughout the project lifecycle - cited by most as the main action towards the credibility of their results, an aspect of research that was also identified by Bornico, (2011). Others had more of an effect on how the various themes impact collaboration. For example, Alexander (2010) also noted that the industry sector has different rights to *intellectual property* on a project in comparison to the university sector.

There are also themes whose effects are more globally felt on the collaboration such as *research streams,* which in the case of a university can be dictated by an individual, whereas in industry is often dictated by the senior management (Curlee, 2011; Drucker & Juli, 2010; Toth et al, 2012) through the strategic intent of the organisation. The main objective of identifying the themes that make up this collaborative project type is to contribute to its understanding and in turn add to the improvement of UIG collaborative endeavours, although it is also important to understand both how and where the themes need to be considered to produce a complete picture. Consequently, it is essential to include the themes that relate to the project level of pre-project, project, and post-project as well as those that directly influence the running of collaborative projects and those that contribute to the formation of the overall endeavour. However, many of the themes are more on a continuum throughout the project, such as project *leadership, subject matter experts* and *influencing* that are present across much of the collaboration. While the model attempts to make sense of the impact of the themes, not all themes can be directly related to areas such as pre-project, project, and post-project, as they become more or less important in specific areas depending on the particular project. *Leadership* for instance may be more relevant at the beginning of a project but become less important across the project as the team develops a sense of understanding and ownership and needs less formality; conversely it can also become more important if a project runs into problems. As such Figure 6.1. integrates the themes into a framework that guides the approach to setting up future collaborations in a framework that endeavours to put each theme and subtheme into context, while for simplicity showing the three project phases with the themes more on a continuum.

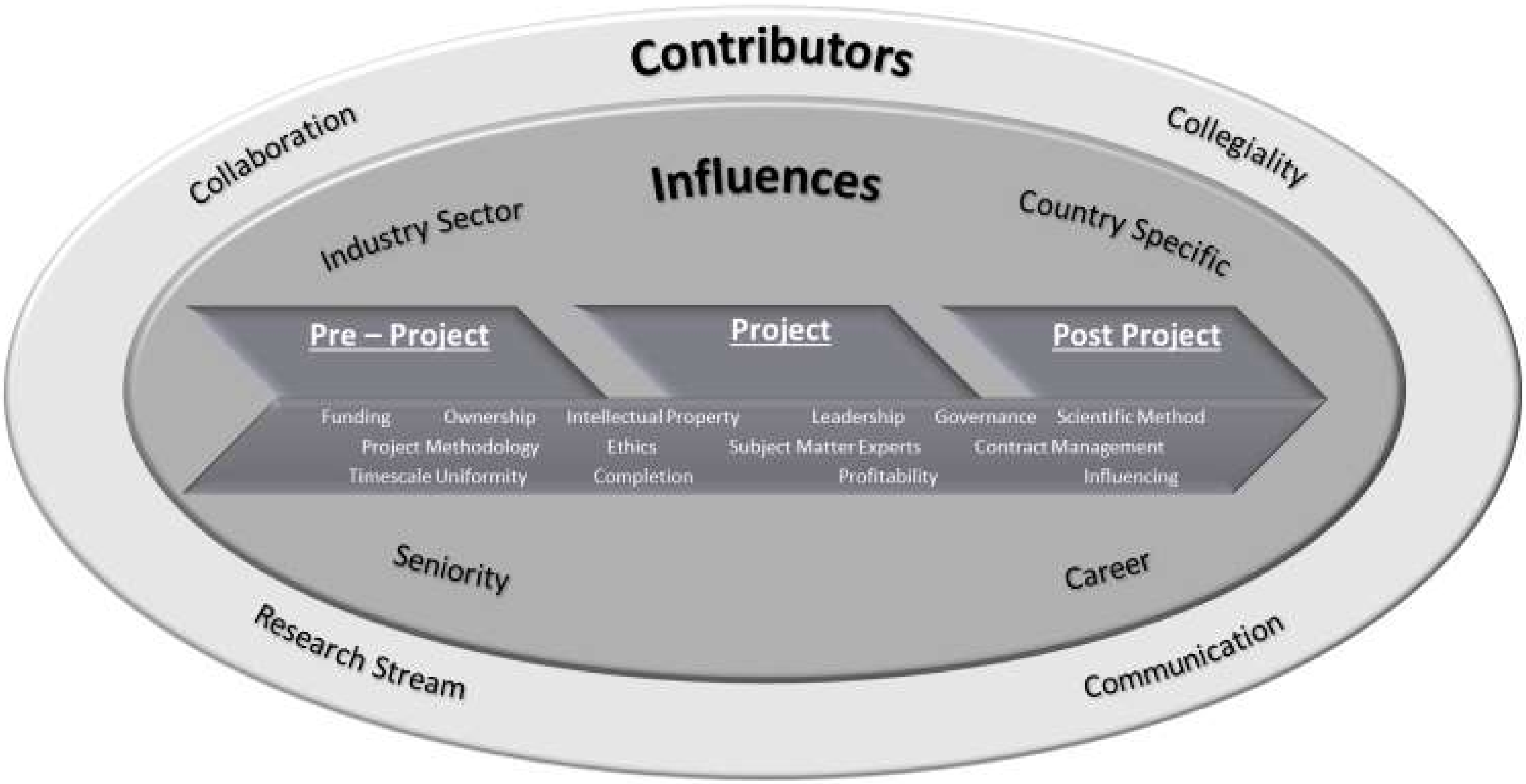

Figure 6.1. UIG collaboration framework

The proposed framework starts with contributors as fundamental to the collaborative effect, without which there is a basic lack of ability to progress through a collaborative route. This ability and willingness are influenced by the choices of both career and industry and guided by individual experience and cultural capabilities, all of which impinge on the conceptualisation of the project. Both contributors and influencers are a part of the wider project environment that encase the project work from inception to *completion* and are pre-cursors to any collaborative project endeavour. The environment is a theme of the project that needs to be addressed before the pre-project or formation stage can occur with or without the identification of collaborative partners. The study shows that, while collaboration is necessary, the effort involved is considerably underestimated, and both Frey (2006), and Perkman (2013) have noted that there are few measurement methods to create better understanding. Where the importance of collaboration is beginning to gain ground within organisations, it is being developed as a strategic initiative in the form of collaborative development between businesses, not quite filtering down to individual collaborative practices. Where individuals are seeking collaborative partners, this is usually upon project formation.

Alexander (2010) found *funding* to be a major hurdle in collaborative endeavours, and similarly this study found that pre-project work has become a barrier to collaborations for many. *Funding* specifically is an onerous undertaking and ownership of *intellectual property* can stop a project from getting started. It is not until pre-project work is complete that collaboration can start, and the actual work begins. However, due to onerous contract procedures and the need for results, specifically from the industry and government sectors, post-project outcomes are often developed before initiation, inhibiting the researcher's ability to innovate or “follow one’s nose” (Kirkland, 2005) as is the idiom of university research. These tensions that continue past the pre-project stage are inherent parts of the influencers and contributors of the wider framework. Many have been identified in the literature and recognised as areas where they hinder development; external influences that have been developed to counteract these, such as policy guidance and *funding* rearrangement (Perkman et al., 2013), appear to bear little impact, with a report on Collaboration between universities and industry by Deloitte Consulting (2018) showing that only 5% of New Zealand research, and 3.5% of Australian research, is done collaboratively between sectors. It is important to understand how each of the identified themes affects these endeavours at the three levels of contributors, influencers, and project work, and how, as a whole, they affect the perceived outcomes.

The framework attempts to encompass all themes that may impinge on the UIG collaboration. An all-encompassing framework can be used as a guide to areas that need to be explicitly considered in this style of project work. Each of the themes should be considered for each specific project and developed as the unique set of themes both inherent to the project and that need to come together to make the collaboration work. When endeavouring to bring together diverse groups of individuals with differing expectations, a framework should cover all aspects that need to be understood and managed in a way that fulfils expectations. At the very least, it should set expectations and provide explanations as to how they differ and why they may not be met in this instance.

The proposed framework also needs to take into account the importance of the different themes for both collaboration and project outcome, and what tensions these create between industry, academic, and government collaborators. The next section brings the individual themes together and discusses them from several views, including their level of challenge within the framework, and the challenges they present at the data collection level. This section also discusses their effect on both the progress and outcome of the project and their importance to ongoing collaboration.

6.3. Challenges to the collaboration

Projects are known to be challenging; they are designed to do something new, which is why they involve risk as the main component (Marcos & Denyer, 2012; Plewa, 2013). Collaborative projects between individuals from varying backgrounds provide another layer of complication. Perhaps the most important finding relating to the literature review was that 12 of the 16 themes measured challenges across both sector and participant types. These differences are also found at framework level as contributors, influences, and project level, a distinction not developed in other studies. There were only four themes that reported similar challenges across all groups: *governance, leadership, team collaboration process* and *subject matter experts*.

Within the new themes, *project justification, project streams, intellectual property ownership* and *ethics* show challenges in three of the grouping variables. *Funder priorities, timescale uniformity, completion goal, scientific method,* and *career aspirations* reported challenges in two of the grouping variables, and *asset distinction, collegiality* and *career focus* reported challenges in one of the grouping variables. Looking at how these relate to the areas of the framework, two are contributors two are influencers, and seven are in the project level, as shown in Table 6.1, which reports the main challenges measured across all areas.

Looking at the weight of influence of each of the themes within the results, the theme of *career* poses the most challenges, followed jointly by the contributor of the *research stream*. Pre-project challenges are clearly around *justification* and *ownership* of the project, together with the ability to generate *funding*. *Project ethics* and *scientific endeavour* at the project level are of least importance even though there are noted challenges. S*cientific endeavour* was reported mostly from the aspect of necessity to the credibility of the project, and *ethics*-while often onerous - is a part of that credibility (Kirkland, 2010).

Table 6.1. Challenges shown by framework level

Framework level	Themes with challenges	Rated level of challenge
Contributors	Research stream	High
	Subject matter experts	High
	Collaboration	High
	Communication	Medium
	Profitability	Low
	Collegiality	Low
	Trust	Low
Influencers	Career	High
	Project ownership	High
	Career credentials	High
	Career aspirations	Medium
	Internationalism	Medium
	Influencing	Low
	Career focus	Low
Pre-project	Funding	High
	Funding availability	High
	Project justification	High
	IP ownership	High

	Funder priorities Asset distinction Governance Leadership	Medium Medium Low Low
Project	Ethics Contract management Project management methodology Teamwork Scientific research Task segregation Project mishaps Team collaboration process	High High High High Medium Medium Low Low
Post-project	Timescale uniformity Completion goal	Medium Medium

With the amalgamation of all themes, the contributors present the most challenges, together with influencers and pre-project challenges. At the project level, the challenges are around the process of the work. Interestingly no challenges were noted at the project level: *project management methodology*, *contract management*, *subject matter experts* and *leadership.* It is important to note that no challenge does not mean unimportant; this means that they are deemed equally important. Both *subject matter experts* and *leadership* were seen as important to all sectors and participant levels, with *subject matter experts* more so than *leadership,* but with no differences of opinion between participants.

Solutions need to be focused on the areas where the effects are most evident. Specific themes such as *career* have wide-reaching challenges which require a variety of solutions to enable collaborations to form, whereas other themes such as *ethical* approach can be provided with more focused attention. Together with understanding the points at which the themes affect the process, it is also essential to understand how they affect individual sectors, participants and project elements. The following section explores this more holistically.

6.3.1. Challenges at the conceptual level

This section discusses the themes across the framework with their specific effects on sector, participant and project.

6.3.1.1. Challenges by sector

The Triple Helix model proposes that innovation requires close cooperation between university, industry and government ((Etzkowitz, 2003; 2008; 2011), but with the recognition that engagement of academic researchers in more business-related activities can be challenging (Tuunainen & Knuuttila, 2009). More recent research into this model suggests that tri-lateral networks of actors in science, industry and government are growing and that the boundaries among the three spheres are becoming increasingly blurred (Meyer et al., 2014). In addition, as previously noted, universities are being geared more towards gaining funding from business. Contrary to this, the present research found that the blurring was not as prevalent as suggested, with fifteen of the themes reporting differences between sectors as listed in Table 6.2., and in each instance, the university sector saw these as having less of an effect on the overall project than both the industry and government sectors. Of the challenges explored, sector created the most considerable degree of difference with the top five measuring as high levels of challenge in the overall study, six of which showed as contributors to the collaboration:

Table 6.2. Level of challenge: Where university respondents received a lower impact than industry or government sectors

High level of challenge
• Project streams • Collegiality • Project ownership • Project drivers • Collaboration
Medium level of challenge
• Outcome goals • Funder priorities • Completion goal • Scientific review • Task segregation • Communication • Internationalism
Low level of challenge
• Trust • Profitability • Influencing

These findings continue to reflect the 'cultural gap' between academics and practitioners first identified by Simon (1967) and further discussed by Kieser and Leiner (2009), and Pohjola, Puusa and Iskanius, (2015). The social system that the university sector operates in continues to be a barrier to external collaborations with *career* in this study being the most significant theme. Although the barriers may be more widely understood, little investigation has been done to reduce them (Bruneel et al., 2010). The fact that these themes were of less importance to the university sector also reflects previous findings that the university sector does not appear to have the sense of urgency found in the other two sectors where continued business relies on external *funding* rather than industry where survival relies on profit.

The ‘cultural gap’ does not necessarily reflect that cultural choice is a more deeply ingrained set of values that define *career choice*. The *career* and ultimately sector choices also impact on the frameworks’s contributing themes of *collaboration* and *collegiality*. Based on the 2018 OECD survey, only 5% of NZ firms are reported to be collaborating with high education or research institutes and only 4% in Australia. The successful collaborations in this field cite a focus on driving innovation (Edmosnon et al., 2012; Pertuze et al., 2010; UDIP, 2013), with the success being attributed primarily to trust and quality of the relationship between sectors. However, the study found little evidence of incentives in either sector to encourage such collaborations.

The study also found that *funding* was rated the second highest individual challenge. It was seen as continually hampering collaborations, both in the process of applying for collaborative *funding* and in the time it takes to negotiate contracts. As Edmosnon et al. (2012) found, while funds may not exclude collaboration, there are no specific grants linked to university-industry collaborations in New Zealand or Australia. Project owners in industry seek external collaborators if there is a need for credibility through the scientific process, or if individuals with specific *subject matter expertise* cannot be found within their sector.

6.3.1.2. Challenges by participant and career length

Looking at the view of the themes from the perspectives of both key informants and team members provides comparisons from those leading research projects to those actively engaged in research. As with most projects, UIG teams are newly formed, reflecting the more typical approach to projects where teams form and ultimately adjourn (Tuckman, 1965) a model under which a significant investment in time and effort is expended to build trusting relationships before performing well (Gratton, 2007). This is contradictory to research streams, where longevity of teams is a primary key to success (Barbolla & Corredera, 2009). Key informants reflected these findings, indicating that tenure in the subject field produced research streams and is the basis of many research institutes where both leaders and team members continue through multiple projects in the same subject area. Differences of opinion between leaders and team members were found in the study within nine of the themes where team members found themes to be more important than team leaders, as shown in Table 6.3. While there were fewer challenges than in sectors, the major challenges were still found across both contributors and influencers:

Table 6.3. Level of challenge: Where key participants perceive a lower impact than team leaders

High level of challenge
• Career focus • Project streams • Ethics • Collaboration
Medium level of challenge
• Career aspirations • Scientific review • Communication
Low level of challenge
• Trust • Influencing

The difference was found in two areas, the first being a forward projection looking at *career focus*, aspirations and the future of the *project streams* where team members saw each of these themes as a higher priority. The team members are more likely to be early or mid-career researchers who have not yet gained team *leadership* roles. Focusing on their career future and the development or ongoing participation in a *project stream* would give them an ability to influence through continuity and longevity, which may not yet be developed. The second level of difference was found in the project detail with scientific review and ethical consideration, reflecting both the urgency and necessary validity of the project. This is also more likely to be relevant to team members preparing material at this level. While the scientific review and ethical process is seen as accepted practice and as necessary by all sectors and by all participants (Boronico, 2011), this close regulation is still onerous and has been found especially challenging, with the main effects found with team members due to the speed at which it is obtained within projects (Kirkland, 2010).

It should be noted that not all participants progress through the management structure. Although the analysis at the conceptual level focused on title, corresponding measures of under and over ten years were also used. Using these descriptions, two new themes were added to the list of challenges and were again more important to team members and individuals with less than ten years' experience, as shown in Table 6.4. This puts more of a challenge onto the participants with a shorter service time:

Table 6.4. Level of challenge: Where participants with fewer than ten years of practice perceive the impact as lower than those with over ten years of practice

High level of challenge
• Project ownership

- Project justification

These participants are likely to be more concerned with *project ownership*, as this would add to their career credentials and future endeavours, including the justification and *funding* of future projects. Both team members and shorter length participants have a dual focus, on both the short-term project needs providing credibility with scientific review and ethics, and how their research will affect their future careers through influential results and ongoing *funding*. As previously noted, university academics follow streams of similar projects to further explore a subject or different facet of a topic (Barbolla & Corredera, 2009). However, this study found longevity as a primary key to success across all sectors and follows the theory of both *subject matter experts* and *collaboration* in their chosen field aligning to individual specialisms within all three sectors. This is a well-documented alignment of university researchers (Calderhead, 2002), but is also a central theme in other specialist fields. Collaborative relationships are described more fully in the university setting as there is an expectation that specialists collaborate to develop their field of knowledge, whereas *collaboration* in other sectors is far less a prerequisite. Much of the research in this area concentrates on the stages of *collaboration* (Fray, 2006; Gajda, 2004; Perkman, 2011), such as the extended seven-phase model by Fray (2006) with the phases of coexisting, communication, cooperation, coordination, coalition, collaboration and coadunation, rather than the practice of *collaboration*, showing the processes that need to be in place for a collaboration to develop and become productive. As well as a lack of practical perspectives, this study found limited evidence of incentives for *collaboration* across borders (Longoria, 2005). Where they did exist, however, there was an active and documented strategy focusing on a future stream of research and possible partners were targeted within other sectors.

6.3.1.3. Challenges by project funding level and length

This level of analysis explores the themes with regard to *funding* levels and length. The two are combined as there was a natural split in the research findings between projects under one year and up to $100K, and those over one year and from $100K upwards. Challenges in *funding* grew as project *funding* grew, whereas the two new challenges found in project length were more of a challenge on smaller projects.

With funding levels, the presented challenges had more of an effect on the larger projects, as shown in Table 6.5. The larger projects generally had a more complicated team of collaborators, meaning that *intellectual property* was harder to allocate. Conversely, they were reported as having greater prospects of developing into either a *stream* of research or of originating from a previous *stream* of research. Ongoing research and more staff brought about more disputes around *intellectual property* (Alexander et al., 2010). The development of the larger projects in all sectors is also more likely to recruit the services of specialist staff for *contract negotiation* and *leadership,* and where *project management methodologies* were reported as being used to satisfy the pressure from industry for results delivery (McKinsey Group, 2017). Larger projects are defined as those over $100K and over one year in length for the purpose of this study and are where larger numbers of team members and stakeholders are found.

Table 6.5. Challenges by project funding

High level of challenge
• Intellectual property • Project streams • Contract • Project management methodologies
Medium level of challenge
• Timescale uniformity • Task segregation

Looking at both budget and length, the themes of *contract, project management methodologies* and *task segregation* measured with significant differences across both. The two themes of *ethics* and *career aspirations* were added to the challenges in project length, explicitly showing a challenge to the shorter projects, as shown in Table 6.6.

Table 6.6. Challenges by project length

High level of challenge
• Ethics • Contract • Project management methodologies
Medium level of challenge
• Career aspirations • Task segregation

In Section 5.3.1.9. *ethics* reported as more of a concern to team members as project progression is dependent on this approval. It also proves to be a concern for projects where time is short (Boronico, 2010). However, where projects require limited ethical approval many ethics committees now have a fast track route. Conversely, *contracts* and *project management methods* are more prevalent in larger projects of over a year where these tasks are also carried out by specialist staff leading to more *task segregation*.

Career aspirations were also noted in Section 5.5.1.1. as being more important to team members. Likewise, shorter projects were seen as of less value with regard to *career aspirations,* with limited ability to produce influential outputs but still needing significant input to both justify and fund. Therefore, larger projects of over one year and more than $100,000 were seen as more beneficial to a team member.

Looking at funded projects, the majority of university funded projects reported were under $100,000, as noted in Section 4.2. for individually funded projects it can be seen that while industry and government show similar levels, university funding is split much more unevenly with the majority of their funds being to smaller projects under $100K. In this study only 13% of university funding was over $100,000, which is a dichotomy to their researchers' needs, but reflects the universities requirements to publish. This gives the university sector far less ability to follow larger, more collaborative work.

6.3.1.4. Challenges by project phase and constraint

Project phases and constraints are also combined for discussion as they share the same six themes reported as their primary challenge, shown in Table 6.7. In challenges by phase and constraint, phases makeup 50% of the responses. Of these challenges, four are presented at conceptual levels: *completion goal, funder priorities, project justification* and *project ownership*. *Project ownership* presented differences between sector and participants; *completion goals* and *funder priorities* presented differences between sectors; and *project justification* presented differences at the participant level. Each of these themes is also in the pre-project phase which shows contention when the project is set up. Only *completion goal* is at the end of the project but still shows dispute in the pre-project phase as well.

Table 6.7. Challenges by phase and constraint

Main challenges by phase and constraint
• completion goal • outcome goal • funder priorities • team collaboration • project justification • project ownership

The relevance of the challenge's change by phase, as shown in Table 6.8. However, the impacts were most notable in the conceptualisation and initiation phase, followed by closure, showing that - once the project is underway - the challenges have less of an effect. Conceptualisation and initiation continue to show a trend towards incongruent teams, a trend that is explicitly noted in the sector challenges. The team styles are essential in any collaborative effort (Bryson et al., 2006; Huxham & Vangen, 2013; Kumar & Van Dissel, 1996), and where collaboration partners have different perspectives these give rise to conflict (Brown et al, 2004; Fox & Faver, 1984; Melin, 2000).

Table 6.8. Main themes by phase

Conceptualisation and initiation	Definition and planning	Execution	Performance and control	Closure
• Funder priorities • Completion goal • Project justification • Outcome goal • Scientific review	• Project justification • Outcome goal • Funder priorities • Team collaboration • Project ownership	• Outcome goal • Completion goal • Team collaboration • Funder priorities • Project drivers	• Completion goal • Outcome goal • Funder priorities • Team collaboration • Project ownership	• Completion goal • Outcome goal • Project justification • Scientific review • Career focus

The three new themes of *contract, project management methodologies* and *task segregation* were also viewed as having challenges within phases. These themes have their primary influence in the conceptualisation and initiation phase. *Project management methodologies* are likely to influence all phases. The phase review reflects the same main challenges found in the previous sections with no new challenges noted.

The same six themes shown in Table 6.9. were present within constraints, together with *timescale uniformity,* and *intellectual property,* which became prominent in scope, and *timescale uniformity* and *project drivers* in time.

Table 6.9. Main themes by constraint

Cost	Scope	Time	Quality
• Funder priorities • Team collaboration • Completion goal • Outcome goal • Project justification	• Completion goal • Outcome goal • Timescale uniformity • Funder priorities • Intellectual property	• Timescale uniformity • Outcome goal • Completion goal • Project driver • Project ownership	• Completion goal • Outcome goal • Team collaboration • Project ownership • Project justification

Scope and time measured as the most important constraints, and the challenges shown here were also present across all sector, participant and project length. The same three new themes of *contract, project management methodologies* and *task segregation* are also present in constraints. The themes of *contract* and *project management methodology* are challenging across all constraints whereas *task* *segregation* is likely to be of more concern to scope and quality due to the necessity for *subject matter expertise* outlined at part of the scope and quality reviews.

6.3.1.5. Summary

This section discussed the collaboration at a conceptual level, looking at the theme challenges across specific industry, participant, phase and constraint levels. The hierarchy shown in the individual themes has been mapped against their impact at this level and helps to develop further understanding of their sphere of influence on the collaboration. The next section explores the collaboration as it evolves from project inception to completion.

6.4. Theoretical changes from inception to completion

The complexity of the UIG collaboration has been viewed at both the conceptual level and traditional project level. The third view taken into account is the theoretical level of collaboration. The theory of collaboration utilised in the present study is underpinned by the SAFAR rubric used to evaluate and understand how collaborations develop over time. The level of integration was measured across the project using a continuum of descriptors from the simplest level of networking to the most sophisticated level of unifying, the results of which are shown in Appendix 3. Results are reported at the beginning of the project and show how the project collaboration progresses. The measures were taken across the conceptual levels of sector and participant, and the main gains show in the university and government sectors, and by team members; conversely, the fewest gains were seen in the industry sector and by key participants.

Before discussing the rubric results, the research limitations need to be understood. The model looks at strategic alliances from two perspectives. It first explores the organisations and the implementation of inter-organisational efforts. Secondly it examines the personal relationship development between partners (Gajda, 2004). Fifty percent of the study participants were in projects less than a year long, meaning they might not have had the time to build the higher levels of trust that we seek to find through collaboration. A second point to note is that the study also did not ask whether the highest levels of integration were needed on the project. as work with more prescriptive outcomes tends to require less collaboration. The participants were also not asked if they had a history of prior collaborators and whether the outcomes from these collaborations produced ongoing work, both of which would be a focus of future research.

The SAFAR network represents a complex network of measures, and overall the results show that the level of collaborative integration stayed towards the lower end in each of the measures, being more aligned to the descriptors of networking, cooperating and partnering. Only the development in *leadership and decision-making* moved more towards merging and unifying at the higher end of the continuum.

The most significant move across the model scales was seen in the descriptor of *Sharing of resources to address a common issue*. This measure showed increases across the projects for university, team members and key participants. Sharing scarce resources in the form of both *subject matter experts* and equipment is reported as a primary reason for seeking out university collaborators. Interestingly, both industry and key informants saw a significant drop in the measure of *Working together to ensure tasks are done*, which also reflects the earlier findings that industry works at a faster speed and often leaves other sector collaborators behind.

In the measure of *Strategies and tasks,* the most interesting point was that both university and team members saw the most significant gains across the top levels of *Highly formal, legally complex and formal structure*, which reflects the literature for university research becoming more formalised and contract driven. Industry has historically worked with contract requirements, and this shows the same dichotomy between the sectors and participants noted in the *contract* theme of the study.

The most significant gains were made in the measure of *Leadership and decision making*, nearly all sectors and participants saw a positive movement in the highest level of *Central hierarchy,* and the most significant change at this level was within the industry sector. The only sector that did not show a positive gain here was the university sector however, neither was there a negative movement. This reflects the fact that there are higher control mechanisms in industry around contracts and project controls, which showed negative change for both *Autonomous leadership* and *strong visible leadership*.

The measure of *Interpersonal and communication* showed positive movement between sectors and participants in the measure of *High degree of commitment and investment* with the university, government and key informants. This measure was where the industry sector saw the largest downward movement, decreasing by more than 50%, which also reflects the urgency and speed reported in the findings, where industry perceives academics do not understand the environment in which they work.

The results reflect some of the theme challenges discussed in the study but did not provide sufficient additional information to understand the development of the collaborations. The complication of the framework requires a more purposeful study focused on this measure. This section looked across project collaboration. The following section assesses the outcome measures used in this study to review perceived success.

6.5. Outcome measure challenges

Along with the development of collaboration, the study looked at collaborative outcomes. The outcome measures used in this study have not previously been applied to this specific collaborative style, and measurement was again taken across the same concept levels used for the rest of the study. A breakdown of the differences are reported in Table 6.10.

Table 6.10 Outcome measures against concept measures

OUTCOME MEASURES	Difference in sectors	Difference between team leaders and	Difference over and under $100K	Difference under and over one year long	Difference under and over ten years	Difference between project phases	Difference between project constraints
1. Perceived measure of collaboration		X	X		X		
2. Perceived measure of future of research streams	X	X					
3. Perceived measure of ongoing relationships		X			X		
4. Perceived measure of working relationships		X			X		
5. Perceived measure of measure of network density		X			X		
6. Perceived measure of increase in power relationships	X						
7. Perceived measure of broadening of views		X					
8. Perceived measure of measure of effectiveness		X					

The most notable finding was a split between participant views. Team members and key informants showed a difference of opinion in all but one outcome measure and in each case key informants perceived them as more important. This is the opposite of the theme findings, where differences between the participants show team members were found to be more important. This reflects the study build in that themes were measured taking the view of their impact on a recent project, whereas outcome variables are measured at the end of the project. This confirms the view that team members focus on the successful outcome of the project, while team leaders or key participants are focused on the outcomes, looking towards ongoing work, ongoing collaborations and continuous streams of research.

The *ongoing measure of collaboration* presented the greatest challenge. The results within the study showed that *collaboration* is seen as a necessity, but the basic issues surrounding the time *collaboration* takes and the ability to measure it is an ongoing issue. Specifically, team members report that they are not given enough time to collaborate and that their roles do not include measures for *collaboration*. It is perhaps not surprising that this measure poses quite so many challenges as no practical collaborative measures were discussed.

Within sectors, the two outcomes where differences show are in *Future of research streams* and the increase in *Power relationships*. In *Ongoing research streams,* challenges were measured across both sector and participants. Industry sector participants viewed the *Development of ongoing streams of research* as less important than either the government and university sector participants, which reflects the type of career industry researchers follow. Research is likely to continue in their chosen field, but not necessarily following the same focused line of inquiry. Both university and government aim to create a future plan with longevity in their research, and in the case of university, this may be a lifelong endeavour aligned to their subject area.

Increase in power relationships was also perceived as a challenge across sectors and was viewed as more critical to the government sector, with political power being reported as a different style of *influence* and one that mainly concerned the government sector. However, purely looking from the perspective of the study participants, both key informants and project team members differed in all other outcome goals except the outcome goal of *increase in power relationships*, with all viewing this equally important. The result reflects the pessimist perspective of collaboration theory, noting that the motivation for collaboration hinges on the political economy for securing both current and future valued resources (Sullivan & Skelcher, 2002), and is the view found to be taken by the participants. University key informant 1 explained that, "this particular immunisation advisory service is run by us. It started as a research team and we were then asked to implement it."

There was only one other difference noted, and this was on the *Perceived measure of collaboration*, where smaller projects reported their measure of *collaboration* to be less important. As previously noted in the results section, there are usually fewer collaborators on smaller projects which will account for a reduced level of *collaboration*.

6.6. Primary challenges for collaboration

The themes where the main challenges were present are also the primary challenges between the collaborative partners, influencing both the project and the collaborative outcomes. These are, in turn, areas within the UIG collaboration that require mechanisms to support their facilitation. Eleven notable principles of difference were revealed within the research, all of which are pre-identified themes except for the primary challenge of sector, which is the inherent reason for the differences. This needs to be viewed separately as the difference that follows on from the choice of career direction, as it is fundamental to this study:

- Primary challenge 1:
    - The challenge of career path.

The primary area of difference is that of career path, which determines whether a researcher decides to go down an academic route, an industry route, or a policy route, in many cases staying in their chosen path for the duration of their career. These foundations, on which the UIG participants work, is well-known (Oxford, 2011), and the study has corroborated these differences, which still present the most substantial challenge to the UIG project type.

- Primary challenge 2:
    - The challenge of sector.

Choice of career path is often a precursor to the sector, and while research is a common theme through all sectors, careers present themselves differently in each sector. Academics have a teaching load and freedom of research, which is often the main attraction of an academic career. Neither industry nor government researchers have a teaching load; however, with this, they potentially give up the ability to follow their interests and are mainly led by business strategy or government policy. A challenge that is not well documented in the literature.

- Primary challenge 3:
    - The challenge of funding.

Not all research requires *funding* in the university sector, and as research is written into role descriptions in this sector, there is no need to acquire it for individual research. In industry and government, there is rarely a remit for research to be engaged in without *funding*, even from the level of conceptualising. Both industry and government primarily provide their own *funding.* Where they do not, similarly to universities, *funding* is both external and contestable, and is of the utmost importance in the production of high-quality research outputs (Harman, 2010). This is also where considerable effort is needed, making funding inaccessible for many businesses, purely due to the effort required to obtain it.

- Primary challenge 4:
    - The challenge of subject matter experts.

Subject matter experts were not a point of contention in that all sectors agreed on the necessity of knowledge; however. gaining their knowledge is the primary driver of the collaborative effort, more by necessity than by design. However, it is noted that streams of research continue to develop through ongoing collaboration developed between *subject matter experts* (Bruneel, 2010; Calderhead, 2002; Lavin, 2007)

- Primary challenge 5:
    - The primary challenge of asset distinction.

All sectors are looking to influence, but this involves different outcomes. The *asset distinction* differences between sectors is a known attribute (Shmaefsky, 2002). In universities, this is primarily through knowledge creation; in industry through prosperity and profit; and in government through policy, all of which need consideration in a collaborative effort.

- Primary challenge 6:
    - The primary challenge of collaboration.

Collaboration in project work, as with *subject matter experts*, is often by necessity rather than design, and there were few examples in the study of purposeful *collaboration* not aligned to a defined project. Collaborative practices were also not incorporated into role descriptions or business planning except in exceptional cases, either led by the individual in the case of university researchers, or in out of office hours for industry researchers. Where industry used a model to collaborate, it was a task segregated to a department specifically tasked with identifying and developing collaborative partnerships. Industrial buying is crucial for academic-practitioner research (Barabasi et al. 2002; Newman, 2004; Wagner, 2008; Wagner & Leydesdorff, 2005)

- Primary challenge 7:
    - The primary challenge of completion.

Completion comes with more than one deliverable and is aligned with the asset description of the sector. For industry, these are goals that progress the strategic plan, whereas academic goals are aimed towards publication, with government goals being policy implementation. Having multiple goals in a project is not unusual, and in many cases the end of a project is not the end of collective learning (Shindler & Eppler, 2003), but the goals in the UIG tend to be dichotomous between sectors.

- Primary challenge 8:
    - The primary challenge of project justification.

How a project is justified differs by sector. In the university sector, it is against research streams and does not need to add to their academic institute beyond academic credentials (Hammerstedt, 2011). Government is similar in that it progresses policy. In industry, justification is against the strategic intent of the company, which equates to collaborators with different views of the project purpose at the initiation.

- Primary challenge 9:
    - The primary challenge of collegiality.

Collegiality takes time and effort to develop, and there are barriers in all sectors due to the need to drive commerciality. With performance tightly monitored, time spent for collegial development is not allocated against *funding* and this precludes *collegiality* specifically in industry. There is also insufficient time allocated to develop projects together or play leading roles in research institutes of industry associations that could forge lifelong *collaboration.* As noted by Gratton (2007) prior relationships are influential both in the formation and the different stages of collaboration. *Collegiality* is understood, but there is limited understanding of how this can be developed.

- Primary challenge 10:
    - The primary challenge of scientific endeavour.

As Boronico (2011) noted, the scientific endeavour was not a point of contention, with all sectors agreeing with the necessity for robust processes. This is the basis of academic work, and industry and government use the method for credibility. The only contention was the inherent length of the process.

- Primary challenge 11:
    - The primary challenge of project management practices.

The justification of *subject matter experts* was not a point of contention in any sector with regard to the research; however, the rationale for a project management specialist was debated heavily. Certain projects will not work without this specialism, and there is an awareness that more extensive projects required better planning and expectations management. The need for this specific specialism is one that many projects are still struggling to justify.

These primary challenges have been developed through the research and are explicitly applicable to the UIG collaborative effort. Unlike scientific principles, the challenges of the UIG collaboration may produce different results at different times and are based more on the behaviour specific to participant and sector types.

From a theoretical stance, project management theories and collaboration theories have traditionally developed separately. In the case of UIG projects, the study has shown inter-connections between the theories that rely on specific preconditions and present challenges in the form of organisation and environmental themes, providing a case for these to be addressed jointly to enable knowledge sharing between sectors.

As these primary challenges indicate, the results of the study provides additional information for consideration within this field of research. The major finding is presented by the structural framework in chapter **five**, which presents the themes that impact the UIG collaboration, and the stage at which their impact is felt. The principal areas of difference show where this framework is specifically different from other project forms and provides a basis for further study. The next chapter provides a conclusion to this study, by reporting the contribution to both collaboration and project management theory and the addition to knowledge and practice. Finally, the conclusion explores the study limitations and suggests future research directions.

CHAPTER SEVEN

CONCLUSION

7.1. Introduction

The research was concerned with understanding the multiple themes present within the UIG collaborative style project, and the influencing dynamics of the sectors and participants addressed from the perspective of both collaboration and the project level determinants to develop understanding of where differentiation is seen at multiple levels and stages.

This final chapter concludes this study and is organised as follows: first, a brief overview of the thesis is presented; second, the key research findings are reported and discussed; third, the contributions and managerial implications of the thesis are noted; and fourth, the thesis limitations are discussed. The recommendations for future research follow this.

7.2. Overview of the study

This thesis critically examined the UIG collaborative project. It endeavoured to identify and explore the many factors (differential themes) that may represent tensions between sectors for effective collaboration in UIG projects, and to explore the perspectives of different participants and sectors involved. The study was guided by a theoretical framework developed from the literature, from which a data collection model was developed, along with a set of research questions. The research was also underpinned by collaboration theory. This is an important contribution as there are few studies concentrated on the development of an encompassing framework, with no published research, to our knowledge, taking into account the different perspectives of those involved in UIG collaborative projects. There are also few studies that consider the three sectors involved, most focusing on University and Industry and not considering the Government viewpoint. Previous research has also noted a lack of understanding in the formation of these collaborations, which is of concern for those involved. These concerns have informed the purpose of this study, in which the overall aim was to understand the themes and dynamics within UIG projects, in a way which will serve as a guide for future research. The project's research objectives were:

i) To identify differentiating themes for university-industry-government (UIG) collaboration that define the unique characteristics of their project environments and the tensions between these approaches.

ii) To examine the challenges these recognised differences may present to university-industry-government (UIG) collaborations from a project management perspective.

iii) To examine how the themes identified impact on the collaboration outcome, either positively or negatively, drawing on collaboration theory.

iv) To develop a research-informed framework to assist in the management of university-industry-government (UIG) project collaborations.

An abductive approach was applied in this research. First, the theoretical framework was developed from the literature review and improved by data collection. Second, data collection was guided by the data collection model through both questionnaire and semi-structured interviews, which allowed new ideas and information to emerge from the participants. Third, while conducting data analysis, the coding exercise created new themes to extend the original framework. Finally, the data were analysed using an abductive approach.

The results from the mixed-methods study were presented, and the importance of the original themes validated. The results showed multiple themes that need to be taken into consideration, many of which present challenges, both within and surrounding the project environment. Each theme also displays a contributory effect on the outcomes of the collaboration, with different degrees of challenge measured across the data collection model of participants and sectors.

The proposed framework presents the sphere of influence of the themes and assesses where the challenges within the framework affect the collaborative effort. The discussion introduced the view of the themes from the perspective of the conceptual study design, showing where they impact the framework, either as contributors, influencers or directly on the project. The progression of *collaboration* across the project and as outcome measure were also reviewed using two theoretical models. This analysis provided the focus for future research within this field.

7.3. Research findings

The main findings are structured around the research goals set out above. The first research question referred to identifying the differentiating themes for university-industry-government collaborations that define their unique characteristics and the tensions between these approaches. Sixteen themes were found that could be summarised into nine main themes of: *funding, project, leadership, teamwork, completion, scientific endeavour, intellectual property ownership, ethics,* and *career*. The literature review discussed the themes from the stance of both collaboration theory and project management theory and identified the tensions that they present for each of the sectors. Additionally, many of the themes were found to be interrelated rather than isolated.

The next research goal was to examine the challenges presented by the themes, which was explored at a conceptual level to gain perspectives of the themes at the participant levels of team members and key informants as well as from the different sectors involved in this project type. The views were also assessed across the traditional project views of phases and constraint. The study confirmed that the themes were significant to the participants across all sectors, but that their view of the effect of the theme differed by involvement level, sector and project size.

The research showed the importance of each of the themes, rated from most to least important, showing subthemes that were reported as more important than several of the main themes. It was shown that the top six themes were equally as important as the rest of the themes combined: *career, funding, collaboration, project management methodology, project ownership, completion,* and *subject matter experts*. This is also where some subthemes were perceived as being more important than other main themes in the study.

As well as showing the importance of the themes, there were also patterns of effect within the conceptual areas of team members and key participants, and within more substantial projects with duration of over a year, and with a value of over $100K. It was shown that in sectors where differences were present, team members viewed the themes as more important. Conversely, key informants across all sectors viewed the outcome measures as more important than team members. In all cases, team members' reports focus on the project level and how the research could add credibility to their career and the future of their work. Key informants focused on longer-term collaborative outcomes and how they could continue to develop relationships and future research streams. The only outcome that presented the same result across both levels was that of an *Increase in power relations,* which was equally important at all levels of participant. The themes also showed a pattern of effect within size of project, the themes having greater effect on more substantial projects with duration of over a year and a value of over $100K, where collaborations were reported to be more complex with multiple individuals and shared *intellectual property*. Only *ethics* and *career aspirations* were shown to have more of an influence on shorter projects. Ethics was time-consuming given the timescale of the project, and shorter projects were not seen to add much weight to the *career aspirations* or *credentials* of the researcher.

This study confirmed the 'cultural-gap' evidenced in previous research (Fernandes, 2015). This cultural gap is considered to exist between university and industry, with no research found that seeks to understand the difference between the three sectors. This research found that the government sector aligns with industry in more differentiators rather than university. In all themes where challenges were noted between the sectors, the university sector reported these as less important than both the industry and government sectors. University aligned with government on one outcome measure, that of *perceived future of research stream*, with industry seeing this as a less important outcome. University aligned with industry on one outcome measure, that of *increase in power relationships,* with government seeking this as a more important outcome.

The next research goal was to examine the challenges these recognised differences may present to university-industry-government collaborations from a project management perspective. The need for project management specialists in this environment has been an ongoing debate. The main debate is that the use of *scientific research* precludes the need for *project management methodology*. This study continues to show the need for expertise in the scientific process as this is the basis of research and a primary requirement for credibility in many research projects. However, the study also shows that at the project level, there are challenges that require a broader project management approach, where six themes presented challenges. This primary concern was on more substantial projects; there was a requirement for better planning and expectations management specifically in the areas of the *outcome goals, funder priorities and team collaboration*. This need is now gaining support, with several key informants and team members requesting project management staff in their work.

The next research goal was to examine how the differentiating themes impact the collaboration outcome, either positively or negatively, drawing on collaboration theory. The collaboration was measured across the project from inception to completion using the SAFAR model, and then as an outcome using five individual outcome measures developed by Thompson, Perry and Miller (2006). Regarding the assessment of the collaboration over time, the measures showed no uniformity of growth. The study showed an increase in several key areas across the *sharing of resources to address a common issue, highly formal, legally complex and formal structure*, and *leadership and decision making.* There was also movement showing a *high degree of commitment and investment.* The sharing of resources was shown in the study to be an expectation in the UIG collaboration, as was a high degree of commitment and investment. A legally complex and formal structure also governs this form of research. The study showed *leadership* and decision making moving towards a centralised hierarchy. The 16 differentiating themes used in this study represent an attempt to develop its meaning and how to measure the process to explore empirical relationships such as that between collaboration and its outcomes (Thompson et al, 2014; Thomson, 2001).

The study showed a definitive divide between key informants and team members in the outcome measures. Key informants rated all except one outcome measure as more important than team members, which was inconsistent with the theme measures, where team members rated these as more important. This also shows a split in the groups between the self-interest of team members at a project level and a more collective interest in key informants when outcomes are at stake. The study pattern across participants also leads to a system level hypothesis that can be tested in other contacts and across time. However, the cross-sectional nature of the study limits our ability to move beyond this hypothesis to generalised statements.

The findings demonstrate the complexity of the collaboration and extend our understanding with the addition of the new differentiating themes. The system of rated importance across the framework provides a more comprehensive view of the effect of each of the themes, which have also been placed in a global framework showing at what stage in the collaboration their effect takes place. The inclusion of both sector and participant perspectives provides a view across the new framework to explain areas that are likely to be contentious and require the development of solutions to achieve positive collaborative outcomes. The study shows a diversity of perspectives, demonstrated between the team members' view of the importance of differentiating themes at the project level, and the key stakeholders' view of the importance of outcome measures. The study also shows a second significant divide between the university sector and industry and government, industry and government measuring similarly when differences were measured. The developed framework, together with the UIG collaboration framework in Figure 6.1. addressed the final research goal to develop a research-informed framework to assist in the management of university-industry-government project collaborations.

7.4. Contribution to collaboration and project management theories

7.4.1. Contribution to collaboration theory

The body of knowledge surrounding the UIG collaborative project style is growing. However, limited research has been undertaken that directly discusses the linkages between collaboration and project management theory. By linking collaboration to the mainstream of project management, this research has advanced the understanding of how the theoretical perspectives of collaboration affect the research project from initiation and has developed a view from participant and sector perspectives - both of which need to be understood to satisfy the needs of the collaboration.

To address the research aims, it was necessary to understand a range of projects across the three sectors and the two participant levels. In so doing, this study makes a significant contribution through further developing collaboration theory in this project type. What is new and different about collaboration theory defined here is that the framework identifies collaboration from the separate perspectives of team members as well as the partner sectors of university, industry, and government. To investigate these perspectives, it was necessary to examine them using a combination of qualitative and quantitative techniques. The research results demonstrate the importance of engaging these collaborative perspectives, showing that each level has a different view. Evidence of this was presented in chapter **five**.

The study used the three theoretical perspectives of collaboration: optimist, pessimist, and realist put forward by Sullivan and Skelcher (2002). The perspectives considered in the study reflect a pessimistic perspective from team members and an optimistic perspective from key informants. The outcome shows the difference between the two groups based on the stage of their careers, and the focus of project level versus ongoing research streams. This shows that length of service has an impact on the broadening of partners' views, as well as increasing partner interactions, and decreasing power imbalances among partners.

Within sectors, universities demonstrate an optimistic view. Key informants also demonstrate more of an optimistic view than participants, which reflects their focus on outcomes and the ultimate goals rather than immediate gains. Universities adopt the view that sustainability and long-term partnerships are the driving force in collaboration rather than a single project-based venture. University collaborations are known for sustainable long-term associations such as those found in heritage relationships and ongoing research streams. These relationships enable collaborative partners to work together more harmoniously as trust and understanding already exist. While this study did not focus on the prerequisites of project collaboration, previous studies have noted that prior relationships are influential both in their formation and the different stages of collaboration (Gratton, 2007). This was specifically noted where streams of research continue to develop through ongoing collaborations developed between *subject matter experts* with ongoing heritage relationships, (Bruneel, 2010; Calderhead, 2002; Lavin, 2007). The finding is congruent with previous studies and is a noted style of collaboration based more in the university sector.

The pessimistic view demonstrated by team members aligned more to industry and government sectors, which have a similar short-term view of the gains to be made from collaborations. This view aligns with the pessimist perspective of collaboration driven by the motivation to enhance the power of the stakeholders. This is closely related to the exchange theory of the optimist perspective but differs in its view of the end product of collaboration, which views collaboration as an opportunistic channel. The view of team members, industry and government sectors in the study were towards a collaborative effort that would enhance the team members' credentials, resources in the case of industry, and power in the case of government. The pessimist perspective presupposes that participation in any collaborative endeavour is based on guaranteed success in enhancing resources and power; otherwise, such collaboration is perceived as unproductive. This study found that team members' *career aspirations* and *career focus* were different from those of key participants and that larger projects had a greater influence on their *careers*. Collaboration is dependent both on the extent to which the outcome will enrich the resources of the individual and the organisation, and on how the aftermath will add credibility to their future work. The study showed the importance of outcomes at all levels, but specifically at the project level. The perspective that collaboration is seen as an opportunity-seeking venture reflects the views of team members who seek to add to their credentials, of industry whose focus is to profit from the collaboration, and of government, which is looking to gain influence from the outcomes.

However, the UIG collaboration is built more on the foundation of realist theory, such as the Triple Helix (Etzkowitz, et al. 1995). The Triple Helix argues that the dynamic nature of collaboration is informed by political, economic and technological changes and is an evolving process that requires learning and adaptation. It is not an automatic activation of action but depends on contextual factors and is enhanced through learning (Sullivan & Skelcher, 2002). The realist view also recognises the evolutionary process of collaboration (Sullivan & Skelcher, 2002) which was reflected in comments throughout the study. Important to this view is the influence of change in an organisation's decision to take part in a collaborative research project, and the need for this to be embedded in the organisation's strategic intent. The philosophical approach to collaboration in each sector differs, and this is where the influence of the economic landscape and government stakeholders are working to bring them into a realist view. However, embedding collaboration in an organisation's strategic intent was an area that was found to be missing through the research.

Collaboration theory helps to explain the perspectives of the participants in the study and helps towards understanding the individual chemistry in the research collaborations. Institutional buy-in is crucial for academic-practitioner research collaboration; project team skills and knowledge, collaboration experience and personal motivation are found to be key determinants for successful collaboration (Barabási et al, 2002; Newman, 2004; Wagner, 2008; Wagner & Leydesdorff, 2005). There are definite advantages to collaboration, but these need to be balanced against the risks and impediments which arise from power imbalances and differentiated perspectives (Jung et al, 2012). Organisational dynamics also influences collaborations; however, the main study influence was found to be dependent on the role of the owner or funder, setting the tone of the project. The study's findings are compatible with results found by previous studies (Cosh & Hughe, 2009; Harman, 2010; Van Looy et al, 2004), in highlighting the importance of the funders' influence and authority. Evidence of this was presented in chapter **five**.

Considering the unclear understanding of collaboration, as to whether the UIG is grounded in its efficacy as a means of achieving specific outcomes or symbolism and ideology, it is important to understand the drivers behind the relationship.

This study notes the prerequisites for collaboration, where the differences between sectors create challenges. It also recognises that further research is needed to fully comprehend collaborative development in this project style. However, this study has developed a view of the differing influences acting upon the UIG collaboration to understand how the sectors and participant levels that comprise the UIG collaborative project style need to be addressed.

7.4.2. Contribution to project management theory

Project management relates only to the portion of this research directly relating to the formulated project, so it is more concerned with the project level measures of phase and constraints. The methodological contribution was made by addressing several gaps in the research. The literature review took the existing themes and developed them from the view of the three sectors, a view not taken in other studies, whose primary focus is on the UI collaboration (Ankrah, 2015; Banal-Estanol et al, 2013; Eom et al, 2010; Fritas et al, 2013). The study then addressed the relative importance of the themes, both individually and across participants and sectors. In addition to this, the differentiating themes have been extended through a practitioner approach at both team member and key informant level while continuing to focus on the differences between participants and sectors. The gaps are the result of a lack of research at project level, and a failure to systematically examine the complexity of the project from the perspective of the parties involved. The contribution of the current study is made through the mixed methods approach of qualitative and quantitative techniques to enable a holistic triangulated research approach, that investigates the structural levels of the project at pre-project, project and post-project stages as well as the informal levels of contributors and influencers that surround this area of work.

The aspects of the study that enabled this methodological contribution are outlined in Section 7. By selecting and researching the three sectors and dual level of participation, this study makes a unique contribution. Through gathering data from the three sectors and two actor levels, it was possible to compare findings to generate more in-depth explanation. Specifically, the mixed method approach comprising in-depth interviews and quantitative techniques provided enriched findings.

The study answers the call by Thomson et al (2014) for more research to examine system level relationships, that provide us with ever more valid and reliable indicators for empirical research. Due to the nature and complexity of this area of research, there is a lack of empirical measurement beyond themes in the UIG literature. This has meant a deficiency in methodological research, as noted by Chin (2011).

The emerging nature and complexity of the phenomena in this field have resulted in a mainly qualitative approach being adopted by researchers (Ankrah et al., 2015; Banal et al., 2013; Bychkova, 2016; Fernandes et al., 2015; Pohiala, 2015; Ramli, 2015). However, to investigate cross-sector and participant pressures it was necessary to examine collaborations using a combination of both qualitative and quantitative techniques although previous research has tended to focus on merely noting the differences in working practices between University and industry sectors.

With the variety of collaborative projects available, it is not feasible to implement a one-size- fits-all strategy. This is why a new dynamic framework was developed in the present study to fill the gap and enable organisations to understand all the areas that may impinge on this style of work. However, understanding the implications of the findings is not enough. In addition to understanding the challenges within this style of work in a systematic way, it is necessary to create a culture that can facilitate collaborative engagement. It also requires all parties to monitor changes in the expectations of those involved and create opportunities for collaborations to develop outside of the project environment.

7.5. Managerial implications

The production of a framework presents a generalisable outline presenting all the themes involved, both where differentiation is found and where no differentiation is found. From here further investigation can be undertaken.

Collaborations are comprised of organisations and participants with different objectives, coming from different backgrounds, meaning a one-size-fits-all solution is precluded. This has implications both for practitioners involved in the projects and for the organisations interested in creating a collaborative style of development. To ensure the effectiveness of collaboration, the research owner needs to satisfy the needs at both levels through the appropriate coordination of project mechanisms, *communication*, and outcomes. Pressures at both levels also need to be considered through the process to understand each party's objectives.

Key participants need to pay attention to the strength of *collaboration* between individuals, as well as an organisational level, and create a platform for ongoing *collaboration* outside of the project environment. Organisational culture that enables ongoing *collaboration* needs to be progressed, through bringing together *subject matter experts* and enabling streams of ongoing *collaboration*.

Suggestions for improvements in business practice are typically based on empirical research, managerial experience, and sound theorising; as such, this study offers several implications for business practice.

First, if it is true that *subject matter experts* and individuals naturally engage in *collaboration* with those in the same field, as suggested through the study, researchers and practitioners may find it valuable to refine these practices by developing tools that will enable these networks to be captured and developed. Collaborative frameworks designed explicitly for the UIG collaborations should contain techniques and tools that enable this style of project development.

Secondly, key informants who are concerned with the development of ongoing *collaboration* can expect a limited benefit from employing development techniques that do not involve the individual researcher. Including the individual gives the ability to generate a positive, open, collaborative culture and to apply this in the strategic intent of the business, developing the ability to communicate and work well across borders at all levels of the organisation. If collaborators engage in these practices, it is likely that they will improve their performance. Heritage relationships and ongoing streams of research are a part of this culture.

Thirdly, the framework that includes all the necessary parts for this style of project can help to focus an organisation on where their deficits lie. These areas of difference are perhaps the most important as they are where issues present within the framework. Developing solutions for several of these areas is more concrete and easier to develop, such as defining acceptable timescales and outcome goals as parts of project initiation that are acceptable to all parties. The study showed that the more concrete aspects of collaboration where processes and procedures are easy to develop and maintain, are not the ones impeding progress. Aspects of collaboration that require more wide-reaching solutions, such as strategic initiatives and incentives that include cross-sector collaboration as part of the strategic intent, are more likely to impede progress due to a lack of understanding both of how to formulate these strategies and how to measure ongoing development and success. It is recommended that evaluators work closely with key informants to develop solutions in which the relationship between the quality of interpersonal collaboration and essential organisational outcomes is empirically determined.

7.6. Study limitations

The strength of this study is in the sampling method used to develop an in-depth understanding of the complex themes and to provide perspectives from all sectors and participants involved. The mixed-methods approach used provides triangulation between quantitative data used to quantify the themes and outcomes and develop connections and weight of importance at a conceptual level, and descriptive qualitative data used to explore the themes and outcomes and add depth to their understanding. There are, however, limitations in the study. The first of these relates to the statistical generalisation of the results. The quantitative data set could be expanded for wider inclusion to make the study stronger. However, this was not realistic due to the time requirements and the nature of the study itself, particularly with a limited pool of participants. As noted in Section 5.3.2.7, both

New Zealand and Australia are considerably below OECD trends for research, and from this smaller pool of funding, a smaller fraction of the projects are done collaboratively. The actual size of the collaborative projects was also a limitation, with only half of the projects considered large at over one year and with a budget of more than $100,000, while the majority of differentiation themes were more important for larger projects. A wider pool of participants would enable a more accurate picture of the importance of the themes by project size, such as the effect of the ethical process, which was found to be greater on smaller projects due to their inherent time restraints. There is also bias in the importance of funding for large and small projects, with both government and industry showing equal amounts of small and large funded projects, whereas university showed 83% of project funds in smaller projects with only 17% gaining larger grants.

As well as the relatively small number of collaborative projects being run in either country, the study targeted individual project leaders and team members who were in current and on-going collaborations with ongoing outcome commitments, proving difficult to gain survey support. Key informants who had leadership or project overview roles were easier to access. No government leadership was present in the quantitative sample, but this was covered by the qualitative interviews. There were also no reported collaborations between government and industry, which possibly shows a gap between their alignment. This could also be evidence of the measurement of external funding through the university system that is not present in other sectors. In turn, this restricted the number of statistical tests that could be run using SPSS. The qualitative sample, also being a purposive sample, exposed the study to potential bias. However, the sample was gained across all three sectors and both participant levels included in the data collection model in order to provide a wide enough sample. The second limitation was the geographical focus being New Zealand and Australia, meaning the findings of this study are limited specifically to these countries. The findings of this study may not apply to countries where organisations and individuals are measured using different criteria. For example, the PBRF system for academics in New Zealand is not used in Australia. However, responses between the two countries showed congruence regardless of this measure.

A further limitation is the lack of quantitative data for the new differentiating themes. These were discovered through qualitative results, and not rated through the survey. With the extensive literature available, there was an expectation that all applicable themes had been discovered, and the inclusion of these in the quantitative instrument would have further strengthened the research. Rerunning the research with the extended framework would produce a more accurate picture of their importance and weighting. With the identification of the new themes though the qualitative research component, however, this research has been able to produce a more composite, layered framework than was initially possible. This study also only sampled successful projects that had already gained funding and were either ongoing on concluded. In future research it would be beneficial to include projects that did not succeed in order to assess the main impediments, and the role the differentiating themes identified in the present study played in failed projects.

The research framework and the moderators that were included in the study design are not exhaustive, and effort was made to include the most essential aspects identified in previous project research as well as being limited for practical reasons.

The research covered many broad themes, many of which now need to be researched in more depth to increase understanding of their affect.

7.7. Further research

This research was initiated to develop a more complete view of this complex project style and to develop its understanding from researchers and sector perspectives. As with any research of this nature, several suggestions for further research arise during its execution. Future research could address the design of this study, where there are potential areas to develop the existing study such as the ability to do quantitative sampling with the new differentiating themes. There are also future research topics that look at developing this work beyond its current boundaries.

There were no intentions to provide solutions in this study where tensions were noted, and as such there are several sub-topics that warrant further investigation, including the exploration of these themes in relation to the factors of age, size, and structure of the organisations, as the role of these factors have not been considered in previous studies.

Each of the primary challenges noted in Section 6.1. warrant further research to understand their implications on collaborations in more detail. The research could also be tested to provide a more in-depth understanding of the collaborative journey by its application across several projects. Collaboration is an emerging area of research interest, and the study of how collaborations work presents a complex methodological problem. Further research is needed to address the complexity of this tri-sector collaboration by investigating them over time to capture the dynamic aspects to continue assessing the cross-level pressures between sectors and participants. The descriptive difference between the actors in the study provides a basis for further investigation into the principal area of differences.

More in-depth detailed studies of collaborative projects which combine both qualitative and quantitative methods - in which data is gathered for all factors within the collaboration - are also called for. One such consideration would be in-depth case studies that follow key stakeholders through the collaborative framework and could be the basis for ongoing research. Such a study would allow for more rigorous testing of the framework developed in the present study, using qualitative techniques such as diaries, observation and other approaches to understand how these tensions play out in actual projects over time. These approaches would also enable the results to be corroborated beyond the landscape of New Zealand and Australia, and to counteract the limitations of the quantitative study size, a larger scale national or international quantitative study could be performed. This would further test the themes within the network and develop a model for understanding broader dynamics of sectors and participants. Such a model could then be used to test the relationship between actors in the collaboration. It might also be that increased awareness of context would increase motivation and commitment levels to the collaborative effort.

Following this study, the researcher has gained extensive knowledge and experience both of the topic and of the research process, and the framework developed in the study will be taken into future research. Presentation on the findings in this study have already been given at the ARMS conference in both Singapore and Hobart Australia, and the PMI conference in Auckland, New Zealand, and gained positive feedback. Future intentions are to produce individual papers for publication.

7.8 Final words

The objectives identified in the study have been addressed and answered as a result of the research process. The use of mixed method strategy enabled the combination of qualitative and quantitative techniques to enrich and add depth to the findings of the research approach and to capture the practices of those involved in the collaboration to present real-life experience. The study highlighted new themes by understanding wider collaboration on which new insights were noted. It also identified the perspectives of both sector and participant and where these differed. The differences found also accounted for many of the barriers to both collaboration start-up and ongoing collaboration, intrinsic in these being strategies to develop collaborations, performance measures that reward collaboration, influence between sectors to advance the benefits of collaboration, and the necessity to understand and accommodate the outcomes needed by all participants. There is a need to translate the impetus for collaboration into practice. This study has added to our current understanding of the complexity of the processes and developed a new framework for future development.

REFERENCES

Agassi, J. (1977). The methodology of research projects: A sketch; *Journal for General Philosophy of Science.* 8, 30-38.

Aghion, P., Dewatripont, M., Hoxby, C., Mas-Colell, A., & Sapir, A. (2009). The governance and performance of research universities from Europe and the U.S. *Economic policy.* 25(61), 7-59.

Al-Ashaab, A., Flores, M., Boultsinou, A., & Magyar, A. (2011). A balanced scorecard for measuring the impact of industry-university collaboration, production planning and control. *The management of operations*, 22(5-6), 554-570.

Alexander, C., Ng, Li Yen., Kroll, J., Koster, E., & Ellison, M. (2010). Who owns intellectual property? *Keeping good companies.* 11, 686-690.

Alshenqeeti, H. (2014). Interviewing as a Data collection method: A critical review. *English Linguistics research,* 3(1), 39-45.

Amabilet. T., Patterson, C., Mueller, J., Woycik, T., Odomirok, P., Marsh, M., & Kramer, S. (2001). Academic-practitioner collaboration in management research: A case of cross-profession collaboration. *Academy of Management Journal.* 44(2), 418-431.

Anantatmula, V. (2010). Project Manager Leadership role in Improving Project Performance. *Engineering Management Journal.* 2(1), 13-22.

Andersen, D., Link, W., Johnson, D., & Burnham, K. (2001). Suggestions for presenting the results of data analysis. *The journal of wildlife management.* 65(3), 373-378.

Andersen, B., Henriksen, B., & Aarseth, W. (2007). Benchmarking of project management office establishment: Extracting best practices. *Journal of management in Engineering.* 23(2) 97-104.

Ankrah, S., & Al-Tabbaa, O. (2015). University-industry collaboration: A systematic review. *Scandinavian Journal of Management.* 31, 387-408.

Ateah, C., Snow, W., Wener, P., MacDonald, L., Metge, C., Davis, P., Fricke, M., Ludwig, S., & Anderson, J. (2011). Stereotyping as a barrier to collaboration: Does interprofessional education make a difference? *Nurse education today.* 31(2), 208-213.

Banal-Estanol, A., Macho-stadler, I., & Perez-Castrillo, D. (2013). Research output from university-industry collaborative projects. Economic development quarterly. 27(1), 71-81.

Barabasi, A., Jeong, H., Neda, Z., Ravasz, E., Schubert, A., & Vicsek, T. (2002). Evolution of the social network of scientific collaborations. *Physica A: Statistical Mechanics and its Applications.* 311, 590-614.

Barbolla, A., & Corredera, J. (2009). Critical factors for success in University-industry research projects. *Technology Analysis and Strategic Management.* 21(5) 599-616.

Barton, D., Manyika, J., Koller, T., Palter, R., Godsall, J., & Zoffer, J. (2017). Measuring the economic impact of shortermism. *McKinsey Global Institute.* Retrieved from http://www.fcltglobal.org/docs/default-source/default-document-library/fclt-global-rising-to-the-challenge.pdf?sfvrsm=0

Barnes, T., Pashby, I., Gibbons, & A. (2002). Effective University–Industry Interaction: A Multi-case Evaluation of Collaborative R&D Projects. *European Management Journal.* 20 (3), 272-285.

Barnes, T., Pashby, I., & Gibbons, A. (2006). Managing Collaborative R&D Projects – Development of a practical management tool. *Journal of Project management.* 24, 395-404.

Bayney, R. (2009) Career progression in project, program, and portfolio management – which roads lead to where? *Project managers.net* Retrieved from http://www.projectmanagers.net/profiles/blogs/career-progression-in-project.

Benda, W., & Engels, T. (2011). The predictive validity of peer review: A selective review of the judgmental forecasting qualities of peers, and implications for innovation in science. *International Journal of Forecasting.* 27, 166-182.

Bernal, V. (2012). Management model for development projects in university – business – government relations. Case study: certification and recertification of professional engineering. *IEEE International conference on management of innovation and technology.* 561-565.

Blaxter, L., Hughes, C., & Tight, M. (2006). How to Research. *New York: McGraw-Hill Education.* (3rd Ed)

Blomquist, T., Hallgren, M., Nilsson, A., & Soderhold, A. (2010). Project as Practice: In search of Project Management Research that Matters. *Project Management Journal. 41(1), 5-16.*

Blumenthal, D., Causino, N., Campbell, E., & Louis, K. (2006). Relationships between Academic Institutions and Industry in the Life Sciences — An Industry Survey. *The New England Journal of Medicine.* 8, 368-374.

Boardman, P. (2009). Government centrality to university-industry interactions: University research centres and the industry involvement of academic researchers. *Research policy* 38, 1505-1516.

Bonardo, D., Paleari, S., & Silvio, V. (2010). Valuing university-based firms; The effects of Academic Affiliation on IPO performance. *Entrepreneurship: Theory & Practice.* 35, 755-776.

Boronico, J., Zirkler, A., & Siegel, H. (2011). Qualifying the Tradeoffs Between Cost and Quality for Systems Service Support. *Journal of Applied Business Research.* 12 (4), 70-88.

Bounds, A., & Atkinson, L. (2006). Steering the Wheels of Change: Measuring Research Quality and Impact – A Driver for Change in the Australasian Research Management Model. *Australasian Research Management Society conference. Australasian Research Management Symposium (ARMS).*

Bowen, P., Akintoye, A., Pearl, R., & Edwards, P. (2007). Ethical behaviour in the south African construction industry. *Construction Management and Economics.* 25, 631-648.

Braglia, M., & Frosolini, M. (2014). An integrated approach to implement Project Management Information Systems within the Extended Enterprise. *International Journal of Project Management 32 (1), 18-29.*

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology.* 3(2) 77-101.

Brown, A., & Phua, F. (2011). Subjectively construed identities and discourse; towards a research agenda for construction management. *Construction Management and Economics.* 29, 83-95.

Bruneel, J., E'Este, P., & Salter, A. (2010). Investigating the factors that diminish the barriers to university – industry collaboration. *Research policy* 39, 858-868.

Bryman, A., & Bell, E. (2015). Business Research Methods. *Oxford University Press.* (3rd Ed).

Bstieler L., Hemmert, M., & Barczak, G. (2014). Trust formation in university industry collaborations in the U.S. Biotechnology Industry: IP Policies, Shared Governance, and Champions. *Journal of product innovation management.* 32 (1), 111-121.

Bubala, J.W. (2016). Considering differences in organisational culture makes joint science-business project successful. *Fundacja Upowszechniajaca Wiedze I Nauke.* 173-182.

Buijs, J., Smulders, F., & Meer, H. (2009). Towards a more realistic creative problem-solving approach. *Creativity and Innovation Management.* 18(4), 286-298.

Bukvova, H. (2009). Research as a process: A comparison between Different research approaches. *All sprouts content.* 9(29), 283.

Bychkova, O. (2016). Innovation by Coercion: Emerging institutionalisation of university – industry collaborations in Russia. *Social studies of science 46(4), 511-535.*

Calderhead, J. (2002). The nature and growth of knowledge in student teaching *Teaching and teacher education.* 7, 5-6.

Camelo, C., Fernandez-Alles, M., & Hernandez, A. (2010). Strategic consensus, top management teams, and innovation performance. *International journal of manpower.* 31, 678-695.

Cann, C., & Brumagim, A. (2008). How Project Management Tools aid in association to Advance Collegiate school of Business (AACSB) International Maintenance of Accreditation. *Journal of Education for Business.* 84(1), 31-39.

Canhoto, A. (2016). The co-production of value in digital, university industry R & D collaborative projects. *Journal of retailing. 85(1) 35-45.*

Carpenter, W., Kownig, J., Bilbe, G., & Bischoff, S. (2004). At issue: a model for academic / industry collaboration. *Schizophrenia bulletin*. 30(4), 997-1004.

Caughron, J., & Mumford, M. (2008). Project Planning: The effects of Using formal planning techniques on Creative Problem-Solving. *Journal of Creativity and Innovation Management.* 17(3), 204-215.

Cavana, R., Delahaye, B., & Sekaran, U. (2001). Applied business research: Qualitative and quantitative methods. *John Wiley & Sons.* (3rd Ed).

Charvat, J. (2003). Project Management Methodologies – Selecting Implementing and Supporting Methodologies and Processes for Projects. *John Wiley & Sons.* (1st Ed).

Chin, C. (2011). Project management methodology university industry collaborative process. *Review of international comparative management.* 12(5), 901-918.

Colarelli, G., Rice, M., Peters, L., & Veryzer, R. (2003). Managing Interdisciplinary, Longitudinal Research teams: Extending Grounded Theory-Building Methodologies. *Organization Science.* 14, 353-373.

Cooke-Davies, T., Cicmil, S., Crawford, L., & Richardson, K. (2007). We're not in Kansas anymore, Toto. Mapping the strange landscape of complexity theory and its relationship to project management. *Project management journal.* 38(2), 50-61.

Cosh, A., & Hughes, A. (2009). Never mind the quality feel the width: university industry links and government financial support for innovation in small high-technology businesses in the UK and the USA. *Technology transfer,* 35, 66-91.

Creswell, J. (2009). Research design, Qualitative, Quantitative and mixed methods approaches. *Sage publications.* (3rd Ed.)

Crescenzi, R., & Filippetti, A. (2017). Academic inventors: collaboration and proximity with industry. *S.J Technology Transfer.* 42, 730-762.

Czajkowshi, J. (2007). Leading successful inter-institutional collaborations using the collaboration success measurement model. *Academy's 16th Annual International Conference: Navigating the Future through Authentic Leadership.*

D'Amour, L., Ferrada-Videla, M., San, L., Rodriques, M., & Beaulieu, M. (2005). The conceptual basis for interprofessional collaboration: Core concept and theoretical frameworks. *Journal of International Care.* 1, 116-131.

Deloitte, Touche, Tohmatsu Ltd. (2018). Universities New Zealand, Collaboration between universities and industry. *Deloitte Access economics.*

Destler, B. (2008). A new relationship. *Nature.* 453, 853-954.

Dlindenbach-Driessen, D. (2010). Subjective performance assessment of innovation projects. *Journal of Product Innovation.* 27, 572-592.

Edmondson, G., Valigra, L., Kenward, M., Hudson, R., & Belfield, H. (2012). Making industry-university partnerships work: Lessons from successful collaborations. *Science, Business innovation board AISBL.*

Eisenhardt, K., Graebner, M., & Sonenshein, S. (2016). Grand Challenges and Inductive Methods: Rigor without Rigor Mortis. *Jounal of Academic management.* 59(4), 1113-1123.

Etzkowitz, H., & Leydesdorff, L. (1995). The triple helix – university, industry, government relationships: A laboratory for knowledge based economic development. *EASST Review,* 14(1), *11*-19.

Etzkowitz, H. (2001). The second academic revolution and the rise of entrepreneurial science. *IEEE technology and science*. 20(2), 18-29.

Etzkowitz, H. (2001). Innovation in innovation: the triple helix of university industry government relations. *Social science information.* 42(3), 293-337.

Etzkowitz, H., & Ranga, M. (2003). Triple Helix Systems: An analytical framework for innovation policy and practice in the knowledge society. *Industry and higher education.* 27(4), 237-262.

Etzkowitz, H., & Dzisah, J. (2008). Rethinking development: circulation in the triple helix. *Technology analysis and strategic management.* 20(6), 653-666.

Etzkowitz, H. (2008). The triple helix: university industry government innovation in action. Papers in regional science. 90(2), *164.*

Etzkowitz, H. (2011). Normative change in science and the birth of the triple helix *social science information.* 50(4-4), 549-568.

Etzkowitz, H. (2012). Triple Helix Clusters: Boundary Permeability at University-Industry-Government Interfaces as a Regional Innovation Strategy. *Environment and Planning C: Government and Policy. 30*(5), 766-779.

Eom, B., & Lee, K. (2010). Determinants of industry-academy linkages and their impact on firm performance: the case of Korea as a latecomer in knowledge industrialization. *Research Policy*. 39, 625-639.

Erno-Kjolhede, E. (2000). Project Management Theory and the Management of Research Projects. *Department of Management, Politics and Philosophy.* MPP Working Paper, 3/2000.

Fear, F., & Doberneck, D. (2004). Collegial talk: A powerful tool for change. *About campus.* 9(1), 11-19.

Fernandes, G., Pinto, E., Machado, R., Araujo, M., & Pontes, A. (2015). A program and project management approach for collaborative university-industry R&D Funded contracts. *Procedia Computer Science.* 64, 1065-1074.

Fernandes, G., Pinto, E., Araujo, M., Pontes, A., & Machado, R. (2016). Perceptions of different stakeholders on managing collaborative university industry R & D funded contracts. *Procedia Computer Science. 100, 878-887.*

Flores, B., Huber, C., Boer, C., Pluss, A., Schock, R., & Pouly, M. (2009). Universities as Key enablers to develop new collaborative environments for innovation. *International Journal of Production Research*. 47, 4935-4935.

Frasquet, M., Calderon, H., & Cervera, A. (2012). University-industry collaboration from a relationship marketing perspective: an empirical analysis in a Spanish university. *High Education.* 64, 85-98.

Freitas, I., Marques, R., & Paula e Silva, E. (2013). University-industry collaboration and innovation in emergent and mature industries in new industrialised countries. *Research Policy.* 42, 443-453.

Freitas, I., Geuna, A., & Rossi, F. (2013). Finding the right partners: institutional and personal model of governance of university – industry interactions. *Research policy*. 42, 50-62.

Frey, B., Lohmeier, J., Lee, S., & Tollefson, N. (2006). Measuring collaboration among grant partners. *American journal of evaluation.* 27(3) 383-392.

Fulton S., & Krainovich-Miller, B. (2010). Gathering and appraising the literature. *Nursing Research: Methods and Critical Appraisal for Evidence-Based Practice. Seventh edition. Mosby Elsevier.*

Gajda, R. (2004). Utilizing collaboration theory to evaluate strategic alliances. *American journal of evaluation*. 25(1), 65-77.

Garousi, V., Peterson, K., & Ozkan, B. (2016). Challenges and best practices in industry-academia collaborations in software engineering. *Information and software technology.* 79, 106-127.

Gluckman, P. (2015). Why do governments support research? The evolving role of the state. *Office of the prime minister's chief science advisor.*

Gratton, L., & Erickson, T. (2007). Eight ways to build collaborative teams. *Harvard Business Review.* 85(11), 100-109.

Gulbrandsen, M., & Smeby, J. (2005). Industry funding and university professors' research performance. *Research policy.* 34, 932-950.

Hauge, E., Pinherio, R., & Zyzak, B. (2016). Knowledge bases and regional development: collaborations between higher education and cultural creative industries. *International Journal of Cultural Policy.* 24(4), 485-503.

Hara, N., Solomon, P., Kim, S., & Sonnenwald, D. (2003). An emerging view of scientific collaboration: Scientists' perspectives on collaboration and factors that impact collaboration. *American Society for Information Science and Technology.* 54*,* 952-965.

Harman. (2010). The relationship between search-based software engineering and predictive modelling. *Acm International conference proceeding series.*

Harrison, L., & Callan, T. (2013). Key research concepts in politics and international relations. *Sage publishing.* (1st Ed).

Harryson, S., Kliknaite, S., & Dudkowski, R. (2007). Making innovative use of academic knowledge to enhance corporate technology innovation impact. *International Journal of Technology Management*. 39(1-2), 131-57.

Hammerstedt, R., & Blach, E. (2007). Commercialization of basic research from within the university and return of value to the public. *Animal reproduction Science.* 105, 158-178.

Hansson, S.O. (2009). Do we need a special ethics for research? *Science and engineering ethics.* 17(1) 21-29.

Hazelkorn, E. (2005). University research management: Developing research in new institutions. *OECD Higher education programme.*

Haycock, K. (2007). Collaboration: Critical success factors for student learning. *School Libraries Worldwide.* 13(1) 25-35.

Herek, G. M. (2011). Developing a theoretical framework and rationale for a research proposal. *A guide for social and behavioural scientists.* (2nd Ed) 137-145.

Herroelen, W., & Leus, R. (2005). Project Scheduling under uncertainty: Survey and research potentials. *European Journal of Operational Research.* 165, 289-306.

Ho, P., Lin, Y., Chu, W., & Wu, H. (2009). Model for Organisational governance structure choices in construction joint ventures. *Journal of construction engineering and management.* 135(6), 518-529.

Hodgson, D., Paton, S., & Cicmil, S. (2011). Great expectations and hard times: The paradoxical experience of the engineer as project manager. *International Journal of Project Management.* 29, 374-382.

Hoegl, M., Ernst, H., & Proserpio, L. (2007). How Teamwork Matters More as Team Member Dispersion Increases. *J Product innovation Management.* 24, 156-165.

Holman, D. (2000). Contemporary Models of Management Education in the UK. *Management Learning.* 31(2), 197-217.

Horowitz, I. (2017). Communicating ideas: The politics of scholarly publishing. *Routledge Group.* (2nd Ed).

Huang, M., Chen, D. (2016). How can academic innovation performance in university industry collaborations be improved? *Technological forecasting and social change.* 123, 210-215.

Hughes, T., O'Reagan, N., & Wornham, D. (2008). The credibility issue: Closing the academic / practitioner gap. *Strategic Change.* 17, 215-233.

Hughes, T. (2014). Co-creation: moving towards a framework for creating innovation in the Triple Helix. *Prometheus.* 32(4), 337-350.

Ito, T., Kaneta, T., & Sundstrom, S. (2016). Does university entrepreneurship work in Japan? a comparison of industry-university research funding and technology transfer activities between the UK and Japan. *Journal of innovation and entrepreneurship.* 5(8).

Jasienski, M., Candi, M., & Rzeznik, M. (2015). Bridging the academic-industry gap while innovating: Two eacmple projects. *Processes and project management.* 61-69.

Julian, J. (2008). How project management office leaders facilitate cross-project learning and continuous improvement. *Project management journal.* 39, 53-58.

Jordan, G., Hage, J., Mote, J., & Hepler, B. (2005). Investigating differences among research projects and implications for managers. *R & D Management.* 35, 501-511.

Jung, I., Kudo, M., & Choi, S. (2012). Stress in Japanese learners engaged in online collaborative learning in English. *British Journal of Educational Technology.* 43, 1016-1029.

Kapsali, M. (2011). Systems thinking in innovation project management: A match that works. *International Journal of Project Management.* 20, 396-407.

Kato, Masatoshi., & O, Hiroyuki. (2012). Development of university life-science programs and university-industry joint research in Japan. *Research policy*. 41, 939-952.

Keller, R. (2001). Cross-Functional Groups in Research and New Product Development. Diversity, Communications, Job Stress, and Outcomes. *The academy of Management Journal.* 44(3), 547-555.

Kenny, J. (2002). Managing innovation in educational institutions. *Australasian Journal of Educational Technology.* 18(3), 359-376.

Kirkland, J. (2010). The Management of University Research. *The Association of Commonwealth Universities, London, UK.* 316-321.

Kohrman, K., Ma, W., & Baker, D. (2008). The research university in transition: the emerging global model. *Higher education policy* 21(1) 5-27.

Kok, S., Douglas, A., & McClelland, B. (2009). Collegiality in Flux? The assimilation of new management paradigms and focus in UK. *International journal of learning.* 16(10), 637-651.

Koole, S., & Spijker, M. (2000). Overcoming the Planning Fallacy through Willpower: Effects of Implementation Intentions on Actual and Predicted Task-Completion Times. *European Journal of Social Psychology.* 30, 873-88.

Lasthiotakis, H., Sigurdson, K., & Sa, C. (2013). Pursuing scientific excellence globally: International research collaborations as a policy target. *Higher Education Policy and Management.* 35, 612- 625.

Lattuca, L., Terenzini, P., Harper, B., & Yin, A. (2009). Academic environments in detail: Hollands theory at the subdiscipline level. *Research in higher education.* 51(1), 21-39.

Lavin, R., Dreyfus, M., Slepski, L., & Kasper, C. (2007). Said another way Subject Matter Experts: Fact or Fiction? *Nursing forum.* 42(4) 189-195.

Leisyte, L., Enders, J., & Boer, H. (2009). The balance between teaching and research in Dutch an English universities in the context of university governance reforms. *Centre for higher Education policy studies.* 58, 619-635.

Liu, A., Liang, O., Tuuli, M., & Chan, I. (2017). Role of government funding in fostering collaboration between knowledge-based organisations: Evidence from the solar PV industry in china. *Energy exploration and exploitation.* Vol 36(3), 509-534.

Liberatore, M.J., & Pollack-Johnson, B. (2009). Quality, time and cost trade-offs in project management decision making. *Portland international conference on management of engineering and technology.* 1323-1329

Lichtenthaler, U. (2011). Open innovation: Past research, Current debates and Future directions. *Academy of Management Perspectives.* 25(1), 75-93.

Lind, F., Styhre, A., & Aaboen, L. (2013). Exploring university-industry collaboration in research centres. *European Journal of Innovation Management.* 16(1) 70-91.

LoBiondo-Wood, G. (2010). Understanding research findings. *Nursing Research: Methods and Critical Appraisal for Evidence-Based Practice. Seventh edition. Mosby Elsevier, St Louis MO.* (7th Ed).

Longoria, R. (2005). Is inter-organisational collaboration always a good thing? *Journal of Social and Social Welfare.* 32(3), 123-138.

Lovelace, K., Sharpiro, D.L., & Weingart, L.R. (2001). Maximizing cross-functional new product teams innovativeness and constraint adherence: A conflict communications perspective. *Academy of management journal.* 44(4), 779-793.

Manson, S. (2009). Personal Journeys, Professional Paths: Persistence in Navigating the Crossroads of a Research Career. *American Journal of Public Health.* 99, 20-25.

Marcos, J., & Denyer, D. (2012). Crossing the sea from They to We? The unfolding of knowing and practising in collaborative research. *Management learning.* 43(4), 443-459.

Martin-Rodriquez, L., Beaulieu, M., D'Amour, D. (2005). The determinants of successful collaboration: A review of theoretical and empirical studies. *Journal of interprofessional care.* 19, 132-147.

Mattesich, P.W., Murray-Close, M., & Monsey, B.R. (2001). Collaboration: What makes it work; A review of research and literature on factors influencing successful collaboration. *Wilder foundation.* (2nd Ed).

Mikler, J., & Harrison, N. (2013). Climate innovation: Australian corporate perspectives on the role of government. *Australian Journal of politics and history.* 57(3), 414-428.

Ministry of business innovation and employment. (2016). National Statement of Science Investment 2015-2025. Ministry of business, innovation and employment (MBIE).

Moodley, K., Smith, N., & Preece, C. (2008). Stakeholder matrix for ethical relationships in the construction industry. *Construction management and economics.* 26, 625-632.

Moreira, M., Pelissari, P., Parr, C., Wohrmeyer, C., & Pandolfelli, V. (2015). Data mining on technical trends and international collaborations in the refractory ceramic area. *Ceramics international.* 43(9), 6876-6844.

Muller, E., Sporri, J., Kroll, J., & Horterer, H. (2017). Equipment designed to reduce risk of severe traumatic injuries in alpine ski racing: constructive collaboration between the international ski federation, industry and science. *British journal of sports medicine.* 50, 1-2.

Muller, R. (2010). Leadership competency profiles are successful project managers. *International journal of project management.* 28(5), 437-448.

Muller, R., & Turner, R. (2007). Matching the project managers leadership style to project type. *International journal of project management.* 25, 21-32.

Caughron, J.J., & Mumford, M.D. (2008). Project planning: The effects of using formal planning techniques on creative problem-solving. *Creativity and innovation management.* 17(3), 204-215.

Mumford, M.D., Schultz, R.A., & Osburn, H.K. (2002). Planning in Organisations: Performance as a Multi-Level Phenomenon. *Research in Multi-Level issues. The Many Faces of Multi-Level Issues.* 1, 3-63.

National research council. (2001). Issues for science and engineering researchers in the digital age. *Washington DC: The national academies press.* (1st Ed)

Neves, F., Rosa, N., Correia, A., & Neto, M. (2010). Knowledge creation and sharing in software development teams using Agile methodologies: key insights affecting their adoption. *Iberian conference on information systems & technologies (CISTI).* 1-6.

O'Connor, G., Rice, M., Peters, L., & Veryzer, R. (2003). Managing Interdisciplinary, Longitudinal Research Teams: Extending Grounded Theory-Building Methodologies. *Organisational Science.* 14(4), 353-373.

Olsson, N., & Berg-Johansen, G. (2016). Aspects of project ownership in theory and practice. *Procedia computer science.* 110, 790-795.

Osburn, H.K., & Mumford, M.D. (2006). Creativity and Planning Training Interventions to Develop Creative Problem-Solving Skills. *Creativity Research Journal.* 18, 173-90.

Pandey, A., Manivannan, A., Nov, O., Satterthwaite, M., & Bertini, E. (2014). The persuasive power of data visualization. *IEEE Transactions on Visualization and Computer Graphics.* 20(12), 14-37.

Perkmann, M., King, Z., & Pavelin, S. (2011). Engaging excellence? Effects of faculty quality on university engagement with industry. *Research Policy.* (40), 539-522.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Brostrom, A., D'Ester, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F., Salter, A., & Sobrero, M. (2013). Academic engagement and commercialisation: a review of the literature on university-industry relations. *Research policy.* 42(2), 423-442.

Pertuze, J., Calder, E., Greitzer, E., & Lucas, W. (2010). Best practices for Industry-University collaboration. *MIT Sloan management review.* 51, 83-90.

Pitagorsky, G. (2003). The business value of embracing a unified Project Management methodology. Retrieved from www.allPM.com

Plewa, D., Korff, N., Baaken, T., & Macpherson, G. (2013). University-industry linkage evolution: an empirical investigation of relational success factors. *R & D management.* 43, 365-380.

Pohjala, I., & Iskanius, P. (2015). Leveraging communities of practice in university-industry collaboration: A case study on Arctic research. *International journal of business innovation and research, Inderscience enterprises Ltd.* 10(2/3), 283-299.

Pohjala, I., Puusa, A., & Iskanius, P. (2016). Antecedents of Successful Collaboration in Community of Practice between Academia and Industry: A Case Study. *The electronic journal of knowledge management.* 14(3), 154-165).

Powers, L., & Kerr, G. (2009). Project management and success in academic research. *Realworld Systems, Research Series.* 2.

Primas, L. (2012). Perceptions of collaborative process in a professional learning focused university community school collaboration. *Dissertation*. Georgia State. Retrieved from https://eric.ed.gov/?id=ED545627

Psillos, S. (1999). Theories of scientific method. *Ratio X11.* 310-316

Ramli, M., & Senin, A.A. (2015). Success factors to reduce orientation and resources-related barriers in university-industry R & D Collaboration particularly during development research stages. *Social and behavioural sciences.* 172, 375-382.

Ramos-Vielba, I., & Fernandez-esquinas, M. (2011). Beneath the tip of the iceberg: exploring the multiple forms of university-industry linkages. *High Education*. 64, 237-265.

Ratcliff D.E. (2001). Analytical induction as a qualitative research method of analysis. Retrieved from http://don-ratcliff.net/qual/analytic.html

Reichert, S. (2006). Research Strategy Development and Management at European Universities. *Brussels EUA publications.*

Richards, G. (2017). The wisdom of research-policy partnerships. *Journal of health services.* 14(2), 104-111.

Riol, H., & Thuillier, D. (2015). Project management for academic research projects: balancing structure and flexibility. *International journal of project organisations and management.* 7(3), 251-269.

Martin-Rodriguez, L., Beaulieu, M., D'Amour, D., & Ferrada-Videla, M. (2005). The determinants of successful collaboration: A review of theoretical and empirical studies. *Journal of Interprofessional Care.* 19(1), 132-147.

Ruuska, I., & Teigland, R. (2009). Ensuring project success through collective competence and creative conflict in public-private partnerships. A case study of Bygga Villa, a Swedish triple helix e-government initiative. *International journal of project management.* 27(4), 323-334.

Sa Couto, J. (2008). Project management can help to reduce costs and improve quality in health care services. *Journal of Evaluation in Clinical Practice.* 14(1), 48-52.

Salem, O., & Mohanty, S. (2008). Project Management Practices and Information Technology Research. *Journal of Construction Engineering and Management.* 134(7), 501-508.

Sarpong, D., AbdRazak, A., Alexander, E., & Meissner, D. (2017). Organising practices of university, industry and government that facilitative (or impede) the transition to a hybrid triple helix model of innovation. *Technological forecasting and social change.* 123, 142-152.

Saunders, M., Lewis, P., & Thornhill, A. (2009). Research methods for business students (5th ed.). *London: Pearson Education.*

Sauser, B., Reilly, R., & Shenhar, A. (2009). Why projects fail? How contingency theory can provide new insights – A comparative analysis of NASA's Mars Climate Orbiter loss. *International journal of project management.* 27 (7) 665-679.

Scarbrough, H., Swan, J., & Laurent, S. (2004). Project based learning and the role of learning boundaries. *Organisation studies.* 25(9), 1579-1600.

Schiele, H., & Krummaker, S. (2011). Consortium benchmarking: Collaborative academic-practitioner case study research. Journal of business research. 64, 1137-1145.

Schindler, M., & Eppler, J.E. (2003). Harvesting project knowledge: a review of project learning methods and success factors. *International journal of project management.* 21(3), 219-228.

Shahu, R., Pundir, A.K., & Ganapathy, L. (2013). An empirical study on flexibility: A critical success factor of construction projects. *Global journal of flexible systems management.* 13(3), 123-128.

Shenhar, A., & Dvir, D. (1997). Mapping the dimensions of project success. *Project Management Journal.* 28, 5-13.

Shahin, A., & Jamshidian, M. (2005). Critical Factors in project management: A comprehensive review. *Journal of Project Management.* 1, 35-40.

Shibayama, S., Walsh, J., & Baba, Y. (2012). Academic entrepreneurship and exchange of scientific resources: material transfer in life and materials sciences in Japanese universities. *American sociological review*. 77(5), 804-830.

Shmaefsky, R. (2002). Tangent Worlds: Academic Science vs. Commercial Science. Retrieved from https://www.actionbioscience.org/education/mccoy_pierce.html?pri

Simon, H.A. (1967). The business school, a problem in organisational design. *The journal of management studies.* 4, 1-16.

Sooryamoorthy, R., & Shrum, W. (2007). Does the internet promote collaboration and productivity? Evidence from the scientific community in south Africa. *Journal of computer-mediated communication.* 12, 733-751.

Siemens, L. (2009). It's a team if you use "reply all": An exploration of research teams in digital humanities environments. *Literary and Linguistic Computing.* 24(2), 225-233.

Simon, H. (1967). The business school: A problem in organisational design. *Higher education for business.* 4(1), 1-16.

Simon, L. (2006). Managing Creative Projects: An empirical synthesis of activities. *International Journal of Project Management.* 24, 116-126.

Singh, C. (2000). An assessment of sources and moderators of stress for project managers. *AIPM.* 1(1), 1-14.

Stackhouse, J & Day, R. (2005). Global and regional practices in university research management: emerging trends. *Journal of technology management and Sustainable Development.* 4(3), 189-205.

Stranger, M., Bell, E., Nicol, D., Otlowshki, M., & Chalmers, D. (2008). Human genetic databanks in Australia: indications of inconsistency and confusion. *New genetics and society.* 27(4), 311-332.

Subramanian, G., Klein, G., Jiang, J., & Chan, C. (2009). Balancing Four Factors in Systems Development Projects; *Communications of the ACM.* 52(10), 118-121.

Sugandhavanija, P., Sukchai, S., Ketjoy, N., & Klongboonjit, S. (2011). Determination of effective university – industry joint research for photovoltaic technology transfer (UIJRPTT) in Thailand. *Renewable Energy*. 36, 600-607.

Sullivan, J., & Beach, R. (2009). Improving project outcomes through operational reliability: A conceptual model. *International Journal of Project Management.* 27(8), 765-775.

Sullivan, H., & Skelcher, C. (2002). Working across boundaries: Collaboration in public sciences. *Red Glove press*.

Sumner, A., Ishmael-Perkins, N., & Lindstrom, J. (2009). Making Science of Influencing: Assessing the Impact of Development Research. *Institute of Development Studies.* 335, 1-45.

Thamhain, H.J. (2003). Managing Innovation R&D Teams. *R&D Management.* 33, 297-311.

Thompson, A. (2001). Collaboration: Meaning and Measurement. *Thesis (Ph.D)*

Thomson, A., Perry, J., & Miller, T. (2014). Linking collaboration processes and outcomes, foundations for advancing empirical theory. *Journal of Public Administration Research and Theory.* 19, 23-56.

Todeva, E., & Etzkowitz, H. (2013). The triple Helix as a highly charger intellectual enterprise. *Helice.* 2(3), 8-12.

Todeva, E. (2013). Governance of innovation and intermediation in Triple Helix interactions. *Industry and higher education.* 27(4), 263-278.

Tomczyk, C. (2005). Project Managers Spotlight on Planning. *Wiley*.

Toth, B., Janssen, P., Stouffs, R., Chaszar, A., & Boeykens, S. (2012). Custom Digital Workflows: A New Framework for Design Analysis Integration. *International Journal of Architectural Computing.* 10(4), 481–499.

Tuckman, B. (1965). Developmental sequence in small groups. *Psychological bulletin.* 63(6), 384-399.

Tuckman, B., & Jensen, M. (1977). Stages of Small-group development revisited. *Group and organization management.* 2, 419-427.

Turner, J.R., & Simister, S.J. (2004). Manual gower de management de project. *Editura codecs.*

Tushman, M., O'Reilley, C., Fenollosa, A., Kleinbaum, A., & McGrath D. (2007). Relevance and Rigor: Executive education as a level in shaping practice and research. *Academy of management learning and education.* 6(3), 345-362.

Universities of New Zealand. (2016). Highlights report.

Van Looy, B., Ranga, M., Callaert, J., Debackere, K., & Zimmerman, E. (2004). Combining entrepreneurial and scientific performance in academia: towards a compounded and reciprocal Matthew-effect? *Research policy.* 33(3), 425-441.

Wanous, J., Reichers, A., & Hudy, M. (1997). Overall job satisfaction: how good are single-item measures? *Journal of applied psychology.* 82(2), 247-252.

Montoya-Weiss, M., Massey, A., & Song, M. (2001). Getting it together: Temporal coordination and conflict management in global virtual teams. *The academy of management journal.* 44(6), 1251-1262.

Williams, R., & Van Dyke, N. (2007). Measuring the international standing of universities with an application to Australian universities. *Higher Education.* 53(6), 819-841.

Wilson, T. (2012). A review of business-university collaboration. *Higher education funding council for England.*

Winters, F. (2005). Ensuring success: Project Management Offices, bring it together. *Retrieved from* www.gantthead.com

Winters, M., Sandersen, E., Elvin, R., & Levene, R. (2006). Focusing on business projects as an area for future research: An exploratory discussion of found different perspectives. *International Journal of Project Management.* 24(8), 699-709.

Woodland, R, H., & Hutton, M. (2012). Evaluating Organisational Collaborations: Suggested Entry Points and Strategies. *American Journal of Evaluation.* 33(3), 366-383.

Wright, K. (2005). Researching internet-based populations: Advantages and disadvantages of online survey research, online questionnaire authoring software packages, and web survey services. *Journal of computer mediated communication.* 10(3).

Ye, F., Yu, S., & Leydesdorff, L. (2012). The triple helix of university-industry-government relations at the country level and its dynamic evolution under the pressures of globalization. *American society for information science and technology.* 64(11), 2317-2325.

Yin, R. K. (2009). Case study research. Design and Methods (4th ed.) Thousand Oaks, CA: *Sage Publications*.

Zedtwitz, M., & Gassmann, O. (2000). Market versus technology drive in R&D internationalization: four different patterns of managing research and development. *R&D Technology Management.* 31(4), 569-588.

APPENDICES

Appendix 1. UIG collaboration survey instrument.

Dear Potential Participants

University-Industry-Government Collaboration Survey

Project collaborations are complicated to run and have multiple factors that influence how well they work. We are starting to understand the nature of these partnerships more, but whilst many collaborations look good on paper, the real test needs to be the outcomes of the enterprise.

We are conducting research at Massey University into how the many factors that affect these projects affect their outcomes, and at what stages they impinge on the benefits to university, industry, and government.

The survey is anonymous and can be found at.

Take the survey

Or copy and paste the URL below into your internet browser:
https://massey.au1.qualtrics.com/SE?SID=SV_bjVMmrUUg84aBNj&Q_CHL=preview&Preview=Survey

Aggregated results will be reported, and individual comments may be used in the report.

Please feel free to contact the researchers directly if you have any questions or comments on;

Researcher: lorraine.skelton.1@uni.massey.ac.nz

Supervisor: Massey Professor Tim Bentley, T.A.Bentley@massey.ac.nz.

Supervisor: Massey Dr David Brougham, D.Brougham@massey.ac.nz

Ethics Notification Number: 4000016930

Section 1.

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The University-Industry-Government Collaborative Project

The survey asks you to provide responses related to your experience on only one specific project collaboration that has either been completed recently (within the last 12 months), or a project that is close to completion, including at what level you were involved.
The survey contains six sections which focus on different aspects of the collaboration and your perceived outcome to the collaboration, and will take about 15 minutes to complete.

This project has been evaluated by peer review and judged to be low risk. The researchers named in this document are responsible for the ethical conduct of this research. If you have any concerns about the conduct of this of this research please contact Dr Brian Finch, Director (Research Ethics), email: **humanethics@massey.ac.nz**

Section 2

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Q0. By clicking yes below you are confirming that you are a researcher and give your consent to participate in this study

Yes

No

Q1. Which country do you work in?

Australia

New Zealand

Section 3

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Q2. Which sector do you belong to?

Q3.
How long have you been involved in this style of collaborative project?

Q4.
What stage is the project currently in or is it complete?

Q5.
What was your role (or nearest description) on the project?

Q6. How many UNIVERSITY researchers worked on the project?

Q7.
How many INDUSTRY researchers worked on the project?

Q8. How long was the research collaboration?

Q9. What was the total funding for your project?

Q10.
Who were the funders of your project?

Section 4

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Q11.

Below are a number of project contrast themes that describe differences between commercial and academic projects. Please indicate the extent to which you believe each project contrast theme impacted on the successful management and outcomes of your collaborative project.

Responses should only relate to your experience on the specific project collaboration you chose at the beginning of the questionnaire.

	Very low Impact	Low impact	Below average Impact	Neither high or low Impact	Above average Impact	High Impact	Very high Impact
Differences in funder priories (i.e. commercial projects funded by business; academic projects funded by external bodies)	O	O	O	O	O	O	O
Differences in outcome goal (i.e. return on investment for commercial projects verses public good for academic projects)	O	O	O	O	O	O	O
Differences in project justification (i.e. strategic fit to business plan for commercial verses justification through the funding decision for academic projects)	O	O	O	O	O	O	O
Differences in project streams (i.e. one-off projects for commercial verses part of research programme or stream for academic projects)	O	O	O	O	O	O	O
Differences in project governance (i.e. project management methodology drives the industry project verses scientific methodology driving the university project)	O	O	O	O	O	O	O
Differences in project ownership (i.e. project manager not a project outcome owner in industry versus principle investigator being project outcome owner in university)	O	O	O	O	O	O	O
Differences in team collaboration (i.e. teams who come together for this project only in industry versus teams who may collaborate on various projects in university)	O	O	O	O	O	O	O
Differences in collegiality (i.e. staff members who change for each project in industry versus staff members who may stay together for several research projects in university)	O	O	O	O	O	O	O
Differences in timescale uniformity (i.e. shorter processes in industry versus longer processes incorporating scientific processes in university)	O	O	O	O	O	O	O
Differences in completion goal (i.e. the goal of project deliverables in industry versus the goal of repeatable good science and academic outcome)	O	O	O	O	O	O	O
Differences in scientific review (i.e. projects in industry do not need peer review versus peer review for scientific rigour in university)	O	O	O	O	O	O	O
Differences in intellectual property (i.e. intellectual property of the business in industry versus intellectual property of the individual in university)	O	O	O	O	O	O	O
Differences in ethics requirement (i.e. project ethics not needed in many industry projects versus ethics always needed in university projects)	O	O	O	O	O	O	O
Differences in career focus (i.e. career credentials measured by completed projects in industry versus career credentials measured through research funding and publications in universities)	O	O	O	O	O	O	O
Differences in career aspiration (i.e. career project manager advancement versus career researcher advancement)	O	O	O	O	O	O	O
Differences in subject matter experts (i.e. project managers have industry alignment versus university researchers that have research field alignment)	O	O	O	O	O	O	O

Section 5

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.

For the following project phases, which of the project contrast themes from section B above had most impact on the successful management of your collaborative project?
Please select as many that apply from the multiple answer listings for each of the following project phases.

Q12. Conceptualisation and initiation The project is carefully examined to determine whether or not it benefits the organisation. During this phase, a decision making team will identify if the project can realistically be completed.

Differences in funder priorities	Differences in timescale uniformity
Differences in outcome goal	Differences in completion goal
Differences in project justification	Differences in scientific review
Differences in project streams	Differences in intellectual property
Differences in project driver	Differences in ethics requirement
Differences in project ownership	Differences in career focus
Differences in team collaboration	Differences in career aspiration
Differences in collegiality	Differences in subject matter experts

Q13.
Conceptualisation and initiation
Please briefly describe how differences between commercial and academic projects affected your project management in the conceptualisation and initiation project phase.

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Q14.
Definition and planning
A project plan, project charter and / or project scope may be put in writing, outlining the work to be performed. During this phase, a team should prioritise the project, calculate a budget and schedule and determine what resources are needed.

Differences in funder priorities	Differences in timescale uniformity
Differences in outcome goal	Differences in completion goal
Differences in project justification	Differences in scientific review
Differences in project streams	Differences in intellectual property
Differences in project driver	Differences in ethics requirement
Differences in project ownership	Differences in career focus
Differences in team collaboration	Differences in career aspiration
Differences in collegiality	Differences in subject matter experts

Q15.
Definition and planning
Please briefly describe how differences between commercial and academic projects affected your project management in the definition and planning project phase.

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Q16.
Execution
Resource tasks are distributed and teams are informed of responsibilities. This is where important project related information is discussed.

Differences in funder priorities	Differences in timescale uniformity
Differences in outcome goal	Differences in completion goal
Differences in project justification	Differences in scientific review
Differences in project streams	Differences in intellectual property
Differences in project driver	Differences in ethics requirement
Differences in project ownership	Differences in career focus
Differences in team collaboration	Differences in career aspiration
Differences in collegiality	Differences in subject matter experts

Q17.
Execution
Please briefly describe how differences between commercial and academic projects affected your project management in the execution project phase.

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Q18.
Performance and control
Project managers will compare project status and progress to the actual plan, as resources perform the scheduled work. During this phase, project managers may need to adjust schedules or do what is necessary to keep the project on track.

Differences in funder priorities	Differences in timescale uniformity
Differences in outcome goal	Differences in completion goal
Differences in project justification	Differences in scientific review
Differences in project streams	Differences in intellectual property
Differences in project driver	Differences in ethics requirement
Differences in project ownership	Differences in career focus
Differences in team collaboration	Differences in career aspiration
Differences in collegiality	Differences in subject matter experts

Q19.
Performance and control
Please briefly describe how differences between commercial and academic projects affected your project management in the performance and control project phase.

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Q20.

Closure

After project tasks are completed and the client has approved the outcome, an evaluation is necessary to highlight project success and / or learn from project history.

Differences in funder priorities	Differences in timescale uniformity
Differences in outcome goal	Differences in completion goal
Differences in project justification	Differences in scientific review
Differences in project streams	Differences in intellectual property
Differences in project driver	Differences in ethics requirement
Differences in project ownership	Differences in career focus
Differences in team collaboration	Differences in career aspiration
Differences in collegiality	Differences in subject matter experts

Q21.

Closure

Please briefly describe how differences between commercial and academic projects affected your project management in the closure project phase.

Section 6

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Taking into account the following project constraints, which of the project contrast themes had most impact on the successful management of your collaborative project? Please select as many that apply from the multiple answer listings for each of the following project phases

Q22.
Cost Constraint
The cost constraint refers to the budgeted amount available for the project.

Differences in funder priorities	Differences in timescale uniformity
Differences in outcome goal	Differences in completion goal
Differences in project justification	Differences in scientific review
Differences in project streams	Differences in intellectual property
Differences in project driver	Differences in ethics requirement
Differences in project ownership	Differences in career focus
Differences in team collaboration	Differences in career aspiration
Differences in collegiality	Differences in subject matter experts

Q23. Please briefly describe how differences between commercial and academic projects affected your project management with regard to the project cost constraint.

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Q24.
Scope
The scope constraint refers to what must be done to produce the project's end result.

Differences in funder priorities	Differences in timescale uniformity
Differences in outcome goal	Differences in completion goal
Differences in project justification	Differences in scientific review
Differences in project streams	Differences in intellectual property
Differences in project driver	Differences in ethics requirement
Differences in project ownership	Differences in career focus
Differences in team collaboration	Differences in career aspiration
Differences in collegiality	Differences in subject matter experts

Q25. Please briefly describe how differences between commercial and academic projects affected your project management with regard to the project scope constraint.

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Q26.
Taking into account the following project constraints, which of the project contrast themes had most impact on the successful management of your collaborative project? Please select as many that apply from the multiple answer listings for each of the following project phases

Q27.
Time
The time constraint refers to the amount of time available to complete a project.

Differences in funder priorities	Differences in timescale uniformity
Differences in outcome goal	Differences in completion goal
Differences in project justification	Differences in scientific review
Differences in project streams	Differences in intellectual property
Differences in project driver	Differences in ethics requirement
Differences in project ownership	Differences in career focus
Differences in team collaboration	Differences in career aspiration
Differences in collegiality	Differences in subject matter experts

Q28. Please briefly describe how differences between commercial and academic projects affected your project management with regard to the project time constraints.

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Q29.
Quality
The quality constraint refers to the degree to which the project fulfills its requirements.

Differences in funder priorities	Differences in timescale uniformity
Differences in outcome goal	Differences in completion goal
Differences in project justification	Differences in scientific review
Differences in project streams	Differences in intellectual property
Differences in project driver	Differences in ethics requirement
Differences in project ownership	Differences in career focus
Differences in team collaboration	Differences in career aspiration
Differences in collegiality	Differences in subject matter experts

Q30. Please briefly describe how differences between commercial and academic projects affected your project management with regard to the project quality constraints.

Section 7

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Q31. Below are a number of project variables that describe the perceived outcomes of the relationship between commercial and academic partners on the project (whether the completed project was perceived as successful or not). Taking into account all contrast themes, please indicate the extent to which you believe project contrast themes impacted on the outcomes and effectiveness of your collaborative project.

	Very low Impact	Low impact	Below average Impact	Neither high or low Impact	Above average Impact	High Impact	Very high Impact
Outcome perceived effectiveness (Overall, how effective is this collaboration in achieving its expected purpose and outcomes)	○	○	○	○	○	○	○
Perceived increase in quality of working relationships (Overall, how would you rate the quality of working relationships that have developed between your organisation and partner organisations as a result of the collaboration)	○	○	○	○	○	○	○
Perceived broadening of views (Overall, to what extent has your organisations view of the issue(s) / problem(s) that brought the collaboration together broadened as a result of listening to your partner organisations views)	○	○	○	○	○	○	○
Perceived increase in network density (Overall, to what extent has your organisation increased its interaction with partner organisations (like increased referrals and / or service contracts, joint program development as a result of the collaboration)	○	○	○	○	○	○	○
Perceived increase in power relationships (Overall, to what extent has the collaboration helped to make partner organisations influence on each other more equal)	○	○	○	○	○	○	○
Perceived ongoing relationship (Overall, to what extent would you perceive the interaction provided a platform for future work with the same partner organisation. Either on a similar or a different research project)	○	○	○	○	○	○	○
Perceived future of research stream (Overall, to what extent do you perceive the collaboration has produced future enhancement for the same research strand)	○	○	○	○	○	○	○
Perceived measure of collaboration (Overall, how would you rate the outcome measurements used for the collaboration)	○	○	○	○	○	○	○

Q32. Do you have any other comments you would like to make on this topic?

Section 8

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Q33. Taking into account the beginning (inception) of the project, please indicate which of the following statements for project purpose best describe how the project was built.

- Created a web of communication, identified and created a base of support and explored interests.
- Work together to ensure tasks are done, leverage or raise money, identify mutual needs, but maintain separate identities.
- Share resources to address common issues, organisations remain autonomous but support something new, reach mutual goals together
- Merge resources to create or support something new, extract money from existing systems / members, and commitment for a long period of time to achieve short and long term outcomes.
- Unification or acquisition to form a single culture, relinquishment of autonomy to support surviving organisation

Q34. Taking into account the beginning (inception) of the project, please indicate which of the following statements for strategies and tasks best describe how the project was built.

- Loose or no structure, flexible, roles not defined, few if any defined tasks.
- Member links are advisory, minimal structure, some strategies and tasks identified.
- Strategies and tasks are developed and maintained, central body of people, central body of people have specific tasks.
- Formal structure to support strategies and tasks is apparent, specific and complex strategies and tasks identified, committees and sub committees formed.
- Highly formal, legally complex, permanent re-organisations of strategies and tasks.

Q35. Taking into account the beginning (inception) of the project, please indicate which of the following statements for leadership and decision-making best describe how the project was built.

- Non-hierarchical, flexible, minimal or no group decision making.
- Non-hierarchical, decisions tend to be low stakes, facilitative leaders, usually voluntary, several people form 'go-to' hub.
- Autonomous leadership, alliance members share equally in the decision making, decision making mechanism are in place.
- Strong, visible leadership, sharing and delegation of roles and responsibilities, leadership capitalizes upon diversity and organisational strengths.
- Central, typically hierarchical leadership, leadership capitalizes upon diversity and organisational strengths.

Q36. Taking into account the beginning (inception) of the project, please indicate which of the following statements for interpersonal and communication best describe how the project was built.

- Very little interpersonal conflict, communication among all members infrequent or absent.
- Some degree of personal commitment and investment, minimal interpersonal conflict, communication among members clear, but may be informal.
- Some interpersonal conflict, communication system and formal information channels developed, evidence of problem solving and productivity.
- High degree of commitment and investment, possibility of interpersonal conflict high, communication is clear, frequent and productive.
- Possibility of interpersonal conflict very high, communication is clear, frequent, prioritised, formal and informal.

Section 9

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA

Q37. Taking into account the end (completion) of the project, please indicate which of the following statements for project purpose best describe how the project was built.

- Created a web of communication, identified and created a base of support and explored interests.
- Work together to ensure tasks are done, leverage or raise money, identify mutual needs, but maintain separate identities.
- Share resources to address common issues, organisations remain autonomous but support something new, reach mutual goals together
- Merge resources to create or support something new, extract money from existing systems / members, and commitment for a long period of time to achieve short and long term outcomes.
- Unification or acquisition to form a single culture, relinquishment of autonomy to support surviving organisation

Q38. Taking into account the end (completion) of the project, please indicate which of the following statements for strategies and tasks best describe how the project was built.

- Loose or no structure, flexible, roles not defined, few if any defined tasks.
- Member links are advisory, minimal structure, some strategies and tasks identified.
- Strategies and tasks are developed and maintained, central body of people have specific tasks.
- Formal structure to support strategies and tasks is apparent, specific and complex strategies and tasks identified, committees and sub committees formed.
- Highly formal, legally complex, permanent re-organisations of strategies and tasks.

Q39. Taking into account the end (completion) of the project, please indicate which of the following statements for leadership and decision-making best describe how the project was built.

- Non-hierarchical, flexible, minimal or no group decision making.
- Non-hierarchical, decisions tend to be low stakes, facilitative leaders, usually voluntary, several people form 'go-to' hub.
- Autonomous leadership, alliance members share equally in the decision making, decision making mechanism are in place.
- Strong, visible leadership, sharing and delegation of roles and responsibilities, leadership capitalizes upon diversity and organisational strengths.
- Central, typically hierarchical leadership, leadership capitalizes upon diversity and organisational strengths.

Q40. Taking into account the end (completion) of the project, please indicate which of the following statements for interpersonal and communication best describe how the project was built.

- Very little interpersonal conflict, communication among all members infrequent or absent.
- Some degree of personal commitment and investment, minimal interpersonal conflict, communication among members clear, but may be informal.
- Some interpersonal conflict, communication system and formal information channels developed, evidence of problem solving and productivity.
- High degree of commitment and investment, possibility of interpersonal conflict high, communication is clear, frequent and productive.
- Possibility of interpersonal conflict very high, communication is clear, frequent, prioritised, formal and informal.

Section 10.

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Q41.

Thank you very much for completing this survey. We appreciate you taking the time to respond to this questionnaire.

The survey results will be available at www.lorraineskeltonkiw.wix.com/website; at the end of September 2017.

If you require a personal copy, please supply your email address here.

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Appendix 2. Semi-structured interview schedule.

University Industry Collaboration Interview 2016/17

Participant Information Sheet

Date Information Sheet Produced:

7 November 2016

Project Title

University Industry Collaboration Survey

Name of Researchers:

Prof Tim Bentley, Dr David Brougham and Lorraine Skelton

An Invitation

The broad aim of this project is to look at the industry - university collaborative project organisation. 16 areas of difference have been identified between university and commercial projects which could be expected to impact on their management and outcomes. The survey phase of the research was to understand to what extent these differences effect the collaborative research project, and how these variables effect the overall experience of the collaborative endeavour.

The interview phase of the research is to look at the areas in the research survey and explore them in more depth. The interview will be 60 minutes long, and the discussion will be kept confidential, however if you wish to obtain a short report of the main findings, there will be an area on the confidentiality agreement for you to supply your contact details. The research is part of the data collection for a PhD thesis in management and is hoped to be developed into a journal article.

What is the purpose of this research?

The primary aim of the study is to produce a research collaboration framework for discussion, so that we can more fully understand current practice and outcomes. We appreciate you being a part of this study and taking the time to attend an interview.

What will happen in this research?

The interviews will be used to discuss and develop the results of the survey to add depth to our understanding of the University – Industry collaborative project. This information will be used as part of the PhD research, and for the development of a paper and possibly articles and presentations on the subject.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Professor Tim Bentley, t.a.bentley@massey.ac.nz;

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Dr Brian Finch, Director (Research Ethics), email humanethics@massey.ac.nz. "

Whom do I contact for further information about this research?

Researcher Contact Details:

Lorraine Skelton, lorraineskeltonkiwi@gmail.com; 0272 308808

Project Supervisor Contact Details:

Professor Tim Bentley, tim.bentley@aut.ac.nz; 64(0)9 921 9999 Ext 43393

Dr David Brougham D.Brougham@massey.ac.nz; 64 (0)9 921 9999 Ext 84906

Ethics Notification Number: 4000016930

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

MASSEY BUSINESS SCHOOL

University Industry Collaboration Interview 2016/17

PARTICIPANT CONSENT FORM - INDIVIDUAL

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I agree/do not agree to the interview being sound recorded.

I wish/do not wish to have my recordings returned to me.

I wish/do not wish to have data placed in an official archive.

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: .... **Date:** ....

Full Name – printed ....

University-Industry
Research Collaboration Question Schedule

The first couple of questions looks at the context in which collaborative research is run from your perspective;

1. Are there any notable differences in research projects when we are look at the environment in which they are run
    a. For environment I would be thinking of the country, industry, organization?
2. Does the type of collaborative project make a difference to the way it is run?
    a. For type I would be thinking of length, amount of funding, and main funding bodies

This next set of questions looks at the different areas that we have found in the literature as having some reported effect on the project management and its outcomes. Although we have found 17 individual themes, we've rolled these up a higher set of 9 themes;

3. To what extent do the funders themselves make a difference to the management and outcomes of a project?
4. To what extent does the initial justification for the project make a difference to the management and outcomes of a project?
5. To what extent does the project leadership make a difference to its management and outcomes?
6. To what extent does teamwork affect the management and outcome of the research?
7. Do the timescale and completion goals make a difference to how the project is managed and its outcomes?
8. How does the view of scientific endeavor effect the project?
9. How does Intellectual property ownership affect the project?
10. What part do ethics play on the management and outcomes of collaborative research projects?
11. What part do differing career aspirations of the team members and leadership plan on the project?

The next section of questions looks at how these themes might affect a research project looking across traditional project phases and constraints;

12. If we look across the phases of a traditional project, being Conception and Initiation, Planning, Execution, Performance and Monitoring, Project

closure which phase or phases would you identify as having the most impact on the successful management of your collaborative project?

13. If we look at traditional project constraints being measured as the project Cost, Scope, Time and Quality, which has the most impact on the successful management of your collaborative projects, either positively or negatively?

The next section of questions looks at the nature of collaboration in the project;

14. Are collaborative projects successful in achieving their expected purpose and outcomes?
15. How does a collaborative project help to develop the working relationships between partners as a result of the collaboration and lead to increase joint development and interaction in those areas?
16. Have collaborations made the partners influence on each other more equal?
17. How do collaborations help to broaden understanding of the issues and problems begin discussed in the research project?

The last 2 sections of questions are the same, but look at the difference between the beginning of a collaborative project and the end of the collaborative project;

18. At the beginning of a collaboration, do you have a project process that you follow and how flexible or rigid is it in nature?
    a. Does it progress and change with the project?
19. What about the structure of the projects, processes, and hierarchy for example, who decides those, and how flexible or rigid are they
    a. Does structure change with the project?
20. How do you determine the leadership structure of the project?
    a. How does the leadership structure develop during the project?
21. How to you build your communication systems at the beginning of a project?
    a. Do they develop or change during a project?

Thank you very much for completing this survey. We appreciate you taking the time to respond to this questionnaire.

The survey results will be available at www.lorraineskeltonkiwi.wix.com/website; at the beginning of October 2017.

Appendix 3. SAFAR breakdown by sector and participant level.

	University			Government			Industry			Team members			Key participants		
	Inception		Completion	Inception		Completion	Inception		Completion	Inception		Completion	Inception		Completion
Project purpose															
created a web of communication	16	≥	10	0	=	0	15.38	≤	23.08	14.55	≥	9.09	8.33	≥	13.64
work together to ensure tasks are done	40	=	40	23.53	≤	36.36	30.77	≥	23.08	38.18	≤	43.64	29.17	≥	22.73
share resources to address common issues	14	≤	34	41.18	≥	27.27	7.69	=	7.69	16.36	≤	25.45	25	≤	45.45
merge resources to create or support	22	≥	10	17.65	≤	27.27	30.77	=	30.77	21.82	≥	12.73	20.93	≥	9.09
unification or acquisition of a single culture	8	≥	6	17.65	≥	9.09	15.38	=	15.38	9.09	=	9.09	16.67	≥	9.09
	University			**Government**			**Industry**			**Team members**			**Key participants**		
	Inception		Completion	Inception		Completion	Inception		Completion	Inception		Completion	Inception		Completion
Strategies and tasks															
loose or no structure	8.51	≤	16	11.76	≥	6.25	7.69	≤	15.38	11.11	≥	9.09	4.55	≤	22.73
member links are advisory	23.4	≥	16	11.76	≤	37.5	23.08	≤	46.15	27.78	≤	29.09	9.09	≤	18.18
strategies and tasks developed and maintained	42.55	≤	44	47.06	≥	31.25	30.77	≥	15.38	40.74	≥	36.36	36.36	=	36.36
formal structure to support strategies and tasks	23.4	≥	18	17.65	=	18.75	30.77	≥	15.38	14.81	≤	18.18	45.45	≥	18.18
highly formal, legally complex	2.13	≤	6	11.76	≥	6.25	7.69	=	7.69	5.56	≤	7.25	4.55	=	4.55
	University			**Government**			**Industry**			**Team members**			**Key participants**		
	Inception		Completion	Inception		Completion	Inception		Completion	Inception		Completion	Inception		Completion
Leadership and decision making															
non-hierarchical and flexible	10.42	≤	12.5	11.76	≥	0	7.69	=	7.69	14.81	≥	9.26	4.35	≤	9.09
non-hierarchical with facilitative leaders	31.25	≥	16.67	29.41	≥	12.5	30.77	=	30.77	35.19	≥	20.37	21.74	≥	9.09
autonomous leadership	22.92	≤	33.33	35.29	≤	43.75	23.08	≥	15.38	24.07	≤	37.04	30.43	≥	27.27
strong visible leaders	31.25	≤	33.33	11.76	≤	25	23.08	=	23.08	18.52	≤	24.07	39.13	=	40.91
central hierarchical	4.17	=	4.17	11.76	≤	18.75	15.38	≤	23.08	7.41	≤	9.26	4.35	≤	13.64
	University			**Government**			**Industry**			**Team members**			**Key participants**		
	Inception		Completion	Inception		Completion	Inception		Completion	Inception		Completion	Inception		Completion
Interpersonal and communication															
very little interpersonal conflict	12.24	≤	18	18.75	≤	23.53	25	=	23.08	18.18	≤	23.64	13.04	≥	9.09
some degree of commitment and investment	36.73	≥	28	31.25	≥	17.65	16.67	≤	38.46	29.09	≤	30.91	39.13	≥	27.27
some interpersonal conflict	26.53	≤	32	43.75	≥	23.53	25	=	23.08	30.91	≥	29.09	26.09	=	27.27
high degree of commitment and investment	18.37	≤	22	6.25	≤	29.41	33.33	≤	15.38	16.36	≥	14.55	21.74	≤	36.36
possibility of interpersonal conflict very high	6.12	≥	0	0	≤	5.88	0	=	0	5.45	≥	1.82	0	=	0