# The Effects of Intra-organisational Collaboration in Reducing Uncertainties for Enhancing the Performance of Innovation Projects: The Role of Organisational Learning

Rola Imad Fanousse

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Supervisors:

Associate Professor Dilupa Nakandala

Professor Yi-Chen Lan

Western Sydney University

School of Business

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# Statement of Authentication Page

The work presented in this thesis is, to the best of my knowledge and belief, original and a result of this PhD research endeavour except as acknowledged in the text. I hereby declare that I have not submitted this work, either in full or in part, for a higher degree at this or any other institution.

[redacted]

Signed ___________________

Rola Fanousse

22nd August 2022

# Journal Publications, Conference Proceedings and Awards

The following journal publications, conference proceedings and awards were achieved during my candidature and are reproduced in this thesis:

Fanousse, RI, Nakandala, D & Lan, YC 2021, 'Reducing uncertainties in innovation projects through intra-organisational collaboration: a systematic literature review', International Journal of Managing Projects in Business, vol. 14, pp. 1335-1358.

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# List of Abbreviations

AMOS: Analysis of Moment Structures

CEO: Chief Executive Officer

CFA: Confirmatory Factor Analysis

CFI: Comparative Fit Index

CMIN: Chi-Square Value

DF: Degree of Freedom

IFI: Incremental Fit Index

IT: Information Technology

NHMRC: National Health and Medical Research Council

NNFI: Non-Normed Fit Index

NPD: New Product Development

OECD: Organisation for Economic Cooperation and Development

PMP ©: Project Management Professional

R&D: Research and Development

RMSEA: Root Mean Squared Error of Approximation

SEM: Structural Equation Modelling

# Abstract

Innovation is essential for business prosperity and a major driver of success and sustainability in today's world. The history of organisation-level innovation projects (products, services and processes) is rich with cases of great ideas that failed to be realised as well as those creative ideas that ended in remarkable success. The rate of reported failure of innovation projects is however, much higher than reported success. Innovation project uncertainty is considered a key reason for innovation project failure (García-Quevedo et al. 2018). Scholars in innovation management studies confirm that uncertainty is a natural and intrinsically inherent characteristic of innovation projects (Roper & Tapinos 2016; Um & Kim 2018). A knowledge gap about how to reduce uncertainty in order to enhance innovation project performance however, persists. Indeed, extant research on managing innovation projects is for the most part theoretical and lacks empirical evidence regarding effective organisational practices that reduce innovation project uncertainty for successful project performance.

This research responds to this lack of empirical evidence by proposing intra-organisational collaboration as an organisational practice, and empirically examining its impact on reducing innovation project uncertainty and improving innovation project performance, whilst considering the mediation role of organisational learning in this relationship. Based on a systematic literature review, this research develops a comprehensive conceptual framework that assesses the relationships between intra-organisational collaboration, organisational learning, innovation project uncertainty reduction and innovation project performance in the context of innovation projects. The thesis draws on the three most common sources of innovation project uncertainty: task, market and technological in examining how innovation project uncertainty can be reduced through intra-organisational collaboration. Additionally, it integrates previous studies to conceptualise intra-organisational collaboration as a multi-dimensional construct made up of by five sub-constructs: collaborative relationship, collaborative leadership, communication and sharing information, trust formation, and commitment.

The study used a quantitative approach to elucidate the direct and indirect impact of intra-organisational collaboration on innovation project uncertainty reduction and innovation project performance, whilst considering the mediation role of organisational learning and innovation project uncertainty reduction. A questionnaire survey was used to collect the data from innovation project professionals around the world through LinkedIn. There were 279 collected responses and once missing data and outliers were removed, 249 were deemed useful for the data analysis. Structural Equation Modelling was used to analyse the data and validate the proposed hypotheses in two main stages of model measurement and structural model testing.

The findings showed that intra-organisational collaboration directly reduces innovation project uncertainty (task, market, and technological). Additionally, the findings revealed that intra-organisational collaboration leads to organisational learning and confirmed that organisational learning partially mediates the relationship between intra-organisational collaboration and technological uncertainty. The findings showed that task and market uncertainty reduction are however, not influenced indirectly by intra-organisational collaboration through organisational learning.

Furthermore, the findings demonstrated that innovation project performance as the ultimate dependent variable is influenced directly by intra-organisational collaboration, market, and technological uncertainty reduction. In addition, it is indirectly influenced by intra-organisational collaboration through market and technological uncertainty reduction. The findings did not support the direct impact of task uncertainty reduction on innovation project performance or its mediation role in the relationship between intra-organisational collaboration and innovation project performance. In light of these findings, this research argues that intra-organisational collaboration directly reduces innovation project uncertainty (task, market, and technological uncertainty) and indirectly reduces technological uncertainty through organisational learning. Additionally, intra-organisational collaboration directly improves innovation project performance and indirectly through innovation project uncertainty reduction (market and technological). Finally, it also established that the variables of organisation size, age, industry and experience in innovation projects do not confound the studied relationships.

The findings of this research offer several insights into the context of innovation projects. First these findings highlight the need for organisations to embed collaborative practices in their project's environment. This research found that collaborative practices operated dialectically in enhancing organisational learning and enabled project members to manage complicated tasks, foresee future demand and market changes as well as solve technological problems. These collaborative practices allowed project members to successfully reduce innovation project uncertainty and enhance project performance.

Finally, the overall findings of this research extended the usefulness of two theories: organisational information processing theory and organisational learning theory in the context of innovation projects by using them as theoretical bases for the tested conceptual model. Further this research confirms the usefulness of these theories in understanding that the relationship between intra-organisational collaboration, organisational learning, innovation project uncertainty reduction and innovation project performance is a valuable endeavour in organisational theory.

# Chapter 1: Introduction

## 1.1 Overview

This thesis empirically examines the impact of intra-organisational collaboration on reducing innovation project uncertainty and promoting innovation project performance. The three most common sources of innovation project uncertainty: technological, market and task are the focus of this study. Additionally, five dimensions of intra-organisational collaboration will be considered when testing the effect of intra-organisational collaboration on reducing these three sources of innovation project uncertainty. This thesis also investigates the role of organisational learning that results from intra-organisational collaboration on the relationship between intra-organisational collaboration and innovation project uncertainty reduction.

This introductory chapter therefore discusses the background of this research project (Section 1.2), provides a discussion of the research problem and gaps in the literature (Section 1.3) and presents the research questions and objectives (Section 1.4). This is followed by an articulation of the research scope and presentation of the conceptual framework based on a preliminary review (Section 1.5). The author's personal motivation for this thesis is then discussed followed by an explication of the significance of the study and notes its major contributions to the body of knowledge and practice regarding innovation management (Section 1.6 and Section 1.7). The chapter closes with a brief discussion of the research methods and analyses (Section 1.8), along with the limitations of the study (Section 1.9). The introductory chapter concludes with an outline of how the thesis meets the research objectives outlined in Section 1.4 (Section 1.10) and a summary of the chapter (Section 1.11).

## 1.2 Background of the Study

Innovation is increasingly perceived as a major driver of success, growth, and competitive advantage of organisations in today's world. A recent finding by Harvard Business Review suggested that innovation today is a key driver of organic growth for all companies regardless of sector or geography (Bolyes 2022). Additionally, innovation is highlighted as a top organisational strategic priority towards competitive advantage since it distinguishes one organisation from others (Bolyes 2022; Percival et al. 2013; Pisano 2015).

Innovation is defined as the process of implementing new organisational ideas and behaviours and incorporates idea generation, development, and implementation (Damanpour 1996). At the organisational level, innovation encompasses new product, services, process technologies, structures and/or administrative systems, as well as new plans or programs (Tidd & Bessant 2018).

While innovation projects are the means through which innovation is realised in organisations (Keegan & Turner 2002), success in innovation projects is never assured. For example, of every seven to ten innovative product concepts, only one commercial success is reached, with nearly 40% of innovative products failing at launch, even after successful development and testing (Cooper 2019).

Innovation project failures are associated with negative consequences that can even lead to the demise of organisations (Szatmari et al. 2020). Innovation project failures are linked with damage to the organisation through the loss of, at times, many millions of dollars and investments in resources that cannot be put into alternative use or recovered (Iacovou & Dexter 2005; Marwa & Zairi 2008). A good example is the Google Glass – Moonshot Project – it was an innovation failure that was associated with $895 million loss to Google. Additionally, Microsoft suffered a $289 million loss because of its innovation failure in Microsoft Zune (cbinsights 2021). The negative consequences of project failures impact employee morale, stifle entrepreneurial thinking, hinder learning, and suppress risk-taking behaviour, that are necessary for innovation (Shepherd & Cardon 2009; Shepherd & Kuratko 2009).

Scholars agree that high uncertainty in innovation projects is a major contributor to the high levels of failure (García-Quevedo et al. 2018; Laine et al. 2016; Lee & Veloso 2008; Um & Kim 2018). The term 'uncertainty' has long been a focus in organisational literature, indeed since the seminal work of Knight (1921) (Brink 2017; Roper & Tapinos 2016), and is defined as "the difference between the amount of information required to perform a particular task, and the amount of information already possessed by the individual" (Galbraith 1973 p.5).

Uncertainty and risk have been used interchangeably in the organisational and innovation management literature (Simangunsong et al. 2012; Walker et al. 2017), and are intrinsic features of innovation projects (Galbraith 1974; Roper & Tapinos 2016; Ryman & Roach 2022; Um & Kim 2018). This terminological conflation creates a dilemma by muddying the waters. Some define, risk as events rather than sources of substantial uncertainty (Ward & Chapman 2003) and by extension see risk management as threat-oriented. This leads to an inability to identify opportunities, which in turn potentially restricts the contribution risk management can make to enhancing project performance. On the other hand, uncertainty management combines the management of risk and opportunities, and may also reflect sources of uncertainty that shape threat and opportunity perceptions. For instance, 'known unknowns', 'unknown unknown' and bias, which cannot be overlooked in the management of projects, are already part of uncertainty management but ignored in risk management (Hall et al. 2014; Walker et al. 2017). This research therefore uses the term uncertainty rather than risk. Focusing on uncertainty may improve the project performance, as effective project management requires addressing *all* sources of project uncertainty, which are not managed in risk management (Ward & Chapman 2003).

Despite increased interest in the theme of uncertainty within the organisational literature, there is lack of agreement on the conceptualisation of uncertainty itself (Gales & Mansour-Cole 1995). This may be due to the dynamic nature of uncertainty (Winch & Maytorena 2012), and that the concept of uncertainty has a great deal of uncertainty per se (Galbraith 1974). Understanding and identifying the sources of uncertainty is essential for conceptualising and measuring uncertainty (Yan & Dooley 2013). The three most identified sources of innovation project uncertainty revealed in the current literature are: technological, market, and task (Fanousse et al. 2021b).

Scholars built on Galbraith's definition of innovation project uncertainty and commonly recognised it as inherent 'knowledge gaps between' in innovation projects. For example, knowledge gaps related to market, technology, and tasks (García-Quevedo et al. 2018; Laine et al. 2016; Lee & Veloso 2008; Rosenberg 1988; Yang et al. 2014). The need to close this gap to reduce uncertainty is thus perceived as fundamental to the innovation process, and crucial for enhancing performance and success (Alam 2006; Bolli & Seliger 2020; Moenaert et al. 1995; Van Riel et al. 2004). This is because as the degree of uncertainty in innovation projects increases, so do its negative consequences, by decreasing the clarity of the project objective, the project's strategic fit, and the team's shared goal (Zhang & Doll 2001). A high level of uncertainty creates several further difficulties in the subsequent stages of innovation process and leads to frequent deviation from project specifications (Thanasopon et al. 2016; Verworn 2009). Hence, if project members face a high degree of uncertainty and are unable to close important information gaps, the consequences are more likely to be serious and can result in project failures (Moenaert et al. 1995; Murmann 1994, Ryman & Roach 2022).

There have been significant efforts in innovation management research to study ways to reduce uncertainty in order to enhance performance. For example, in some studies, traditional risk management practices that include risk mitigation actions, and risk management processes were suggested in order to reduce New Product Development (NPD) risk and uncertainty (see for example; Chavas & Nauges 2020; Hall et al. 2014; Ilevbare et al. 2014; Oehmen et al. 2014; Reed & Knight 2010; Ryman & Roach 2022; Silvestre & Țîrcă 2019). Risk management practices were shown to be directly associated with improved decision making, program stability and problem solving, however, there remains a research gap understanding the mechanisms through which risk management practices influence NPD program success (Oehmen et al. 2014). Inter-organisational collaboration is emphasised as an important practice in dealing with inherent uncertainty and to reduce people and process ambiguities (Eriksson et al. 2017; Jugend et al. 2018; Liu & Hart 2011; Thanasopon et al. 2016; Walker et al. 2017). Open innovation is highlighted as an essential way to leverage external knowledge to reduce innovation project uncertainty (Jugend et al. 2018; Cooper 2019). Moreover, recent studies encouraged innovation alliances and networks in the reintegration of existing knowledge for the reduction of the uncertainty and risk in innovation projects (Aggarwal 2020; Ahuja et al. 2012; Phelps et al. 2012; Ryu et al. 2018; Wang & Yang 2022). However, there remains a limited empirical understanding of specific internal organisational practices which may reduce innovation project uncertainty and boost project performance. Further, few efforts have been made to empirically investigate the effectiveness of intra-organisational collaboration as an organisational practice in reducing innovation project uncertainty and improving project performance.

Although most studies discussed the value of open innovation, networking and inter-organisational collaboration in reducing innovation project uncertainties (see for example, Cooper 2019; Gkypali et al. 2017; Zhang & Tang 2017), this thesis draws critical attention to the role of intra-organisational collaboration in improving performance compared with open innovation, networking and inter-organisational collaboration. As recent studies have revealed, open innovation, networking and inter-organisational collaboration do not always lead to a "win-win" situation for all parties involved. In fact, there remains a dearth of evidence to confirm they are more effective than intra-organisational collaboration (Cooper 2019)

Intra-organisational collaboration is the subject of growing interest in the organisational literature. It is defined as the synergy between teams to fulfil a certain task and encompasses members from various functional units (Lin et al. 2015b). The multi-dimensional nature of the intra-organisational collaboration has been established by scholars (Cao & Zhang 2011; Cooper 2019; Ko et al. 2011; Lin et al. 2015b, Um & Kim 2018; Yan & Dooley 2013). However, very few studies have considered the multi-dimensional nature of intra-organisational collaboration when conceptualising it. For example, previous studies conceptualised intra-organisational collaboration as a one-dimensional construct that includes measures of collaborative relationship as well as communicating and sharing information (Gupta et al. 1986; Li & Calantone 1998; Moenaert & Souder 1990). Nevertheless, as established by Lin et al. (2015b), such an approach may unintentionally ignore other vital components of intra-organisational collaboration. Therefore, this current research provides a novel overarching re-conceptualisation of intra-organisational collaboration by integrating previous studies. Here, intra-organisational collaboration is conceptualised as an overarching construct with five dimensions: collaborative leadership, collaborative relationships, trust formation, communicating and sharing information, and commitment.

A review of the academic literature revealed that there is a scarcity of attempts to empirically explore the impact of intra-organisational collaboration in the innovation projects context. As suggested by Lin et al. (2015b), the new conceptualisation of intra-organisational collaboration as a multi-dimensional construct is the first step towards building a much-needed body of knowledge on cross-functional collaboration and its effectiveness in supporting other industrial activities. This is a critical research context since innovation is a key driver of business growth and prosperity.

Previous studies showed that intra-organisational collaboration supports learning and knowledge creation within organisations. The importance of learning for innovation has indeed been demonstrated in theory and practice (Gkypali et al. 2017), yet the role of organisational learning that results from intra-organisational collaboration has not been empirically examined in the innovation project context within the literature. Moreover, the importance of organisational learning in reducing uncertainty has been assumed, but not tested directly

(Stevens 2014). Additionally, what is not yet known is the role organisational learning plays in the relationship between intra-organisational collaboration and innovation project uncertainty reduction. This thesis addresses the phenomenon and the literature gap.

## 1.3 Research Problem and Gaps in the Literature

Understanding the high rates of failure in innovation projects has been a driving factor behind extant studies in organisational literature that seek to determine ways to enhance performance and success in innovation projects (Chavas & Nauges 2020; Gkypali et al. 2017; Jugend et al. 2018; Ryman & Roach 2022; Silvestre & Ţîrcă 2019; Zhang & Tang 2017). This is a critical area of research since innovation is a key driver of business growth and prosperity. Yet, the factors and practices that contribute to a successful innovation project remain vague (Cooper 2019).

Innovation project uncertainty is highlighted as a major reason for the high rate of failure in innovation projects (Krane & Olsson 2014; Liu & Hart 2011; Souder & Moenaert 1992). Despite seminal and recent research examining ways to reduce innovation project uncertainty, an understanding of how to best manage innovation project uncertainty remains elusive. There is a current scarcity of empirical evidence for effective organisational practices that reduce innovation project uncertainties to improve innovation project performance. Scholars are yet to examine the impacts of the variety of links among aspects of intra-organisational collaboration for reducing innovation project uncertainty. Consequently, the role of organisational learning in facilitating this linkage remains unexamined.

Moreover, while research studies emphasise the importance of intra-organisational collaboration as a crucial factor for success in innovation projects (Bendig et al. 2018; Cooper 2019; Cserháti & Szabó 2014; Rodríguez et al. 2008), there remains no study that considers the multi-dimensional nature of intra-organisational collaboration that tests its impact on innovation project uncertainty reduction and innovation project performance.

Based on the research background discussed in section 1.2, there is a need to understand how to reduce innovation project uncertainty in the innovation management context. This is required to minimise failure rates in innovation projects. Accordingly, this thesis responds by examining the impact of intra-organisational collaboration on reducing the impact of the three most common sources of innovation project uncertainty. In doing so, the thesis provides a more coherent and comprehensive understanding of the organisational practices through which innovation project uncertainty can be reduced and performance enhanced. The next section presents the research questions and objectives that this research seeks to address.

## 1.4 Research Objectives and Research Questions

In the context of previous research and the consequent knowledge gap, there is a clear need and opportunity to understand the role of intra-organisational collaboration in reducing innovation project uncertainty and enhancing performance. This thesis identifies the dominant sources of innovation project uncertainty in the innovation literature, explores the main dimensions of intra-organisational collaboration from the literature and integrates them into a multi-dimensional construct. In doing so, this research scrutinises the impact of intra-organisational collaboration on reducing innovation project uncertainty and enhancing performance, whilst accounting for the role of organisational learning in enabling this relationship. Hence, the main research objectives to be addressed in this research are:

1. To develop a comprehensive conceptual framework that assesses the relationships between intra-organisational collaboration, organisational learning, innovation project uncertainty reduction and innovation project performance in the context of innovation projects.
2. To empirically examine the direct impact of intra-organisational collaboration on reducing innovation project uncertainty and its indirect impact through organisational learning.
3. To empirically examine the direct impact of intra-organisational collaboration on enhancing innovation project performance and its indirect impact through innovation project uncertainty reduction.

Through addressing the above research objectives, the main research questions will be addressed which include:

4. What are the key sources of uncertainty in innovation projects that have been addressed in the academic contributions?
5. What are the key dimensions of intra-organisational collaboration in innovation projects that have been identified in academic contributions?
6. How does intra-organisational collaboration lead to innovation project uncertainty reduction?
    a. How does intra-organisational collaboration lead to organisational learning?

b. How does organisational learning as the most important outcome of intra-organisational collaboration come into play in the relationship between intra-organisational collaboration and innovation project uncertainty reduction?

7. How does intra-organisational collaboration lead to enhanced innovation project performance?
8. Does innovation project uncertainty reduction (task, market, and the technological) mediate the relationship between intra-organisational collaboration and innovation project performance?
9. Do organisation size, age, industry and experience in innovation project confound the relationships between intra-organisational collaboration, organisational learning and both innovation project uncertainty reduction and performance?

The research objectives are conceptualised into testable hypotheses in the fourth chapter of this thesis. The proposed conceptual framework is shown in the following section to present a concise summary of the research.

## 1.5 Scope of the Study

The proposed investigation is built on two theoretical considerations: organisational information processing theory and organisational learning theory (discussed in chapter 2), and will cover:

- While the terms uncertainty and risk have been used interchangeably in the wider innovation literature, this research is focused only on uncertainty in innovation projects.
- Although many sources of innovation project uncertainty have been discussed in the literature, the main focus of this research is reducing the three most common sources of innovation project uncertainty: market, the technological, as well as task. Only these three uncertainties are included in the tested conceptual model. Other uncertainties such as financial, collaboration, environmental etc., are not included in this research.
- Of all the organisational practices that have been discussed in literature, this research is focused on intra-organisational collaboration and its impact on reducing innovation project uncertainty and promoting performance.
- Previous studies are consolidated to provide a single comprehensive conceptualisation of the intra-organisational and only include five dimensions: collaborative leadership,

collaborative relationship, trust formation, communication and sharing information, and commitment.

- While many outcomes of intra-organisational collaboration have been uncovered in the literature, organisational learning is the only outcome that is included as a mediating factor in the model in the relationship between intra-organisational collaboration and innovation project uncertainty reduction. This is in part because organisational learning is identified as a major outcome of intra-organisational collaboration in literature. Other intra-organisational collaboration outcomes such as mutual understanding and team's loyalty are not included in the research.
- Toward generalisability of the findings, primary data has only been collected from innovation project professionals around the globe through an online survey. Data from non-innovation project professionals were not included in the data collection.
- The proposed conceptual model has been tested to verify the direct relationships and the mediating effects of some of the variables in the model.

The conceptual framework presented in Figure 1.1 depicts a complex set of relationships that exist among the direct impacts of intra-organisational collaboration on organisational learning, innovation project uncertainty reduction and innovation project performance. The Figure also indicates the mediating role of organisational learning in the relationship between intra-organisational collaboration and innovation project uncertainty reduction. Further, the mediation role of innovation project uncertainty reduction in the relationship between intra-organisational collaboration and innovation project performance is also depicted in the Figure. All the suggested relationships based on the literature require the empirical verification, which will be achieved through this study.

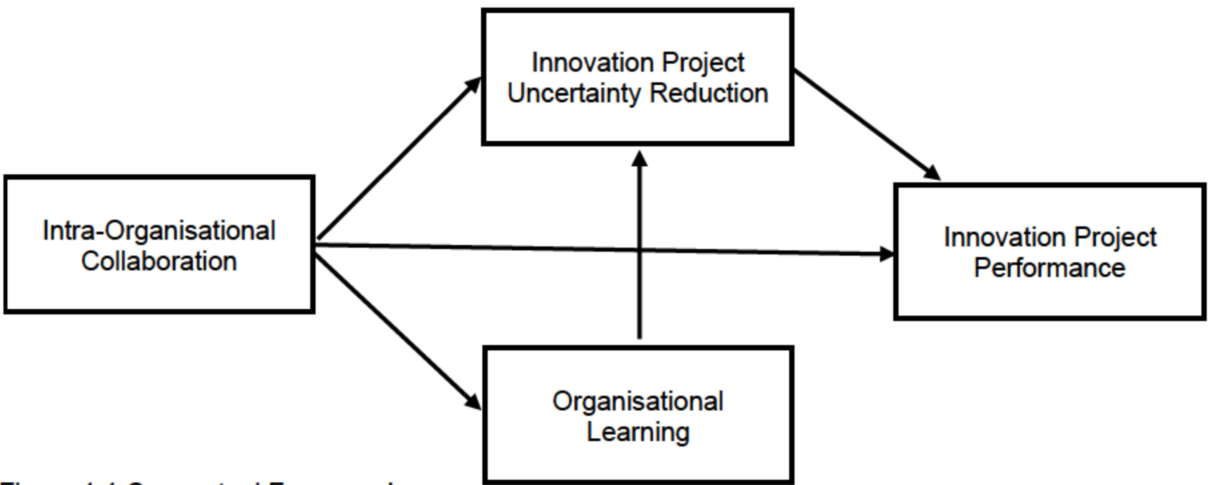


Figure 1.1 Conceptual Framework

## 1.6 The Author’s Personal Motivation

My background in IT project management motivates my desire to find ways to enhance the success of innovation projects. My PhD thesis reflects my passion about innovation project management as it promises to guide innovation project management professionals to the best organisational practices for successful innovation project management. Through this thesis, a novel model will be proposed and empirically verified as a best practice approach for reducing the uncertainties that are inherent in innovation projects and can subsequently enhance the success of such projects.

## 1.7 Significance of the Study and Major Areas of Contributions

The study is significant both theoretically and practically. From a theoretical perspective, the research examines two organisational theories; organisational information processing theory and organisational learning theory, to gain a better understanding of the relationship between intra-organisational collaboration, organisational learning, innovation project uncertainty reduction and innovation project performance. This builds an understanding of the generalisability of these theories by extending their tenets into innovation project management.

Second, the review of the innovation management literature revealed the most common sources of innovation project uncertainty and those most frequently focused on in the literature are market, technological, and task. This is significant, since despite uncertainty as a common focus in the literature, there is little consensus about the concept itself-ironically, the concept of uncertainty is itself uncertain (Galbraith 1974; Gales & Mansour-Cole 1995). Building on this, a plethora of studies have placed emphasis on the need to identify the sources of uncertainty in innovation projects, through the belief that being able to identify its sources underpins an ability to understand and measure it (Yan & Dooley 2013). A synthesis of the many sources of uncertainty identified in previous studies confirmed three - market, technological, and task as the most common sources of uncertainty in innovation projects (Bailey et al. 2010; Kim & Vonortas 2014; Souder & Moenaert 1992); these form the main focus of this research and the basis for its proposed significance.

Third, this study is the first in the innovation management literature to examine the impact of the new multi-dimensional conceptualisation of intra-organisational collaboration for reducing uncertainty. This research integrates a number of studies to provide a more comprehensive conceptualisation of intra-organisational collaboration, a construct that here is defined as consisting of five sub-constructs: collaborative leadership, collaborative relationships, trust formation, communicating and sharing information, and commitment.

Fourth, although there is extant research on the importance of organisational learning in innovation performance, the mediating role of organisational learning in the relationship between intra-organisational collaboration and innovation project uncertainty reduction has not been examined. Thus, this research is significant as it is the first attempt to empirically determine the role of organisational learning in this context.

Fifth, the conceptual framework proposed in this research is empirically validated and achieved a good fit to the data. Thus, the research contributes to the innovation management literature by proposing an empirically validated conceptual model that can be used as a best practice approach by innovation project professionals when running innovation projects in collaborative environments.

Sixth, the research contributes to the innovation management literature by incorporating primary data from innovation project professionals around the globe into an empirical generalisation of the findings where managerial implications in an innovation management context are significant.

Finally, this research contributes a methodological approach to innovation management research by rigorously assessing construct measures for their reliability and validity through an appropriate methodological process. Thus, the findings of this research expand our understanding of intra-organisational collaboration, innovation project uncertainty, organisational learning, and innovation project performance, via measurement tools that are tested and then verified for their reliability and validity.

From a practical perspective, firstly, the research determined the dominant sources of innovation project uncertainty. This increases real-world awareness of the important uncertainties to be addressed and managed for better performance in innovation projects. Second, the comprehensive conceptualisation of intra-organisational collaboration sheds light on the important collaborative practices that should be forged in organisations to achieve collaborative innovation environments. Third, the findings highlight organisational learning as a way in which project practitioners can deal with future project challenges, by being more responsive as well as flexible to change, improving actions, preventing recurring mistakes, and learning new ways to deal with them. Finally, the findings inform an appreciation among project practitioners for establishing a collaborative and learning environment when implementing an innovation project in order to effectively manage project uncertainties.

## 1.8 Research Method and Analysis

The theoretical foundations underpinning the study are organisational information processing theory and organisational learning theory which are covered in Chapter 2. A conceptual research framework is derived, based on the systematic literature review, to present the hypothesised relationships to be examined in this study. To verify the conceptual research framework, a quantitative approach has been employed (discussed further in chapter 5). Primary data were collected from 277 innovation project professionals around the globe through an online survey to conduct quantitative testing of the proposed model. After elimination of responses with missing data and outliers, 249 responses were used in the data analysis. Covariance Based Structural Equation Modelling (CB-SEM) is utilised in this study for testing the conceptual model. Initially, measurement models in CFA were established and tested using Analysis of Moment Structures (AMOS) 26.0.0 software. In the process of model refinement, six measurement items out of 50 were excluded. The remaining 44 items with six construct measures have been included in the model for empirical testing. A detailed discussion on research methods and analysis is presented in chapters 5 and 6.

## 1.9 Limitations of the Study

Due to time and resources constraints, this study collected data from innovation groups in LinkedIn that have mainly members from Australia and UAE with only a few responses collected from other countries including Canada and the US. Additionally, most of the innovation types in the data collected were process and product innovation types, with fewer numbers recorded for business innovation and marketing innovation. The proportional diversity in data allows a comparison between the different groups, however due to the time limit, the data collection stopped when 277 responses were collected. A detailed discussion on the limitations of the study is provided in Chapter 9.

## 1.10 Thesis Outline

The structure of this research thesis follows the structure of the doctoral thesis recommended by Perry (1998). The study commences by outlining the broad view of innovation and innovation projects that forms the focus of the research issue. The research problem is then identified alongside the proposed conceptual framework. The main bodies of literature and theoretical contributions of scholarship in the thesis area are then reviewed, giving context to the proposed conceptual model to be empirically tested and verified. The thesis incorporates the following eight chapters in addition to the introduction chapter:

Chapter 2: **Theoretical Foundation of the Study** reviews the theoretical lens of the study including organisational information processing theory and organisational learning theory. The chapter also justifies the use of these two theories in this thesis.

Chapter 3: **Literature Review** explores scholarship on innovation project uncertainty in innovation projects context. Additionally, the literature on intra-organisational collaboration is reviewed, considering its five important dimensions. The literature on organisational learning as a major outcome of intra-organisational collaboration is also presented.

Chapter 4: **Conceptual Framework** presents the conceptual model developed, with hypothesised relationships, which contain direct effects and those that are achieved through mediators and thus indirect. This chapter also explains the theory behind the development of each hypothesis.

Chapter 5: **Methodology and Research Design** covers all the relevant aspects of the quantitative research approach followed in this research. This chapter incorporates the rationale for adopting a quantitative survey for this research, provides an overview of the population and sample, response rate, unit of analysis, selection key informants, measurement of constructs, research instrument, survey data, and the data analysis tool.

Chapter 6: **Preliminary Data analysis** includes two major sections: sample profile and measurement model development. The sample profile details the sample demographics, responses, data cleaning and descriptive statistics. Secondly, in the process of measurement validation, common method bias problem and its procedural remedies are discussed. Additionally, all construct measures have been assessed individually in CFA models and sequentially in an overall measurement model to verify the unidimensionality of the measures. Construct validity and reliability are also assessed in this chapter.

Chapter 7: **Structural Model Assessment and Hypotheses Testing** presents the structural model and tests it in SEM to verify the overall fit to the data and the theory. Further, the research hypotheses are tested, reported thoroughly.

Chapter 8: **Discussion** discusses the results pertaining each of the main hypothesis and the results are linked with previous studies.

Chapter 9: **Conclusion** provides the research summary and implications. This chapter synthesises the overall findings, which follows the theoretical and practical implications of the research in the field of innovation management. Detailed contributions to innovation management theory and body of knowledge are also demonstrated. Based on the findings of this research, the limitations of this research are discussed. Finally, future research directions are suggested.

## 1.11 Summary

Overall, this chapter provides the background and overview of this research. Based on the background discussion, the research gap in the literature is explicitly specified, which establishes a need to provide evidence of organisational practices that reduce innovation project uncertainty and enhance the performance while also considering the role of organisational learning. The research problem, questions, and objectives make clear the significance of this research. This chapter also presents an outline of the thesis, incorporating the conceptual framework employed in this research, the methodology, and areas of contribution as well as limitations of the study. Given the framework of this thesis, the next chapter demonstrates a thorough discussion of the relevant theories which emerged from a comprehensive review of the literature on innovation uncertainty, intra-organisational collaboration, organisational learning, and innovation project performance.

# Chapter 2: Theoretical Foundations of the Study

## 2.1 Overview

This chapter details the theoretical foundations underpinning the study: organisational information processing theory and organisational learning theory. Organisational information processing theory emphasises the relationship between intra-organisational collaboration and innovation project uncertainty reduction. Organisational learning theory stresses the importance of intra-organisational collaboration and knowledge sharing in knowledge creation and diffusion in an organisation. This chapter reviews organisational information processing theory (Section 2.2) and organisational learning theory (Section 2.3) and then justifies including the two theories to provide a more robust foundation for this research (2.4).

## 2.2 Organisational Information Processing Theory

Organisational information-processing theory has been utilised widely as a key conceptual framework for understanding innovation (Cuijpers et al. 2011). Moreover, it is one of the most quoted theories in the literature when examining the impact of uncertainty (Alam 2006; Clark & Fujimoto 1991; Souder & Moenaert 1992; Van Riel et al. 2004; Verworn 2009). Organisational information processing theory proposes that the tasks of organisational departments are different in their level of uncertainty. As defined in the background section in chapter 1, uncertainty is defined as the difference between information possessed about the task and information needed to complete the task (Galbraith 1974). The theory suggests that the higher the degree of uncertainty of a task, the greater the amount of information required to fill the knowledge gap and attain a higher performance (Galbraith 1974; Tushman & Nadler 1978). The nature of the organisation departments' work is a major determinant of the level of uncertainty. Accordingly, the theory identifies three sources of work-related uncertainty: task characteristics, task environment as well as inter-department task interdependence (Tushman & Nadler 1978).

Task characteristics includes task predictability, complexity and interdependence (Tushman & Nadler 1978). Task predictability is commonly identified as a strand of task uncertainty among organisational studies (Lynch 1974). Tasks vary in their level of predictability and hence in the level of uncertainty (Galbraith 1974). Task complexity and interdependence are further sources of uncertainty and information processing requirements (Comstock & Scott 1977). As complex and interdependent tasks cannot be pre-planned, they are associated with greater uncertainty (March & Simon 1958).

The second source of work-related uncertainty, the task environment, involves external factors attended to by organisational members and not under the control of organisation departments (Weick 2015). Hence, task environment is unpredictable and a source of uncertainty. Research identifies many drivers of uncertainty in the task environment including the state of the environment (Duncan 1972), the situation itself, the multiple project members involved and making concurrent efforts (Von Corswant & Tunälv 2002), and/or technology and market newness (Moenaert et al. 1995). The more dynamic the environment, the higher the levels of uncertainty confronted by the organisational departments (Duncan 1972).

Inter-department task interdependence is the third identified source of work-related uncertainty, and it is understood as the degree to which a department is dependent upon another department to complete the task. It is associated with the need for effective coordination and joint problem-solving (Van de Ven et al. 1976). The more complicated the inter-department task interdependence, the higher the level of uncertainty which must be managed by the organisational departments (Van de Ven et al. 1976).

The three sources of work-related uncertainty explained in organisational information processing theory are intrinsic characteristics of innovation projects (Fanousse et al. 2021b, Lievens & Moenaert 2000; Um & Kim 2018). Organisational information processing theory claims that as the amount of uncertainty faced by organisational departments increases, the need for information processing increases (Tushman & Nadler 1978). Organisations can anticipate the risks involved in the innovation projects by sharing and processing information among organisational departments (Cuijpers et al. 2011; Peng et al. 2014). High uncertainty yields greater information processing requirements for the whole organisational structure (Zaltman et al. 1973). Effective information processing has been found to reduce uncertainty and enhance performance (Tushman & Nadler 1978). Scholars, who built on this theory, confirm that reducing uncertainty enhances innovation project performance (Alam 2006; Moenaert et al. 1995; Van Riel et al. 2004; Verworn 2009; Verworn et al. 2008).

Beyond the sources of uncertainty, organisational information-processing theory is the primary theoretical lens scholars employ to examine innovation collaboration (Mishra & Shah 2009). Organisational information-processing theory is mainly concerned with the internal structure of the organisation and provides a robust theoretical basis to clarify how organisation structure impacts upon innovation (Cuijpers et al. 2011). Specifically, organisational information-processing theory suggests organisations build internal design/ structures that have congruence with the uncertainty of a given task; the higher the degree of task uncertainty, the more flexibility is needed in the internal organisation structure (Daft & Lengel 1986; Tushman & Nadler 1978). This is because flexible design/structures allow more information to be processed which helps reduce uncertainty and enhances innovation project performance (Cuijpers et al. 2011). The structure of an organisation should thus fit the attributes of the internal and external variables of the organisational system (Daft & Lengel 1986; Tushman & Nadler 1978).

Organisational information processing theory accordingly conceptualises organisations as open social systems, information processing systems and sets of groups or departments. Organisations conceptualised as open social systems deal and respond to several sources of work-related uncertainty (Katz & Kahn 1978). These organisations rely on inputs from an external turbulent environment which necessitates the ability to manage environmental-based uncertainty (Weick 2015). The different functional units inside organisations must be able to solve problems associated with diverse tasks, and with the tasks' interdependence (Tushman & Nadler 1978). To do so, organisations must establish information processing mechanisms that enable them to deal with internal and external sources of uncertainty (Zaltman et al. 1973).

Organisations envisaged as information processing systems (Tushman & Nadler 1978) respond to uncertainty by forging effective configurations of work units including a linkage to enable effective information collection, processing, and distribution (Duncan 1973). The information includes plans, work standards, budgets, performance feedback, inventory levels, external technical and market condition, etc (Galbraith 1974).

Organisations that consist of a set of groups or departments expand to achieve economies of scale and areas of specialisation; departments are created for specific tasks and with features (Katz & Kahn 1978). The departments are interdependent to varying levels, and their activities are connected, with limited resources being shared among them (Van de Ven et al. 1976). This type of organisation focuses on creating structure that enables effective coordination between distinct, but interdependent, departments (Comstock & Scott 1977).

As noted, uncertainty is an intrinsic characteristic of innovation projects that necessitates the need to have information processing within the organisation. The high information processing requirements necessitate collaboration, communication, and coordination among the organisational departments (Tushman & Nadler 1978). This is in part because collaboration, communication, and coordination enable effective problem solving and the synthesis of different points of view. For example, information about the functions of various organisation components, the quality of outputs, and external technological and market domain conditions can and should be shared and processed (Tushman & Nadler 1978). Thus, intra-organisational collaboration improves innovation projects through allowing the sharing and processing of large amounts of information among departments (Cuijpers et al. 2011; Daft & Lengel 1986).

To sum up, organisational information processing theory has served as one of the main conceptual frameworks for understanding uncertainty and collaboration (Cuijpers et al. 2011; Peng et al. 2014; Tatikonda & Rosenthal 2000b). The theory identifies three work-related uncertainties: department task characteristics, task environment and inter-department task interdependence. These three uncertainties are inherent in innovation projects. The theory asserts that organisations can anticipate and respond to several sources of uncertainty through increasing their information processing capacity among organisational departments.

Additionally, the theory conceptualises organisations as open social systems, information processing systems and sets of groups or departments where organisational functional units collaborate to increase the information processing within an organisation. The importance of collaboration in increasing information processing to more effectively manage uncertainty has been addressed in innovation management studies (Cuijpers et al. 2011; Peng et al. 2014; Tatikonda & Rosenthal 2000b, West 2000). The theory, however, has so far, not been well integrated into empirical investigations of the effects of intra-organisational collaboration in uncertain environments. This research responds to this gap and employs organisational information processing theory to empirically investigate the effect of intra-organisational collaboration in reducing innovation project uncertainty and enhancing performance.

## 2.3 Organisational Learning Theory

The concept of learning fundamentally emerged in the field of psychology and has become increasingly interesting to the organisational literature (see for example, Bontis et al. 2002; Dodgson 1993; Fiol & Lyles 1985; Huber 1991; Nonaka & Takeuchi 1995; Slater & Narver 1995). Organisational learning is the ability

> "within an organization to maintain or improve performance based on experience. This activity involves knowledge acquisition (the development or creation of skills, insights, and relationships), knowledge sharing (the dissemination to others of what has been acquired by some), and knowledge utilization (integration of learning so that it is assimilated and broadly available and can be generalised to new situations)" (DiBella et al. 1996 p. 363).

Learning in organisations is referred to as the accumulated learning, training and development of individuals and a learning organisation integrates individual learning into its organisational learning (Ikehara 1999), with the significant role of individual learning in organisational learning widely recognised (Argyris & Schon 1978).

Organisational learning takes place when individuals within an organisation encounter a challenging situation and start to investigate it on the organisation's behalf (Wang & Ahmed 2003). Individuals, during their investigation, experience an unforeseen discrepancy between expected and actual results of action and start a process of thought and further action in responding to that mismatch. As a result, their understanding of organisational phenomena is adjusted and their activities are reformed to bring outcomes and expectations into alignment, hence transforming organisational theory-in-use (Wang & Ahmed 2003). In this way, individuals are "agents" that promote their organisations' learning (Argyris & Schon 1978).

The learning and behaviour of the individuals within a learning organisation contributes to its development (Kolb 1984). Further, the capability of individuals in an organisation to learn faster than those in other organisations forms a viable competitive advantage at the disposal of a learning organisation (Wang & Ahmed 2003). Hence, a learning organisation should expand the individual development of its employees since organisational learning occurs when individuals interact with others by the process of learning and experience (Preston et al. 1999). Accordingly, organisational learning is a result of a collection of individuals learning within the organisation. While this collective learning occurs at the individual level, it cannot occur if all the individuals in an organisation are not allowed to learn (Kim & Mauborgne 1999). Consequently, a learning organisation can be explained, or measured, in terms of the sum of accumulated individual combined with collective learning (Hyland & Matlay 1997).

The learning activities of individuals are enabled or the inhibited by an eco-system of factors named as organisational learning (Argyris & Schon 1978). Accordingly, the learning-based interactions between individuals and the organisation that employs them are crucial in enhancing the learning (Fiol & Lyles 1985). Learning is, however, not always positive. Individuals in an organisation may learn something negative in relation to the organisation, or learn to improve themselves, rather than improving their organisation (Field 1997), or fail to learn in the environment. Additionally, the relationship between individual and collective learning is the key factor that differentiates learning organisations from one another (Matlay 2000).

Organisational learning research has also defined organisations as learning systems (Revans 1982), and argued that organisational learning occurs when organisations understand and manage their experiences (Fiol & Lyles 1985). The system view of organisational learning is derived from the information processing perspective (Cyert & March 1963). Within this view, organisations are defined as information processing systems that involve activities such as information acquiring, interpreting, distributing, and storing within the organisation (Huber 1991).

A robust ability to transform acquired information and knowledge is imperative when developing innovation as it yields connections between different pieces of information, thus reducing uncertainty (Strese et al. 2016). Transforming acquired knowledge is likewise significant in obtaining a comprehensive understanding and creating broader perspectives (De Luca & Atuahene-Gima 2007). Increased knowledge reduces the variability of performance and makes it more reliable (James 1991; Levinthal & March 1993). As work is standardised and techniques are learned through increased knowledge, variability, both in the time required to realise tasks, and in the quality of task performed, is decreased (James 1991; Levinthal & March 1993). Ultimately, the total value of knowledge gained, both collectively and individually, is leveraged through translating and integrating the knowledge into novel products or services (Grant 1996).

This thesis builds on organisational learning theory and proposes that intra-organisational collaboration enables organisational learning that reduces uncertainty in innovation projects. An intra-organisational collaboration capability enables employees to identify, absorb, transform, and implement valuable knowledge across functional departments (Luo et al. 2006). When intra-organisational collaboration ability involves employees' skills, organisations with a high level of collaboration capability within their departments are able to promote innovations through organisational learning (Strese et al. 2016). The capability to acquire knowledge increases the breadth and depth of the organisational knowledge base and enables organisational learning, which is crucial in innovation projects (Abernathy & Clark 1985; García-Morales et al. 2012; Yli-Renko et al. 2001).

In this study, intra-organisational collaboration is defined as a means to achieve and exploit knowledge to reduce uncertainty in innovation projects and enhance innovation project performance. A large body of work has built on organisational learning theory and its information processing perspective, emphasising the imperative role of the collaborative knowledge sharing among individuals within an organisation in enhancing the learning (De Luca & Atuahene-Gima 2007; García-Morales et al. 2012; Maltz & Kohli 2000; Rindfleisch & Moorman 2001). Yet, the explanation provided by organisational learning theory of organisational learning as an enabler in the relationship between intra-organisational collaboration and innovation project uncertainty, has not been empirically validated. Therefore, this research strives to fill this identified gap by empirically studying the impact of intra-organisational collaboration on enabling organisational learning. This research also empirically investigates whether organisational learning explains the impact of intra-organisational collaboration on innovation project uncertainty reduction.

## 2.4 A Combined Theoretical Approach

The combination of organisational information processing theory and organisational learning theory explains the multi-dimensional concepts of this thesis. These include innovation project uncertainty, intra-organisational collaboration and organisational learning. Organisational information processing theory is the main theoretical lens through which scholars have examined innovation collaboration and uncertainty (Cuijpers et al. 2011; Peng et al. 2014; West 2000). Organisational information processing theory emphasises the importance of collaborative organisational functional units to increase information processing that reduces uncertainty and enhances performance (Tushman & Nadler 1978). Organisational learning theory also stresses the importance of collaboration to enhance the collective learning within an organisation. If the individuals in an organisation do not learn, collaborate, communicate, and share knowledge to enable the information processing within an organisation, organisational learning cannot occur (Kim & Mauborgne 1999). Organisational learning theory emphasises collaboration to enable knowledge acquisition, knowledge sharing, and knowledge utilisation (DiBella et al. 1996) to optimise the organisation's information processing systems. However, organisational information processing theory does not explicitly acknowledge the key role of organisational learning in processing information within an organisation. Thus, when organisational learning theory, which explains the importance of collaboration and information processing in creating knowledge, is combined with organisational information processing theory, a complementary conceptual framework to underpin and inform this research is formed.

In summary, organisational information processing theory is a prominent framework that has been widely utilised in discussions around uncertainty and innovation collaboration in the organisational literature (Galbraith 1974). Additionally, organisational learning theory and its information processing perspective explicitly acknowledges and explains the importance of intra-organisational collaboration in enhancing organisational learning and performance (De Luca & Atuahene-Gima 2007; García-Morales et al. 2012; Maltz & Kohli 2000; Rindfleisch & Moorman 2001). Thus, the two theories complement each other and together provide a robust theoretical foundation to underpin the study of innovation project uncertainty, intra-organisational collaboration organisational learning studies and their complex set of interconnected relationships. The following chapter reviews the literature in innovation project uncertainty, intra-organisational collaboration, and organisational learning.

# Chapter 3: Literature Review

## 3.1 Overview

This chapter reviews the extant literature on innovation project uncertainty, intra-organisational collaboration, and organisational learning studies. The chapter consolidates these studies to identify the relationships between innovation project uncertainty, intra-organisational collaboration and organisational learning that support innovation project performance.

This chapter first reviews the literature on innovation and innovation projects (Section 3.2), and briefly includes the systematic literature review method adopted in this study (Section 3.2). It then reviews the literature on innovation project risk and uncertainty (Section 3.4) and the sources of innovation project uncertainty: task, market and technological (Section 3.5). A review of uncertainty reduction in innovation projects and innovation project performance follows (Section 3.6). The uncertainty reduction strategy proposed in this study: intra-organisational collaboration, is then critically reviewed using intra-organisational collaboration dimensions identified in the literature (Section 3.7) and the impact of intra-organisational collaboration on innovation project performance (Section 3.8). The chapter then examines the links between organisational learning and its processes (Section 3.9) and intra-organisational collaboration, and between organisational learning and innovation project uncertainty (Sections 3.10 and 3.11) This critical review explicitly identifies the gaps in the literature this research addresses in a summary that concludes the chapter (Section 3.12).

The majority of the content of this chapter: innovation project uncertainty, intra-organisation collaboration, organisational learning and innovation project performance, has already been published in the *International Journal of Managing Projects in Business* and presented in 2021; International Conference on Industrial Engineering and Engineering Management (IEEM) and the International Society for Professional Innovation Management Conference 2021 (ISPIM) (Fanousse et al. 2021b, Fanousse et al. 2021a). The identification of the three common sources of uncertainty: task, market and technological, as well as the conceptualisation of intra-organisational collaboration with five dimensions: collaborative relationship, collaborative leadership, communication and sharing information, trust formation, and commitment have already been published in the same publications mentioned above.

## 3.2 Innovation and Innovation Projects

Innovation is a major driver of success, growth, and competitive advantage for firms in today's world. Schumpeter, the originator of innovation theory, defines innovation as new idea that is applied commercially (Schumpeter 2016). He emphasises the distinction between invention and innovation, explaining invention produces ideas while innovation is the implementation of novel ideas. Schumpeter's innovation theory continues to be used, and extended, in more recent studies of innovation in organisations (see for example, Daft 1978; Damanpor 1996; Rogers 2010; Tan et al. 2022). Damanpour (1996) for example, provides the most widely used definition of innovation in studies of the last decade. His research, which concentrates on innovation at the organisation level, defines innovation as the implementation of new idea and behaviour in the organisation (Daft 1978; Damanpour & Evan 1984). He also considers innovation as a way in which organisations evolve, either as a response to external environmental changes or as a proactive action to change the environment (Damanpour 1996). This aligns with Roger's (2003) later definition of innovation as the implementation of an idea, practice or object that is conceived as new or an improvement by the entity adopting it.

More recently, the Organisation for Economic Cooperation and Development's (OECD) Oslo Manual (2018) provides an internationally accepted definition of innovation that makes a distinction between innovation as an outcome and activities needed to come up with innovation. The manual defines innovation as the implementation of a new or enhanced product (good or service), process, a new organisational method in business practices, workplace organisation or external relations or a new marketing method (OECD. et al. 2005). The OECD's Bogota manual proposes a broad definition of innovation explicitly for developing countries that includes technological and organisational innovations (Salazar & Holbrook 2004). It defines innovation as any action taken by an organisation that aims to apply any concepts, ideas and methods required for acquiring and integrating new knowledge (Jaramillo et al. 2001).

The novelty and newness of innovation is context specific however, as it depends on the adopter's experience; what seems innovative in one context could be routine in another (Zhou et al. 2017). Hence, definitions of innovation need to entail the new idea, practice or object to be implemented to assess if it is an innovation.

Whether innovation is a process or a discrete event is widely debated (Bessant 2003; Cooper 1998; Damanpor 1996). Joseph Schumpeter (1941) views innovation as a specific form of change process in which things are seen and done differently because of the innovation which he refers to as creative destruction (Schumpeter 2013). In part, this is because it reflects discontinuity with the past (Bessant 2003). Innovation is also perceived as an iterative process in which an idea is iteratively developed, continually improved and implemented over time (Utterback & Abernathy 1975). Innovation is also referred to as a process of success and failure (Smits 2002) due to the uncertainty innovators face in making rational choices (Foster 2010).

Most scholars agree that innovation is a process that involves different stages, from initiation to implementation (see for example, Altshuler & Zegans 1997; Rogers 2010). Damanpour (1996), for example, details innovation as a process that encompasses idea generation, development, and implementation. Sotarauta & Srinivas (2006) conceptualise an evolutionary, four stage generic process from invention to innovation through variation, selection, retention, and struggle. In the stage of variation, ideas are generated where some will be selected, and others will be eliminated based on the organisational capabilities and environmental factors. Retention refers to the duplication of selected ideas with the result that they are duplicated in the future. Struggle may occur due to the scarcity of resources within organisations.

Rogers (2010) process of innovation is a five-stage process: agenda-setting, matching, redefining/restructuring, clarifying, and routinising. In agenda-setting, organisations identify a problem that requires an innovation. The problem is then matched with the innovation to be implemented. In the redefining/restructuring stage, the innovation is altered and re-invented to fit the organisation and in clarifying, a detailed definition of the relationship between the organisation and the innovation is presented. Lastly, the innovation becomes a part of the organisation's everyday routine.

Regardless of the different definitions and perceptions of innovation as a process, innovation is implemented through a project (Keegan & Turner 2002). Thus, innovation projects are the means through which organisations implement innovation (Keegan & Turner 2002). Innovation projects, at the organisation level, include several types such as new product, new services, new process technologies, new administrative systems or organisational structures, and/or new organisational plans or programs (Damanpour 1996). Innovation projects are also recognised as a process of coping with uncertainty (Lievens & Moenaert 2000; Van Riel et al. 2004). As uncertainty is a natural characteristic of innovation projects (Ilevbare et al. 2014; Lee & Veloso 2008; Rosenberg 1988), information processing is an integral component of innovation projects.

This uncertainty in innovation projects means success is not guaranteed. Of every seven to ten innovative product concepts, only one commercial success is realised, with nearly 40% of innovative products failing at launch, even with successful development and testing (Cooper 2019). Both academics and practitioners agree that innovation projects have a low probability of meeting profit objectives and the uncertainty in innovation projects considerably contributes to the failure of many (García-Quevedo et al. 2018; Laine et al. 2016; Rosenberg 1988; Yang et al. 2014).

## 3.3 Systematic Literature Review Method and the Findings

A systematic review of the literature on innovation project management in the last ten years was done as a part of this research and published in the *International Journal of Managing Projects in Business* (a SCIMAGO Q1 ranking journal)[1]. The literature review approach used in the published paper was informed by Tranfield et al. (2003) and comprised of four phases: scoping, collection, reduction, and analysis.

The scoping phase identified key contributions to the field of innovation project uncertainties and intra-organisational collaboration along with what represented cohesion and what represented discrepancy across the contributions. In the collection phase, bibliographic information was assembled from multiple databases such as Scopus and Science Direct using a pre-defined list of keywords. In the reduction phase, the relevancy, rigour and source of the search results were checked with only business and management journal articles published in Q1 and Q2 journals included. Seminal contributions published earlier and cited in the selected contributions were also considered. The identified articles were then analysed. The following sections represent the findings of the systematic literature review.

## 3.4 Innovation Project Risk and Uncertainty

Uncertainty and risk are intrinsic characteristics of innovation projects (Galbraith 1974; Lee & Veloso 2008; Rosenberg 1988). Uncertainty and risk have been an emphasis in the literature since the seminal work of Knight (1921), with Roper & Tapinos (2016) more recently drawing out Knight's (1921) distinction between risk and uncertainty (Roper & Tapinos 2016; Williams et al. 2021). Uncertainty is immeasurable since the distribution of its possible outcomes is itself uncertain. Yet, risk can be measurable or immeasurable and the measurability of the risk can be established through a specific context (Brink 2017; Knight 1921; Roper & Tapinos 2016). Risk is involved in situations where probabilities and variables are known; however, uncertainty goes beyond this to incorporate variables that are known but the probabilities are unknown (Hall et

[1] (Fanousse et al 2021)

al. 2014). Despite the distinction established between risk and uncertainty, the wider literature often links risk with uncertainty and uses the terms interchangeably (Simangunsong et al. 2012; Walker et al. 2017).

Although uncertainty and risks are often used interchangeably in the wider literature (Simangunsong et al. 2012; Walker et al. 2017), some claim that uncertainty is a legitimate substitute for risk because risk represents events rather than sources of substantial uncertainty (Ward & Chapman 2003). Moreover, risk management is threat-oriented and overlooks opportunities, this may hinder its contribution to enhancing project performance. Likewise, risk management is threat-oriented and neglects opportunities which may restrict its contribution to enhancing project performance. On the other hand, uncertainty management combines the management of risk and opportunities, and may also reflect sources of uncertainty that shape threat and opportunity perceptions. For instance, 'known unknowns', 'unknown unknowns' and bias, which cannot be overlooked in the management of projects, are already part of uncertainty management but ignored in risk management (Hall et al. 2014; Walker et al. 2017). Thus, this study focusses on uncertainty rather than risk to improve project performance. Indeed, effective project management requires the proper management of *all* sources of project uncertainty, which are not addressed and managed in risk management (Ward & Chapman 2003).

## 3.5 Uncertainty in Innovation Projects

As briefly defined in the background section in chapter 1, uncertainty is "the difference between the amount of information required to perform a particular task, and the amount of information already possessed by the individual" (Galbraith 1973 p.5). In a similar vein, Brashers (2001 p. 478) explained that uncertainty occurs when "details of situations are ambiguous and complex; when information is unavailable or inconsistent; and when people feel insecure about their own knowledge or the state of knowledge in general". Defining uncertainty as a state where there is a knowledge gap also implies the notion that uncertainty can be diminished by increasing the available amount of information (Daft & Lengel 1986; Galbraith 1974). This is aligned with Ellsberg (1961) concept of 'known uncertainty' which refers to situations where variable and outcome probabilities are known; however, their values remain indistinct. In such a situation, probabilistic analysis can be used to define possible outcomes (Bullen et al. 2006; York & Venkataraman 2010). The situation gets worse when the values together with the variable and outcome are unknown, defined as 'unknown uncertainty' (Ellsberg 1961). Unknown uncertainty is characterised by unclear cause-effect relationships, lack of consensus between involved parties, difficulty of finding apt sources of information (Gales & Mansour-Cole 1995), and conflicting interpretations (Daft & Lengel 1986). In 'unknown uncertainty' probabilistic analysis cannot help identifying the outcome unlike the case of 'known uncertainty' (Bullen et al. 2006). Whether 'known' or 'unknown', uncertainty is considered as a condition which yields dissatisfaction within organisations since individuals and organisations do not know how to proceed in an uncertain situation (Bullen et al. 2006).

Uncertainty is envisaged in various ways among innovation project members. For instance, uncertainty may be articulated in numerical form or in subjective probabilities or odds that the project is likely to succeed (Frishammar et al. 2010). These articulations are based on the clarity and the amount of information available. The provision of information expands the perception of validity of the data at hand (Frishammar et al. 2010; Stevens 2014). If there is no accurate information, heuristic principles are mainly used to decide the subjective assessments of probabilities that decrease the complexity to simpler judgmental estimation procedures (Tversky & Kahneman 1974; Yates 1990).

From a knowledge perspective, uncertainty is a knowledge gap between the amount of information needed to complete a task, and the amount of information already known about the task, and it is inherent in innovation projects (Lee & Veloso 2008; Rosenberg 1988; Galbraith 1974; Williams et al. 2021). The need to close this gap is perceived in the literature as the key objective of innovation process activity as well as the core of the whole innovation process (Liu & Hart 2011; Souder & Moenaert 1992). This is because when the level of uncertainty in innovation projects increases, its negative impact increases on the team's clarity of project objectives, shared goal, and the strategic fit (Zhang & Doll 2001).

From an information perspective, uncertainty has been referred to as information adequacy, which is the main distinction between conventional projects and innovation projects (Pich et al. 2002). Three fundamental project management strategies have been identified to deal with uncertainty in projects: instructionism, learning, and selectionism (Pich et al. 2002). In conventional projects, information about actions that affect project outcomes is adequate when it enables project teams to establish plans and policies for the whole project up front through traditional task planning, scheduling and risk management (Gutierrez & Kouvelis 1991). Task planning, scheduling and risk management represent instructionism which is effective as long as information about the state of the world and actions that affect the project payoffs is adequate (Pich et al. 2002). However, innovation projects are characterised by inadequacy of information caused by unknown events and/or unknown effects of actions (uncertainties) (Lee & Veloso

2008; Rosenberg 1988; Galbraith 1974). Scholars have thus argued that inadequacy of information in high uncertain projects necessitate a combination of learning and selectionism (Lee & Veloso 2008; Pich et al. 2002; Um & Kim 2018). This study proposes intra-organisational collaboration as an organisational practice that provides a means for learning and selectionism strategies that deal with the high uncertainty in innovation projects.

Innovation project uncertainties have been the emphasis of previous research (see for example, García-Quevedo et al. 2018; Laine et al. 2016; Lee & Veloso 2008; Rosenberg 1988; Yang et al. 2014). However, as stated by Um & Kim (2018) and Walker et al. (2017), there are few empirical studies on ways to manage these uncertainties. As a result, empirical evidence of effective organisational practices that may reduce innovation project uncertainties and enhance project performance is still underrepresented. Many studies have examined the impact of intra-organisational collaboration on the performance of innovation projects (Gkypali et al. 2017; Jugend et al. 2018; Zhang & Tang 2017), however few studies have examined its impact on reducing innovation project uncertainties. Therefore, this research contributes to addressing this gap by focusing on uncertainty reduction in innovation projects from their start until the final delivery.

### 3.5.1 Sources of Innovation Project Uncertainties

Understanding the sources of uncertainty is fundamental for the conceptualisation and measurement of uncertainty (Yan & Dooley 2013). This is because even with the dominance of uncertainty as a theme in the organisational literature, there is no consensus on the conceptualisation of the concept itself (Gales & Mansour-Cole 1995). This is due to the dynamic nature of uncertainty and that the concept of uncertainty involves a great deal of uncertainty per se (Galbraith 1974; Rickaby et al. 2018; Winch & Maytorena 2012).

It is agreed that uncertainty is a deficiency or faultiness of knowledge or information and widely referred to a knowledge gap that is inherent in innovation projects (Galbraith 1974; Ilevbare et al. 2014; Karlsen 2010; Lee & Veloso 2008; Rosenberg 1988). The sources of innovation project uncertainty include the newness of projects, the experience of the project team, and the availability of information (Thomé et al. 2016). Research also identifies other sources of uncertainty such as the situation itself, the state of the environment (Duncan 1972), technology and market newness (Moenaert et al. 1995), or the multiple project members involved and making concurrent efforts (Von Corswant & Tunälv 2002). Therefore, there are a large variety of sources that decide the level of uncertainty in a certain situation (Frishammar et al. 2010).

The various sources of innovation project uncertainties were identified and discussed thoroughly in literature and are listed in Table 3.1[2] (Fanousse et al 2021).

Table 3.1 Sources of Innovation Project Uncertainties in Literature

| Uncertainty Type | Resource |
|---|---|
| Task uncertainty | (Bailey et al. 2010; Galbraith 1974; Gann & Salter 2000; Mohan & Mitzi 2001; Peng et al. 2014; Puranam et al. 2009; Tang et al. 2015; Tatikonda & Rosenthal 2000b, Um & Kim 2018; Vickery et al. 2016; Yan & Dooley 2013; Zhao et al. 2014) |
| Perceived environmental uncertainties | (Daft et al. 1988; Duncan 1972; Koetse et al. 2006; May et al. 2000; Miles et al. 1978; Sawyerr 1993; Roper & Tapinos 2016; Taminiau 2006) |
| Decision uncertainty | (Ilevbare et al. 2014) |
| Technological uncertainty | (Alam 2006; Andersen 2008; Christensen & Bower 1996; de Vasconcelos Gomes et al. 2021; Eisenhardt & Tabrizi 1995; Kim & Vonortas 2014; Liu et al. 2011; Mu et al. 2009; Thanasopon et al. 2016; Van de Ven 1986; Verworn et al. 2008; Verworn 2009; Wu & Olson 2010) |
| Operational uncertainty | (Kim & Vonortas 2014; Liu et al. 2011) |
| Financial uncertainty | (Kim & Vonortas 2014; Liu et al. 2011; Miorando et al. 2014; Reed & Knight 2010; Wu & Wu 2014) |
| Collaboration uncertainty | (Wu 2012; Wu & Wu 2014) |
| Institutional/regulatory uncertainty | (Wu & Wu 2014) |
| Perceived social uncertainty | (Hall et al. 2014) |
| Market uncertainty | (Alam 2006; Bendoly et al. 2012; de Vasconcelos Gomes et al. 2021; Kim & Vonortas 2014; Liu et al. 2011; Miller 1992; Moriarty & Kosnik 1989; Souder & Moenaert 1992; Thanasopon et al. 2016; Van Riel et al. 2004; Verworn et al. 2008; Verworn 2009; Wu & Wu 2014) |
| Organisational uncertainty | (Mu et al. 2009; Palmer & Wiseman 1999) |
| Ontological uncertainty | (Fox 2012; Fox 2011) |

Table 3.1 illustrates the 11 different sources of innovation project uncertainties identified in literature. However, the three most dominant and cited sources of innovation project uncertainty are market (n = 12), technological (n = 14), and task (n = 12), and these form the key focus of this study. The other eight sources of innovation project uncertainties are: Perceived environmental (n = 8), financial (n = 5), collaboration (n = 2), organisational (n =2), operational (n = 2), ontological (n = 2), decision (n = 1), regulatory/institutional (n = 1), and perceived social (n = 1).

[2] A systematic literature review has been conducted and accordingly 11 sources of uncertainties were identified in literature

Market and technological uncertainty have always been considered by scholars in seminal and recent studies as the key drivers of uncertainty in innovation projects[3]. Furthermore, Um & Kim (2018) more recently drew on Galbraith's (1973) seminal definition of uncertainty to recommend considering task uncertainty to accurately measure innovation project uncertainty. This is because the characteristics of innovation project tasks are neither routinised nor simple (Yan & Dooley 2013). This is corroborated in other recent literature[4].

This research therefore focuses on innovation projects and covers the project from the start until the final delivery of the project outcome. The most dominant sources of innovation project uncertainties identified in the literature review will be considered in this research: market, technological, and task. The following sections, detail and analyse each type of uncertainty.

#### 3.5.1.1 Task Uncertainty

Task uncertainty is defined as the difference between all the information needed to accomplish a task and the information the organisation knows about that task (Galbraith 1974). Task uncertainty is a natural characteristic of innovation projects that involve non-routine and complex tasks that are hard to be pre-planned (Tushman & Nadler 1978; Yan & Dooley 2013). Uncertain task environments make it difficult for project team members to pre-specify interdependences between tasks, and to pre-plan an effective task strategy (Van de Ven et al. 1976). This yields high information asymmetry that makes it harder to detect any uncooperative behaviour while performing tasks (Carson et al. 2006; Eisenhardt 1989). Hence, such projects with a high level of task uncertainty tend to have more risk of uncoordinated tasks. (Yan & Dooley 2013). This is due to adopting non-routine technology and executing interdependent tasks which can easily generate conflicts in actions and interest (Yan & Dooley 2013).

Innovation projects vary in their level of task uncertainty, and Yan & Dooley (2013) discussed the importance of recognising the sources of task uncertainty to rigorously measure the uncertainty. Accordingly, scholars have identified three major causes of innovation project task uncertainty: technological novelty, product complexity, and task interdependence (Galbraith 1973; Swink 1999; Um & Kim 2018; Yan & Dooley 2013).

[3] (See for example, Alam 2006; Andersen 2008; Bendoly et al. 2012; Christensen & Bower 1996; Eisenhardt & Tabrizi 1995; Kim & Vonortas 2014; Liu et al. 2011, Miller 1992; Moriarty & Kosnik 1989; Mu et al. 2009; Souder & Moenaert 1992; Thanasopon et al. 2016; Van de Ven 1986; Van Riel et al. 2004; Verworn et al. 2008; Verworn 2009; Wu & Olson 2010: Wu & Wu 2014).

[4] (See for example, Bailey et al. 2010; Gann & Salter 2000; Mohan & Mitzi 2001; Peng et al. 2014; Puranam et al. 2009; Tang et al. 2015; Tatikonda & Rosenthal 2000b; Vickery et al. 2016; Yan & Dooley 2013; Zhao et al. 2014)

Product complexity arises from the variety of components of the innovation project outcome that involves high levels of discrepancies as well as interdependencies (Gann & Salter 2000; Peng et al. 2014). Scholars have proposed that product complexity is one of the innovation projects' characteristics that poses threats and is considered a significant source of difficulty (Swink 1999). A high level of product complexity yields ambiguity as a result of the presence of multiple and conflicting interpretations about task statuses (Koufteros et al. 2002). The higher the degree of complexity in developing a product, the higher the potential concerns of the project stakeholders (Vickery et al. 2016). These concerns also trigger uncertainty since misleading and inconsistent interpretations may be held, or evolve, among project stakeholders about the product (Vickery et al. 2016).

When project members with their various knowledge and expertise are involved in the co-development of complex products, the struggle to consolidate the diverse knowledges and skills into the right task strategy increases (Yan & Dooley 2013; Um & Kim 2018). This complexity increases when higher numbers of heterogeneous specialists get involved in the projects due to the difficulties in coordination and decision-making (Clark & Fujimoto 1991; Griffin 1993; Meyer & Utterback 1995). As a result, this enhances the chances of establishing the wrong task process and imposes uncertainty as a result of the high interdependences between the components involved (Um & Kim 2018). High interdependences between components increase the challenge to comprehend and foresee the impact of distributed decisions or the potential effect of faulty components on the entire task performance (Yan & Dooley 2013). Hence, this makes the performance of the innovation project unpredictable (Tang et al. 2015; Zhao et al. 2014). Therefore, innovation projects that involve highly complex products often take more time to complete (Griffin 1997).

The second identified cause of uncertainty is technological novelty which refers to the level of newness of the technology and varies from one innovation project to another (Mohan & Mitzi 2001; Tatikonda & Montoya-Weiss 2001). The level of newness encompasses the technologies to be used when developing the product, the product components and configuration, and the process framework in the early stages of the project (Tatikonda & Rosenthal 2000b, Yan & Dooley 2013). In NPD studies, product newness is distinguished from technological uncertainty by relating product newness to how much of the product must be redesigned, while linking technological uncertainty with how much technical invention should take place (Griffin 1997). Additionally, product newness was abstracted as the percentage of new designs embraced by the product independent of the level of new technologies involved (Swink 1999).

With technological novelty, the struggle of the project members usually increases in direct proportion to their lack of understanding of the technology, how it can be utilised and the result of utilising it (Yan & Dooley 2013). The newness of the technology may affect the project members' confidence in exploiting and solving related problems and can challenge their adaptability with the technology (Um & Kim 2018). The degree of uncertainty may be heightened by the reliability and applicability of the new technology not being provable in the marketplace (Iansiti & West 1997). This creates additional challenge the project members as they try to foresee the potential market size of the product and its commercial value (Yan & Dooley 2013). These factors further affect the project decision-making process because the outcome of such decisions is difficult to anticipate (Um & Kim 2018). This knowledge gap about the non-routine technology subsequently contributes to the total uncertainty of completing innovation project tasks (Yan & Dooley 2013). Scholars through empirical studies found that innovation projects adopting novel technology are often less likely to thrive because of their higher degree of uncertainty (Griffin 1997; Tatikonda & Rosenthal 2000a).

The third identified cause of uncertainty is the task interdependence, which is the impact of one activity or its outcome on another activity (Puranam et al. 2009). It results from components that are strongly attached in a product design (Novak & Eppinger 2001). Task interdependency can go beyond the expected tasks and activities to incorporate the interdependences among people, materials, processes and information (Bailey et al. 2010). Uncertainty arising from task interdependencies is generated whenever there is a requirement to change a task in the project, requiring other dependent tasks to respond to this change (Bailey et al. 2010; Puranam et al. 2009). For example, a change in the product design will result in changing other dependent components such as design layout and the associated design schedules (Um & Kim 2018).

If the project entails high task interdependencies, significant uncertainty will surround the project members (Bailey et al. 2010; Puranam et al. 2009; Um & Kim 2018). Moreover, the success of one task does not ensure the success of the whole project until all the dependent tasks are accomplished successfully (Um & Kim 2018). Hence, task interdependence necessitates constant interaction among project members in order to successfully complete the tasks as they cannot be certain about their task performance due to its high dependence on other tasks (Sosa et al. 2004). Failure to accomplish a task creates another source of uncertainty where rework and extensive communication will often be required (Yan & Dooley 2013).

In brief, task uncertainty in innovation projects occurs because of the product complexity, technological novelty, and task interdependence. Research found that innovation projects with a high level of technological novelty, product complexity and task interdependence are often less likely to thrive because of their higher degree of uncertainty. This is because a high degree of task uncertainty leads to increased misunderstanding and misinterpretation among project team members which negatively affects the performance of innovation projects.

#### 3.5.1.2 Technological Uncertainty

Technology can involve both technical tools and the knowledge required to utilise the tools (Rogers 2010). Building on the current organisational literature, both aspects of technology are sources of uncertainty in innovation projects (Jalonen 2012; Zhao 2021). Technological uncertainty is summed up by the question 'will it work?' (Eisenhardt & Tabrizi 1995).

Technological uncertainty includes uncertainties about the development platform, product design, manufacturing technology, the environment for the processes involved, and the intellectual property (Kim & Vonortas 2014). Technological uncertainty also reflects uncertainties related to experience with the technology, as well as the advantages of the technology, including its reliability, maturity, and substitutability (Liu et al. 2011). It also includes uncertainties in technical requirements and specifications such as timelines and skills, and possible technical defects (Thanasopon et al. 2016). This includes uncertainty about the quality of the applied technologies such as information technologies, the user-friendliness and cost-efficiency of the project adopted technologies, and the required research and development (R&D) strategy for the project (Lievens & Moenaert 2000).

Technological uncertainty is encountered in product specification and the production process of innovation projects (Harris & Woolley 2009). Uncertainties related to product specification occurs when the innovation's technical feasibility, usefulness, functionality, or quality is at least partly unknown (Allen 1982; Buddelmeyer et al. 2010; Hall & Martin 2005; Hall et al. 2011; Leifer et al. 2001), and it usually depends on the newness of the technology (Carbonell & Rodriguez 2006; Nieto 2004; Swink 2000; Tatikonda & Montoya-Weiss 2001; Tidd & Bodley 2002). Uncertainties related to production process are associated with the different processes, techniques and knowledge needed to deliver products and services (Jalonen 2012).

Innovations that involve new technologies not only require new technical skills but also new business models in which those technical competencies become advantageous (Gibbert 2005). Technological uncertainties also arise from inconsistent specifications, rapid planning, impractical design, ineffective communication and coordination between the development team, and/or ineffective project leadership, (Wu & Olson 2010). Furthermore, the technology life cycle adds an additional source of technological uncertainty (Andersen 2008).

Technological uncertainty is either dependent or independent to an organisation as determined by predictability and capability (Christensen & Bower 1996; Mu et al. 2009). In predictability, the organisation cannot accurately forecast whether the result of the innovation can function as it promises, whether the technical standard of the new product will be in the future, or what, if any, the potential side-effects of the new product are (Mu et al. 2009). On the other hand, capability relates to the organisation being uncertain if it possesses sufficient NPD capability for developing and scaling-up the new product to the market (Christensen & Bower 1996).

Innovation projects vary substantially in the level of new technology adopted or developed (Swink 1999). Four types of innovations are defined based on the level of technological novelty: low, medium, high, and super-high technological uncertainty innovations (Shenhar et al. 1995). The last two types are examples of fundamental technological transformation that are associated with higher level of uncertainty (Dosi 1982). The higher the novelty of the technology adopted or developed, the higher the technological uncertainty due to the knowledge gap about the technology (Utterback 1971; Moenaert & Souder 1990).

The newness of the technology causes uncertainty in terms of the skills and knowledge needed to succeed in using the new technology (Cantarello et al. 2011; Carbonell & Rodriguez 2006; Nieto 2004; Ortt & Smits 2006; Veryzer Jr 1998). As explained by Ortt & Smits (2006), new technologies are not offering themselves as ready-made packages, they are offered more as opportunities. Technological novelty implies both new solutions and new problems associated with uncertainties that are permanent rather than transient (Coughlin 2010; Weick 1995). Additionally, the relevance of past practice for new technology turns out to be increasingly uncertain (Scranton 2007). For example, in NPD projects the increased utilisation of new manufacturing technologies raises the volume of potential problems since project team members are unfamiliar with the new process capabilities, and have less experience in identifying and resolving product–process fit dependencies (Swink 1999). A high level of technological uncertainty such as design change frequency, exerts a negative influence during innovation projects (Souder et al. 1998).

In short, technological uncertainty in innovation projects occurs because of the lack of knowledge needed to use new technology or the lack of knowledge of the details of new technology. A high degree of technological uncertainty has a negative impact on innovation projects.

#### 3.5.1.3 Market Uncertainty

Innovation is implemented to meet the need of the real or perceived market, as innovation without a targeted market has no value (Jalonen 2012). Market uncertainty encompasses uncertainties about the possible reactions of the potential consumer, public, trade as well as competitors (Kim & Vonortas 2014; Moriarty & Kosnik 1989). Market uncertainty encompasses the product's attractiveness, the volume of acceptance and time, the product life cycle, market response to the new technology, marketing capabilities, market channel readiness, and the effect of potential rivals (Liu et al. 2011). It also involves uncertainties related to customer demand, potential competitors and their marketing strategy, pricing and market conditions as well as customer satisfaction with the specific new product (Lievens & Moenaert 2000; Moriarty & Kosnik 1989; Souder et al. 1998; Thanasopon et al. 2016; Verworn et al. 2008). These factors of market uncertainty are summarised by the question 'will it sell?' (Wu & Wu 2014).

Market uncertainty has been organised into three categories based on its source. First, the consumer which is the most important source of uncertainty, including uncertainty around the demand for the innovation, and the unknown behaviour as well as needs of customers (Corrocher & Zirulia 2010; Freel 2005; Gilbert & Cvsa 2003; Leifer et al. 2001; Rose-Anderssen et al. 2005). It is difficult to predict what consumers might want or need in the future (Harris & Woolley 2009). Scholars have discussed how a growing market fragmentation appeared as a result of changing demographics, values, expectations and behaviours of consumers (Gupta & Wilemon 1996; Smits 2002). York & Venkataraman (2010), for example, examined how customers' changing opinions concerning environmental issues created uncertainty for organisations as they cannot foresee what environmentally friendly innovations may satisfy the needs of consumers and markets. This aided in transferring the power from producers to consumers (Hamel & Valikangas 2004).

The second category is the market uncertainty that concerns the behaviour of competitors (Jalonen 2012). The main logic of innovation relies on the idea that an organisation does things differently from its competitors, yet this is difficult as organisations cannot foresee with certainty, its competitors' intentions (Banerjee & Chatterjee 2010; McDermott & ''Connor 2002; Naranjo-Gil 2009; Souder & Moenaert 1992). This source of uncertainty results from the globalisation and liberalisation of markets (Ortt & Smits 2006). The third category is related to the price of development associated with competing products and services (Jalonen 2012). This is caused by difficulty with forecasting prices of raw materials needed for substitutive commodities (Gibbons & Littler 1979), which depends on several factors such as the demand and supply of raw materials (Jalonen 2012).

Furthermore, market uncertainty includes uncertainties involved with shifts in market demand and supply, or unpredictability in the quantity needed by consumers (Miller 1992). These factors generate uncertainties around producing acceptable quantities along with qualities of the product to start the production process (Miller 1992). This is also associated with difficulties measuring the market potentiality of products as the product might be in an early stage or not even exist (Kim & Vonortas 2014). Further, market uncertainty concerns future market conditions (i.e., Foster 2010), and comprises "the disruptive effects of emerging technologies, empowered customers, new market entrants, shorter product life cycles, geopolitical instability, and market globalization" (Muller et al. 2005; p. 1). High levels of market uncertainty can impact commercialisation capability and affect market forecast (Souder et al. 1998), with inappropriate marketing sometimes resulting in failure in innovation projects (Hartley & Claycomb 2013).

In brief, market uncertainty in innovation exists because of the unanticipated fluctuations of customer demand, unpredictable competitors' behaviours, and difficulty in defining marketing strategy, and pricing. High levels of market uncertainty can negatively impact commercialisation capability and cause failure in innovation projects.

## 3.6 Uncertainty Reduction in Innovation Projects and Innovation Project Performance

In the innovation projects literature, three causes of the innovation projects fuzziness have been identified: complexity, uncertainty, and equivocality (Bentley et al. 2021; Burström & Wilson 2018; Frishammar et al. 2010; Koufteros et al. 2005; Stevens 2014), however, of these three sources of fuzziness, uncertainty reduction is most often associated with innovation projects success (Lievens & Moenaert 2000; Moenaert et al. 1995; Verworn 2009; Verworn et al. 2008). The concept of uncertainty has received increasing interest in the organisation theory literature (Thanasopon et al. 2016). Scholars refer to uncertainty as a 'knowledge gap' that is inherent in innovation projects (Galbraith 1974; Lee & Veloso 2008; Rosenberg 1988). The need to close this gap in order to reduce the uncertainty is a key objective of innovation process activities, and central to the whole innovation process (Krane & Olsson 2014; Liu & Hart 2011; Souder

& Moenaert 1992). This is explained by the high degree of uncertainty in innovation projects leading to negative impacts on the team's clarity of project objectives, the shared goal, and the strategic fit (Zhang & Doll 2001). Also, high degree of uncertainty creates several difficulties in the subsequent stages of innovation process and leads to frequent deviation from project specifications (Thanasopon et al. 2016; Verworn 2009).

Moreover, innovation projects with a high level of uncertainty are linked to a lack of understanding and ineffective management strategies (De Brentani & Reid 2012). The greater the uncertainty in the early stages of innovation projects, the less focus there is on the communication between all project participants (Verworn 2009). If project members face a high degree of uncertainty and are unable to close important information gaps, they are more likely to face severe consequences and project failures (Moenaert et al. 1995; Murmann 1994). If uncertainty is not sufficiently reduced, it forces project members to take larger risks, and these increase the probability of failure (Weick 1995).

Research has also demonstrated how high a level of uncertainty can yield major difficulties in innovation projects (Frishammar et al. 2010). Technological uncertainty for instance, influences prototype development and increases the frequency of design change (Souder et al. 1998). Moreover, market uncertainty effects both market forecast accuracy as well as product launch proficiency, and moderates prototype development and the frequency of design change (Souder et al. 1998). Thus, reducing uncertainty in innovation projects is crucial for promoting performance and achieving success (Alam 2006; Moenaert et al. 1995; Van Riel et al. 2004; Verworn 2009; Verworn et al. 2008).

Several scholars have since built on organisational information processing theory and established that uncertainty reduction leads to enhanced performance of innovation projects (see for example, Alam 2006; Clark & Fujimoto 1991; Souder & Moenaert 1992; Van Riel et al. 2004; Verworn et al. 2008; Verworn 2009). Recent research has used the degree of innovation project uncertainty reduction as a proxy for innovation project success (Thanasopon et al. 2016). Furthermore, the positive relationship between market, technology and decision-making uncertainty reduction in innovation projects and overall project success has been empirically proven (Alam 2006; Moenaert et al. 1995; Van Riel et al. 2004; Verworn et al. 2008; Verworn 2009). Moreover, uncertainty reduction improves the probability of realising both financial and non-financial success in innovation projects (Thanasopon et al. 2016). Scholars have also stressed the importance of uncertainty reduction in improving innovation project performance through promoting communication among stakeholders and reducing the frequency of deviation from specification (Verworn 2009).

Overall, the reviewed studies corroborated that notion that uncertainty reduction is one of the key objectives in the conduct of innovation projects and core to the whole innovation process. Most emphasised the significance of uncertainty reduction in enhancing the performance of innovation projects. This is mainly to meet the desired specifications and to maintain effective communication. In addition, empirical findings of previous studies have demonstrated a positive relationship between uncertainty reduction and innovation project success.

## 3.7 Uncertainty Reduction Strategy: Intra-organisational Collaboration

Intra-organisational collaboration has received increasing attention in the organisational literature, being referred to differently across the literature[5]. Intra-organisational collaboration is defined as the synergy between teams to accomplish a certain task and consisting of members of the same hierarchical level from diverse functional areas (Lin et al. 2015b). It refers to the level of cooperation, the extent of representation, and the contribution of functional units to the innovation process (Kahn 1996; Li & Calantone 1998; Ruekert & Walker Jr 1987; Song et al. 1997). Examples include R&D–marketing collaborations and R&D–manufacturing collaborations. It is also defined as the collaboration among a group of people who apply diverse skills, with a high level of interdependence to ensure the effective realisation of a common organisational objective (Holland et al. 2000). Intra-organisational collaboration is intangible, volitional, and unstructured in that it manifests strategic interdependence among functional units and emphasises the need to collaborate for the benefit of the organisation (Galunic & Rodan 1998; Kahn 1996; Kahn & Mentzer 1998; Olson et al. 2001), while ensuring the alignment of goals among them (De Luca & Atuahene-Gima 2007). This applies to teams working within a functional, matrix or project-based organisation (Holland et al. 2000).

Within intra-organisational collaboration, the members not only represent their roles but also act as true members of the project team (Cooper 2019). Project goals are set on a collective basis and the standards of whole team integration and best performance to achieve the task to

[5] For example, scholars used terms such as intra-organisational collaboration, intra-firm collaboration, cross-functional collaboration, internal collaboration, and inter-departmental collaboration. However, these different terminologies were found to represent the same concept. The term collaboration also has been used interchangeably with several terms in literature such as coordination, cooperation and integration to denote to the concept of people working together to realise a specific goal of common interest.
Rodríguez, N. G., Pérez, M. J. S. & Gutiérrez, J. A. T. 2008. Can a good organizational climate compensate for a lack of top management commitment to new product development? *Journal of Business Research,* vo. 61**,** 118-131.

accomplish a shared vision are emphasised (Cooper 2019; Ko et al. 2011). In intra-organisational collaboration, the opportunity to integrate diverse perspectives increases and this enhances the potential for developing a successful product.

Several scholars discussed the difficulty of delimiting the definition of intra-organisational collaboration and demarcated its multidimensional nature. Most previous studies (see for example, Gupta et al. 1986; Li & Calantone 1998; Moenaert & Souder 1990) have conceptualised intra-organisational collaboration as a one-dimensional construct that includes measures of collaborative relationship and communicating and sharing information. Yet, as suggested by Lin et al. (2015b) such an approach may unintentionally ignore other essential components of intra-organisational collaboration. For example, Commitment was absent in the previous studies scale of intra-organisational collaboration whilst it was indicated as pivotal dimension of intra-organisational collaboration by Morgan & Hunt (1994). Furthermore, trust and leadership were missing from Li & Calantone (1998) and Moenaert & Souder (1990) scale of intra-organisational collaboration but were incorporated in the intra-organisational collaboration construct by Lin et al. (2015b).

To establish a comprehensive conceptualisation of intra-organisational collaboration, previous studies are integrated, and consequently intra-organisational collaboration is conceptualised as a reflective second-order construct with five dimensions (subconstructs): collaborative leadership, collaborative relationships, trust formation, communicating and sharing information, and commitment (Fanousse et al. 2021b). The sources of intra-organisational collaboration dimensions[6] identified in literature are compiled in Table 3.2 with their corresponding studies. The following sections details each of the five dimensions.

Table 3.2 Sources of Intra-organisational Collaboration Dimensions in Literature[7]

| Intra-organisational Collaboration Dimensions | Corresponding Studies |
|---|---|
| Collaborative relationship | (Frishammar et al. 2012; Holland et al. 2000; Lin et al. 2015b, Perks 2000; Stalk & Hout 1990; VanVactor 2012) |
| Collaborative leadership | (Blindenbach-Driessen 2014; Hage et al. 2008; Jitpaiboon et al. 2019; Karlsen 2011; Lee & Chen 2007; Le Meunier-FitzHugh et al. 2011; Lin et al. 2015b, Lin et al. 2015a, Nakata & Im 2010; Qian et al. 2013; Sivasubramaniam et al. 2012; Urueña et al. 2016) |
| Communicating and sharing information | (Bendoly et al. 2012; Cooper 2019; Kwon & Suh 2004; Park & Lee 2014) |

[6] A systematic literature review has been conducted and accordingly five dimensions of intra-organisational collaboration are identified in literature

[7] The table is taken from (Fanousse et al. 2021)

| Intra-organisational Collaboration Dimensions | Corresponding Studies |
|---|---|
| Trust formation | (Lin et al. 2015b, Maurer 2010; Pinto et al. 2009; Rodríguez et al. 2008; Rosenberg 1988; Xu & Ma 2008) |
| Commitment | (Coote et al. 2003; De Ruyter et al. 2001; McDonough III 2000; Moorman et al. 1992; Rodríguez et al. 2008) |

### 3.7.1 Collaborative Relationship

Collaborative relationship refers to establishing a team relationship that fosters resources integration (Stalk & Hout 1990), information exchange (Perks 2000), and knowledge transfer among the team (Holland et al. 2000). Collaborative relationship serves as a catalyst for yielding better business acumen among multiple stakeholders within an organisation, and helps in eliminating traditional organisational silos, as well as inter-departmental barriers (VanVactor 2012). This collaborative relationship produces effective teamwork that increases the efficacy of each individual contribution (VanVactor 2012).

Existing evidence advocates the strong positive impact of these collaborative relationships between various functional units on the performance of innovation projects (Bendig et al. 2018; Cooper 2019; Cserháti & Szabó 2014; Rodríguez et al. 2008). This is because an effective collaboration mechanism underpins the development of ideas and knowledge, and reinforces interactive conflict (Lin et al. 2015b). Collaborative relationship also involves problem solving activities as well as brainstorming and collective resolution that enhance organisational learning (Lin et al. 2015b). High quality innovation teamwork openly communicates information, synchronises activities which consequently assures that all team members can fully contribute their knowledge and as a result promotes innovation team performance (Hoegl et al. 2008).

Kouzes & Posner (2006) added that collaborative relationship is critical to success in uncertain environments and should be treated as if it were a lifelong endeavour. A collaborative environment indeed promotes a continuing integration of ideas and interdependencies among different functional units throughout the organisation (VanVactor 2012). Additionally, it strengthens social networks, facilitates an environment of trust that allows the access of diverse skill sets essential for creative problem-solving strategies (Uzzi & Dunlap 2005), and smooths the transfer of individual knowledge into the organisational knowledge-base (Frishammar et al. 2012).

### 3.7.2 Collaborative Leadership

Leadership refers to top management leading and supporting innovation efforts at every opportunity (Cooper 2019). Collaborative leadership is a unique style of leadership, it is a transformational style of leadership (VanVactor 2012). It refers to the development of relationships to integrate ideas and information that allow decision making and the identification of best practices (VanVactor 2012). It encourages a collaborative environment that promotes an inter-departmental integration of ideas and nurtures interdependency (VanVactor 2012). Collaborative leadership crafts the vision for the diverse project members, and offers the essential cognitive and emotional support that enhance the team's loyalty and commitment (Hage et al. 2008). It inspires and motivates employees to be creative and intuitive when being forced out of comfort zones (VanVactor 2012). Kouzes & Posner (2006), explain that when collaborative leadership creates a climate of trust, this climate eliminates restriction and thus provides employees with freedom to innovate.

Extant research has linked leadership support with innovation project success (see for example, Baker et al. 1986; Lee & Na 1994; Pinto et al. 1993; Zirger & Maidique 1990). Likewise, existing innovation literature has discussed the vital role of organisation leadership in innovation projects especially innovation projects that involve risky processes and strategies with a high chance of failure (Rodríguez et al. 2008). For example, studies of organisational behaviour have emphasised the significance of leaders in anticipating changes, managing conflict, improving performance, and coordinating and integrating processes (Blindenbach-Driessen 2014; Lee & Chen 2007).

The significance of leadership increases in team management that involves allocating and synchronising resources, building teams with positive synergy, and motivating different team members toward a common goal (Le Meunier-FitzHugh et al. 2011; Lee & Chen 2007; Lin et al. 2015a). It is significantly important for managers to show a sense of priority that encourages team members to overcome barriers, to become more interested in the project, to take greater ownership and to be more willing to take risks (Swink 1999). A qualitative study has found that collaborative leadership is paramount in facilitating a successful implementation of innovation projects in e-health sector (Urueña et al. 2016). Likewise, rigorous meta-analysis studies on innovation team characteristics concluded there is a significant positive influence of collaborative leadership on the performance of innovation projects (Sivasubramaniam et al. 2012).

Collaborative leadership is a key dimension of a successful cross-functional team in innovation projects (Holland et al. 2000; Lin et al. 2015b, Sivasubramaniam et al. 2012). This is due to the structure of the innovation cross-functional team formed by a group of qualified members from various backgrounds and specialties, which can stimulate potential problems, such as conflicts of interest, inconsistent goals, and poor information flow between members (Lin et al. 2015b, Moenaert & Souder 1990; Nakata & Im 2010). This necessitates the presence of collaborative leadership to facilitate an environment that encourages open communication and information-sharing whilst consolidating diverse opinions (Lin et al. 2015b). This environment sustains motivation and positive emotions within cross-functional team members to overcome attitude and stereotype barriers (Nakata & Im 2010). Clear leadership that drives the project from the phase of ideation to the phase of launching the end result is imperative in cross-functional collaboration (Cooper 2019).

Innovation projects necessitate the involvement of leadership throughout the development process, and their support of the innovation activities (Montes et al. 2004; Song et al. 1997). Leadership support is a vital dimension of collaborative leadership and includes fostering cross-functional collaboration, providing teams with encouragement and aiding them in overcoming challenges (Rodríguez et al. 2008). As the teams perceive the leadership support and involvement their enthusiasm about the project and their interest to fulfil the tasks will increase, and their willingness to assume the inherent risks throughout innovation process will grow (Sivadas & Dwyer 2000; Swink 2000). Managers can nurture a working environment that encourages effective relationships between cross-functional units (Boyle et al. 2005; Gupta & Wilemon 1990).

Leadership can provide an environment that may be either conducive or inhibitive to collaboration among functional units (Souder 1977; Souder & Chakrabarti 1978). For instance, collaborative leadership through a joint reward system can encourage collaboration among the organisation’s functional units (Souder & Chakrabarti 1978). This is important because it enhances the sense of functional units’ responsibility for the success or failure of the project based on leadership supporting the essential collaboration (Souder & Chakrabarti 1978). Effective collaborative leadership is paramount in creating a climate that is conducive to organisational innovativeness (Abbey 1982). For example, through encouraging positive relationships among functional units, collaborative leadership promotes the innovation process (Gupta et al. 1986).

Previous studies have encouraged leaders to show entrepreneurial behaviour through supporting new ideas and risk-taking in order to exert a positive effect on innovation success (Quinn 1979; Roberts & Fusfeld 1981; Wind 1979). Collaborative leadership attitudes are fundamental for promoting collaboration between functional units. These include balancing the organisation's short-term and long-term objectives, being tolerant of initial failures in the innovation process, encouraging risk-taking and entrepreneurial pursuits, setting up joint reward systems for the collaboration, and endorsing the need for integration among the functional units (Gupta et al. 1986).

The importance of collaborative leadership's attitude toward risk and their willingness to accept failures as a natural element of innovation projects have been emphasised in literature (Menon et al. 1997; Rodríguez et al. 2008). The management attitude toward risk affects innovation project performance. For example, when managers are risk averse, this may increase the conflicts among the different functional units as each unit will try to avoid risk and the responsibility for failures (Rodríguez et al. 2008). Thus, the higher the risk aversion of the managers in innovation projects, the higher the focus of the involved functional units on the less risky tasks instead of the complicated ones, in order to avoid failures (Rodríguez et al. 2008). This was emphasised in an empirical study that argued that when managers do not foster risk assumption, innovation project performance will most likely suffer (Rodríguez et al. 2008).

### 3.7.3 Communication and Sharing Information

Communication and sharing information refer to the extent to which information is transferred among project members, and the conversion of several inputs into a consistent and reliable output (Glaser 2004; Park & Lee 2014). Cross-functional communication and sharing information is the formal and informal sharing of timely and meaningful information among parties (Anderson & Narus 1990). It serves as a means by which people from different functional departments share critical information for the successful implementation of projects (Pinto & Pinto 1990), via planned activities like meetings, seminars, or report exchange at specified time (Rodríguez et al. 2008). It includes the exchange of information between departments about consumer needs, technology, or competitive behaviour which define the innovation projects outcome (Ayers et al. 1997).

Researchers have discussed the importance of communication and sharing information in enhancing the performance of innovation projects (Cooper 2019; Kwon & Suh 2004; Leenders et al. 2003; Lievens & Moenaert 2000; Parker 2000; Rodríguez et al. 2008; Yan & Dooley

2013). Later research has shown that communication and sharing information indirectly exerts positive effects on innovation project performance through collaboration (Rodríguez et al. 2008). These findings indicate that flows of communication and sharing information between departments must reflect real collaborative activities in order to work as a catalyst for innovation project success. In turn, the frequent flows of communication and sharing information among different functional units enhance their collaboration (Anderson & Narus 1990), and are considered key mechanisms for stimulating cross-functional collaboration and enabling the involvement of project team members (Lievens & Moenaert 2000). Frequent communication and sharing information also aid the building and maintenance of a team's social capital, working to promote team member's relationships (Joshi et al. 2007), and contributes to building trust among team members due to an increased understanding of personal characteristics (Irma Becerra-Fernandez 2001). Additionally, it encourages team members to exchange information that in turn enhances the knowledge sharing within the project (Park & Lee 2014).

Communication and sharing information are also associated with the high performing cross-functional team using a central platform for sharing project information between team members among their diverse functions and locations (Cooper 2019). Scholars have emphasised the substantial role of communication and sharing information in strengthening the quality and performance of the cross-functional collaborative team, and in realising their diverse capabilities (Glaser 2004; Park & Lee 2014). This enhances their understanding of the product design and development and improves their forecasting of potential changes and market demands (Kwon & Suh 2004). In addition, coordinated communication and sharing information among cross-functional units shapes the performance of the innovation projects creativity (Leenders et al. 2003), and is a critical factor for a successful innovation process (Parker 2000).

The degree of uncertainty in innovation projects will determine how much communication and information sharing among departments is needed (Gupta et al. 1986). Innovation projects with higher task uncertainty require higher information processing which can be achieved through intensive communication between cross functional team members (Tushman & Nadler 1978). This intensive communication assists innovation project team members with processing more information for a better understanding of the uncertain task and the interdependencies among them (Jiménez-Jiménez & Sanz-Valle 2011; Moenaert et al. 1995; Montoya-Weiss & ''Driscoll 2000; Yan & Dooley 2013). In addition, project team members advance their knowledge, learning as they exchange information (Levitt & March 1988). Hence, project communication effectiveness is defined as a change of the status-quo of knowledge which is conceived as a reduction in the level of innovation project uncertainty (Lievens & Moenaert 2000). Project team members through communication and sharing information can also reduce market uncertainty (information gap about the competitors and customers) and technology uncertainty through building knowledge that is drawn from the external environment (Lievens & Moenaert 2000). The greater the intra-organisation collaboration between departments, the more effective the communication and sharing information in reducing the level of innovation uncertainty (Lievens & Moenaert 2000). Collaborative communication contributes to the mitigation of organisational risk, as it provides collective knowledge around possible strategies and what works to effectively mitigate anticipated risks (VanVactor 2012).

The importance of using intensive communication for collaborative functional units' activities is increased in innovation projects due to higher task uncertainty that requires greater information processing (Tushman & Nadler 1978). In such an uncertain task environment, it is difficult to ascertain the interdependencies between task components, or comprehensively plan the correct strategy for avoiding unsynchronised activities (Van de Ven et al. 1976). Even uncooperative behaviour is difficult to detect in information asymmetry and ambiguity (Carson et al. 2006; Eisenhardt 1989). Intensive communication and sharing information allows innovation project teams to process more information that facilitates a greater understanding of the uncertain task environment and adds value for integrating activities since task interdependencies are more easily identified in a timely manner (Yan & Dooley 2013).

Additionally, evidence from several case studies showed that the incomplete and inaccurate assessment of customer requirements was one of the reasons behind the failure of numerous NPD projects (Von Hippel 1998). The knowledge gap related to customer demand necessitating greater integration among marketing and R&D in order to meet customer requirements (Gupta et al. 1986). Such a gap can only be closed through effective communication and information processing among these two functional units (Li & Calantone 1998; Tsai & Hsu 2014). Communication and sharing information among manufacturing and marketing units within the organisation was found to enable the transmission of complex and often tacit customer preferences into actual customer solutions (Eisenhardt & Tabrizi 1995; Ghosh et al. 2006). This reduces market uncertainty, decreasing the mismatch between what is needed in the market and what is developed which in return enhance the NPD success (Bendoly et al. 2012; Li & Calantone 1998).

Lank (2005) has provided suggestions for cross-functional effective communication, such as maintaining open and collaborative communication and exchanging opinions, taking the path of least resistance to communicate wherever possible, investing sufficient time and attention in communication and information-sharing processes, ensuring that needed information reaches its targeted stakeholders in a timely manner. This is evident in applied industry practice. For instance, the 3M Company has its own internal channels for communicating and sharing information, research data, and messages throughout different departments to maximise collaboration and facilitates the cross-fertilisation of innovative ideas (Conceição et al. 2002). Additionally, innovation projects that are associated with new value creation result from collaboration, information sharing, and merging diverse knowledge to yield the implementation of novel ideas (Černe et al. 2013; Hage & Hollingsworth 2000; Taylor & Greve 2006)

Research on innovation projects has stressed the significance of meaningful and timely information sharing in resolving conflicts and aligning perceptions and expectations, which in turn fosters trust formation (Morgan & Hunt 1994). Hence, timely, accurate, open, and adequate communication and sharing information is essential to establishing a shared understanding, promotes collaborative relationships, nurtures commitment and trust, and ensures that deadlines are maintained (Dyer & Chu 2003).

### 3.7.4 Trust Formation

Trust formation is a vital base for intra-organisational collaboration and is defined as a long-term social psychological process built through the development of understanding and knowledge sharing among team members based on their interactions (Lin et al. 2015b). Trust is based on one’s expectation of others’ intentions, capabilities, expertise, knowledge and motives (Rousseau et al. 1998). Trust includes two fundamental dimensions: honesty and sincerity. Honesty reflects the belief that one party will keep its word and promises, while sincerity is the belief that one party is interested in the other party’s well-being and will not take unexpected actions that will result in negative consequences (Geyskens et al. 1999).

Trust is essential within an organisation that seeks to develop projects because it is essential for maintaining a strong, positive project team environment (Pinto et al. 2009). The literature emphasises the importance of collaborative relationships, communication and sharing information among functional units for the success of innovation projects (Rodríguez et al. 2008). However, since these functional units are made up of people, aspects of a social nature such as trust or internal commitment are crucial as they influence the interactions among the functional units (Rodríguez et al. 2008). Trust is crucial in both across hierarchical levels and among functional units within the organisation. For instance, trust between team, project managers, and top management is vital for a successful project (Pinto & Slevin 1987). In addition, research on the impact of different organisational structures, such as matrix type, agrees with the necessity for trust-based relationships within the organisation in negotiation for resources or critical project support (Larson & Gobeli 1987; Laslo & Goldberg 2001).

In intra-organisational relationships, trust is an essential basis for establishing a work environment characterised by open communication, cooperation between different functional areas, and high team spirit (Rodríguez et al. 2008). Especially in innovation development activities where uncertainty is inherent, trust enables the project team to ask for help and manage risks with novel idea generation (Lin et al. 2015b, Rosenberg 1988). This increases the quality of information sharing and improves inter-functional relationships (Gupta & Wilemon 1990; Jassawalla & Sashittal 1998). Inter-functional trust exerts a positive and direct effect on innovation project performance. For example, Sivadas & Dwyer (2000), who proposed "cooperative competency"- a construct consisting of trust, communication, and coordination, proved the positive impact of trust in innovation projects success (Sivadas & Dwyer 2000). On the other hand, the lack of trust creates confidentiality concerns, hinders the sharing of the ideas, information, resources between the team members, and leads to project failure (Lin et al. 2015b).

Previous research has provided substantial evidence on the vital role of trust in knowledge sharing. For example, in organisational design research, trust is conceived as an essential base for knowledge creation (Nonaka et al. 2000). Organisations in which staff from functional units trust each other are more likely to adopt a double-loop learning style that yields new knowledge to evolve new practices, perspectives, and operational frameworks rather than a single-loop style (Rodríguez et al. 2008). In relationship management research, trust has been identified as a key factor affecting knowledge sharing in virtual communities (Lin et al. 2009; Ridings et al. 2002), in intra-organisational relationships (Chowdhury 2005), in inter-organisational collaboration (Patnayakuni et al. 2007), and in supply chain relationships (Cheng et al. 2008). Within information systems research, trust is also conceived as a basis of effective knowledge sharing activities (Staples & Webster 2008), and in management research, trust facilitates knowledge sharing within and between teams (Renzl 2008). In the context of project management research, trust is found to be essential for knowledge acquisition (Maurer 2010), as project team members in an environment with high levels of trust have been shown to be more likely to obtain project-related knowledge (Xu & Ma 2008). In the same context, the role of trust has been highlighted as imperative in knowledge sharing (Kanawattanachai & Yoo

2007), for example, if system engineers from diverse groups trust each other, they are more likely to share knowledge with each other, expecting to make the best use of knowledge in the project (Park & Lee 2014).

Empirical studies support the notion that trust serves as a catalyst between collaborative units or employees (Zahra & Nielsen 2002), and feeds collaboration creativity (Bstieler 2006). Studies have also shown that trust, internal commitment and communication and sharing information must translate into effective cooperative and joint activities to exert a positive influence on innovation process success (Rodríguez et al. 2008).

### 3.7.5 Commitment

Commitment is a key factor in the development and success of long-term collaborative relationships (De Ruyter et al. 2001; Morgan & Hunt 1994; Wetzels et al. 1998). It has been referred to as a lasting desire to sustain a valued relationship (Moorman et al. 1992). When commitment exists, the parties involved assume a long-term relationship orientation based on their desire to sustain a longer relationship and their willingness to make short-term sacrifices to capture greater benefits in the long-term (Coote et al. 2003; Morgan & Hunt 1994). Two fundamental dimensions of commitment exist: affective commitment and calculative commitment. Affective commitment reflects the affective tendency to maintain a relationship established through the identification of the parties' values in the relationship towards the development of an emotional bond between them (Morgan & Hunt 1994). Calculative commitment results from cognitive and rational evaluations of the costs and benefits of sustaining the collaborative relationship (Geyskens et al. 1996).

In intra-organisational collaboration, and particularly in the context of innovation projects, most authors referred to the concept of commitment, as the team's commitment to the project. It is defined as the team's sense of duty to achieve the project's goals and their willingness to work towards success (McDonough III 2000). It is also conceived as a common denominator for collaborative relationship activities, communication and sharing information among the cross-functional teams (Coote et al. 2003). It is considered a determinant for collaboration and communication, which directly affects performance of the innovation projects (Rodríguez et al. 2008). It is an essential factor in the development and success of collaborative, long-term, and valued relationships (De Ruyter et al. 2001; Moorman et al. 1992).

In innovation projects, internal commitment may take another direction, one which implies mutual interdependence among the functional unit to successfully perform the project tasks

(Rodríguez et al. 2008). This mutual interdependence commitment stresses the need for mutual commitment, which provides a basis for collaborative relationship (De Ruyter et al. 2001; Morgan & Hunt 1994; Wetzels et al. 1998), and communication and sharing information (Sivadas & Dwyer 2000). Scholars have added that intrafirm commitment limits opportunism, reduces uncertainty, and reinforces a double-loop learning process which in return improves innovation project performance (Rodríguez et al. 2008).

## 3.8 Intra-organisational Collaboration and Innovation Project Performance

Innovation project performance, consistent with previous research, demonstrates the commercial benefits an organisation obtains from launching an innovation into the market or from employing it within the organisation (Czarnitzki & Hottenrott 2009; Kirner et al. 2009; Prajogo & Ahmed 2006). Abundant research on the performance of innovation projects in different industries supports a positive relationship between collaboration and innovation performance (Cao & Zhang 2011; Ernst et al. 2010; Olson et al. 2001; Troy et al. 2008). This is because innovation projects require a multidisciplinary process which necessitates collaboration between heterogeneous functional units (Olson et al. 2001). In order for this process to be established effectively, high interaction, information sharing, and close collaboration among heterogeneous functional units is required (Griffin & Hauser 1996). The need for intra-organisational collaboration increases in cases where the innovation projects involve reciprocal task interdependencies between departments (Galbraith 1973; Tushman & Nadler 1978).

Research has also revealed that high performance of innovation projects requires an environment in which resources are allocated to the project from a shared “resource pool”, joint decision-making is enabled, and loss and risks are shared within project members (Um & Kim 2018). For instance, in NPD projects, collaboration facilitates information sharing that is conducive to accurate prediction of demand and market changes, and aids the reduction of potential errors (Cao & Zhang 2011; Yan & Dooley 2013). Intra-organisational collaboration ensures that technical, marketing, along with other functional capabilities are integrated to create a result that accords with customer requirements (De Luca & Atuahene-Gima 2007). Likewise, joint decision-making through collaboration strengthens timely responsiveness and this accelerates the problem-solving process, enabling products to be launched faster than competitors (Um & Kim 2018).

Relationship-oriented factors including collaboration among the project team are found to be more influential in achieving the project objectives and external stakeholders' satisfaction than task-oriented factors throughout the implementation of innovation projects (Cserháti & Szabó 2014). The task-oriented factors are vital in the definition and planning phase of the project. However, throughout the implementation phase, soft skills comprising relationships and effective communication can ensure success (Cserháti & Szabó 2014). Moreover, cooperation of the team members is shown to be the key direct conditioning factor over trust and commitment for enhancing the NPD performance (Rodríguez et al. 2008).

In addition, research studies on the performance of NPD in different industries have proven the importance of intra-organisational collaboration as a key success factor in NPD projects (Bendig et al. 2018; Cooper 2019; Cserháti & Szabó 2014; Rodríguez et al. 2008). Intra-organisational collaboration enhances the performance of incremental and radical innovation projects and promotes innovation in organisations (Gkypali et al. 2017; Jugend et al. 2018; Zhang & Tang 2017). This is because innovation is the end result of collective team efforts (Carnabuci & Operti 2013; Černe et al. 2013; Cooper 2019). Intra-organisational collaboration promotes the formation of novel ideas and the integration of knowledge in a multi-functional work environment, and fosters the team's capacity to handle technologically complicated tasks (Jugend et al. 2018; Zhang & Tang 2017). Effective intra-organisational collaboration also entails a high level of technological heterogeneity between employees, as well as positive team synergy with a common vision, shared understanding of tasks, and efficient knowledge sharing (Zhang & Tang 2017). Additionally, intra-organisational collaboration enhances the internal learning and knowledge base of the firm which in turn improves the innovation potential of organisations (Gkypali et al. 2017).

The importance of intra-organisational collaboration in innovation performance has been empirically verified in the literature. For example, Hise et al. (1990) found that intra-organisational collaboration predicted the level of product success, while Zeller (2002) recommended that strong intra-organisational collaboration ties between functional units such as R&D and marketing units are critical to innovation capabilities. De Luca & Atuahene-Gima (2007) empirically demonstrated that intra-organisational collaboration among functional units increases innovation performance indirectly through knowledge integration, and Love & Roper (2009) showed that intra-organisational collaboration benefits innovation performance, particularly in the technical stages such as product design, product development, and product engineering. It has been also observed that one of the strong motivations of the intra-organisational collaboration in innovation projects is the expected benefits in terms of innovation performance (Becker & Lillemark 2006).

Extant research on collaboration in innovation projects highlights how the quality of teamwork promotes their performance, especially in innovation projects which are characterised by high levels of uncertainty (Adler 1995; Olson et al. 1995). Teamwork quality and cohesiveness of project teams enhance the performance of highly complex projects (Cserháti & Szabó 2014; Gölgeci et al. 2019; Suprapto et al. 2015). For example, the effective collaboration between the marketing and supply chain departments is found to enhance the projects that involve external collaboration, and to improve the project performance itself (Gölgeci et al. 2019).

Research has also found that intra-organisational collaboration fosters and necessitates process innovation because of the huge amount of information being shared and processed among departments (Cuijpers et al. 2011; Daft & Lengel 1986). This is because of the high level of information processing that aids in anticipating downstream risks involved in the project such as design incompatibilities or market constraint (Eisenhardt & Tabrizi 1995). The earlier the identification of the risks, the less time and cost required for mitigation (Cuijpers et al. 2011). The riskier the innovation task, the more information processing and knowledge creation is required to achieve a successful implementation of innovation project (Gemser & Leenders 2011).

High level of information processing, in particular customer and marketing information, likewise helps to reduce uncertainty and increase the chances of the innovation meeting the customer and market needs (Jalonen 2012). Studies accordingly suggest that organisations foster a project environment that involves effective cross-functional collaboration (Gupta & Maltz 2015; Rodríguez et al. 2008; Spieth & Joachim 2017) since it enables early uncertainty detection and effective management of the identified uncertainties in complex projects (Oehmen et al. 2014). These capabilities of knowledge generation and information processing are enhanced through cross-functional collaboration (Souder & Moenaert 1992).

Studies on intra-organisational collaboration also drew on the collaboration between the functional department heads, which were found to be effective in enhancing project efficiency and reducing cross-functional collaboration conflict (Anthony et al. 2014). Collaboration between cross-functional teams is considered favourable as it promotes creativity, problem solving and information sharing (Hoegl et al. 2008). However, there are challenging conditions that highly diversified cross-functional teams may present for decision-making process as a result of diverse opinions, stereotypes, biases, and absence of team unity (Chatman & Flynn 2001; Sethi & Nicholson 2001); good collaboration between the functional department heads was found to be effective in managing these challenges (Anthony et al. 2014).

The benefits generated from cross-functional collaboration are more deeply emphasised in literature with some highlights on the importance of supporting the team building process that integrates team efforts and enhances innovation team performance (Hoegl et al. 2008). Some studies investigated the cost associated with intra-organisational collaboration in terms of delay and termination (i.e., Tushman & Nadler 1978), yet empirical evidence revealed that its benefits exceeded its costs, and these costs were found to have little or no effect at the organisation level (Cuijpers et al. 2011).

Moreover, evidence of studies in NPD projects corroborated the idea that innovation performance is enhanced where there are financial resource constraints on projects, this was explained through the presence of a highly engaged team process (Hoegl et al. 2008). This is because highly engaged teams leverage the team’s skills and capabilities to achieve an appealing project objective (Hoegl et al. 2008). Additionally, highly engaged teams were verified to not only enhance the project success but also to enhance business performance (Smirnova et al. 2011; Tsai & Hsu 2014). Further, reviews of NPD projects that ended in failure confirmed that failure was associated with the absence of team commitment to the project as well as a lack of communication among the diverse functional areas of the organisation (Cooper 2019).

Project outcomes are shaped by the way the project team is organised and functioned. It has been noted that intra-organisational collaboration improves innovation project success and the overall innovation in the organisation. Therefore, the collaboration among diverse departments and the variety of team expertise enhances learning and accordingly improves the success of innovation projects. These benefits have been agreed upon in the evolving research outlined, despite the argued costs associated with the intra-organisational collaboration.

## 3.9 Organisational Learning

Organisational learning is also receiving increasing interest in the innovation management literature (De Toni & Pessot 2021; de Vasconcelos Gomes et al. 2021; Dodgson 1993; Tortorella et al. 2020). Dodgson (1993) discussed three main reasons behind the growing interest in organisational learning. First, the concept of organisational learning is itself of particular novelty among organisations as they develop cultures and structures that are flexible and responsive to change (Senge 1990). Additionally, organisations aim to have a sustainable competitive advantage, and it is widely agreed that learning is key to competitiveness (Garratt 1987). Second, the internal and external uncertainties facing organisations, including uncertainties involved in innovation projects, increase the need for organisations to learn to do things in different ways (Dodgson 1993; Rothwell 1994; Ying et al. 2021). Third, the concept of 'learning' is increasingly gaining a broad analytical value, particularly in management literature that seeks a new language to explain the turbulence facing organisations (Dodgson 1993; Tortorella et al. 2020). An example of this is seen in the economics literature that attempts to go beyond the static view of 'organisation' to a more dynamic one, using learning, a dynamic concept that stresses the continually changing nature of organisations (Dodgson 1993).

Organisational learning is defined as the process of transforming individually gained knowledge into organisational knowledge (García-Morales et al. 2012; Levinthal & March 1993; Tortorella et al. 2020), where actions are enhanced and repetition of mistakes is avoided through better knowledge, understanding, and experience (DiBella et al. 1996; Fiol & Lyles 1985; García-Morales et al. 2012). It is defined as the process through which an organisation integrates employees' experiences and develops new knowledge and insights that have the potential to change behaviours as well as expand an organisation's capabilities (Fiol & Lyles 1985; Huber 1991; Slater & Narver 1995). It is also described as the process by which organisations build, add and manage knowledge and practices around their activities and within their cultures, and utilise the skills and experience of their workforce to promote organisational efficiency (Dodgson 1993). These broad definitions of organisational learning are based on some broad assumptions, for example they assume there are positive outcomes of learning, and that learning takes place in all the activities of the organisation at various speeds and levels (Dodgson 1993).

There is no accord among business related disciplines as to what learning is, nor how it happens (Fiol & Lyles 1985). For example, management and business literature links learning to sustainable competitive efficiency (García-Morales et al. 2012). Economists associate learning with an improvement in activities, and the innovation literature views learning as promoting comparative innovative efficiency (Dodgson 1993). Additionally, research relates organisational learning to the knowledge generated and exploited within the organisation which allows sustainable competitive advantage (Caiazza et al. 2015; Fiol & Lyles 1985; Levinthal & March 1993).

### 3.9.1 Organisational Learning Processes

The concept of learning does not simply include learning outcomes but also the learning processes (De Toni & Pessot 2021; Dodgson 1993). The first view of the learning process has stressed the cognitive and behavioural dimensions of learning, and linked learning to the change of action in the structures, systems or processes of the organisation (March 1991). This perspective links learning to the change in how organisations or individuals process information, build shared meaning, and interpret events (Hedberg 1981; Huber 1991). The second view articulated learning as single, double or deuteron loop (de Weerd-Nederhof et al. 2002).

The idea of single-loop and double-loop learning was first introduced by Argyris & Schon (1978); these have also been labelled lower-level and higher-level learning (Fiol & Lyles 1985), generative and adaptive learning (Senge 2006), or learning how and learning why (Edmondson & Moingeon 1996). The single-loop learning occurs while following the organisational structure and rules, whereas double-loop learning takes place to alter and improve the overall rules and norms (de Weerd-Nederhof et al. 2002). Double-loop learning occurs by using heuristics, skill developments and insights and has long-term effects on the organisation (de Weerd-Nederhof et al. 2002). Deuteron learning occurs when the organisation understands how to use the single-loop and double-loop learning processes and thus helps to improve product innovation performance (Argyris & Schon 1978; Saban et al. 2000).

Learning in the organisation occurs at three different levels: individual, group and organisational. Research has addressed these three levels of learning and the mechanisms used in each. Senge (2006) discussed the mechanisms of personal mastery in the individual level, team learning in the group level, and systems thinking in the organisational level. Learning at the organisational level usually takes place when the learning that occurs at individual or group level is captured by the organisation and embedded in the organisation’s memory (Argyris & Schon 1978; Garvin 1993; Levitt & March 1988).

Organisational learning is an organisational process rather than an individual process and involves sharing information, knowledge, and experiences between individuals and groups (de Weerd-Nederhof et al. 2002). The levels of learning and the relationships between them, along with the different mechanisms used in each level indicate how organisational learning is a complex construct. Accordingly, several models are proposed in the literature for organisational learning. The most cited is Huber’s 1991 model that has been employed in a wide body of literature (Argote et al. 2021; Dung et al. 2021; Sinkula 1994; Slater & Narver 1995). It notes four stages integrally linked to organisational learning: information acquisition, information dissemination, information interpretation, and organisational memory.

Information acquisition is the process by which the organisation obtains new information and knowledge (Argote et al. 2021; Dung et al. 2021). Three different sources of information and knowledge have been discussed in the literature (Slater & Narver 1995). The first source is the direct experiences of the organisation that have an internal focus, for example, process improvement or those with an external focus such as market research. The second source is the experience of others, which can include informal discussion with customers, suppliers, etc. (Kohli & Jaworski 1990). An organisation's memory is the third source, which usually serves as a repository of organisation's information and knowledge and is also an outcome of organisational learning (Argote et al. 2021).

The second stage is information dissemination which is the process of knowledge sharing and distribution in which new information from various sources is shared among functional units through formal and informal channels within the organisation and thereby leads to new information and/or understanding (Maltz & Kohli 2000; Slater & Narver 1995). Sharing knowledge and information is a vital activity in the learning process - beyond various information simply being shared, a sense of shared meaning is formed (Dung et al. 2021).

The third stage is knowledge interpretation, which occurs when the newly distributed knowledge is given a meaning or linked to a more commonly understood interpretation (Argote et al. 2021; Slater & Narver 1995). As the information is disseminated within the organisation, consensus on the meaning of the information evolves and consequently leads to a common understanding of the information and its impact on the organisation's future strategy (Tippins & Sohi 2003). Once the organisation's members reach a common understanding of the meaning of the information, they can act upon in a collaborative and effective way (de Weerd-Nederhof et al. 2002). The common understanding of the information can also affect the future acquisition and interpretation of information as information will be assessed against that which already exists (Tippins & Sohi 2003).

The last stage is organisational memory, which includes the process of storing the knowledge to be used in the future (Argote et al. 2021; Slater & Narver 1995). Organisational memory refers to the amount of stored information and knowledge held within the organisation about a certain phenomenon (Moorman & Miner 1997), and plays a vital role in an organisational learning process (Tippins & Sohi 2003). It provides the basis for change that is achieved through generative learning processes and influences the type of information that is obtained and the way the information is analysed and interpreted (Moorman & Miner 1997; Slater & Narver 1995). Organisational memory is classified as declarative and procedural (Moorman & Miner 1998). Declarative memory concerns knowledge of facts and events such as knowledge about market condition, marketing strategy and competitive positions (Moorman & Miner 1998). The procedural memory concerns knowledge about organisation's routines, processes, and procedures such as procedures to deal with customers and procedures to know customers' requirements. Declarative memory has been associated with general knowledge that is relevant to a broader spectrum of conditions, and procedural memory tends to be more rigid and is linked to domain-specific skills or routines (Tippins & Sohi 2003).

In brief, organisational learning refers to the outcomes of the learning as well as the learning processes. The four-stages of the organisational learning process introduced by Huber (1991) is the most frequently employed in a wide body of literature, and includes information acquisition, information dissemination, information interpretation, and organisational memory. Each stage is found to contribute to the overall organisational learning.

## 3.10 Intra-organisational Collaboration and Organisational Learning

The importance of intra-organisational collaboration in promoting organisational learning has been highlighted in the literature. Research has shown that the development of organisational learning relies on the extent to which organisational members collaboratively share knowledge (De Luca & Atuahene-Gima 2007; García-Morales et al. 2012; Maltz & Kohli 2000; Rindfleisch & Moorman 2001). This is because organisational learning involves knowledge acquisition, knowledge sharing, and knowledge utilisation (DiBella et al. 1996), and this takes place when a collaborative interaction within an organisation shares and creates knowledge that expands between tacit and explicit knowledge (de Vasconcelos Gomes et al. 2021; Lakemond et al. 2016).

Research has confirmed the importance of intra-organisational collaboration in emphasising explorative learning and perfection (Alegre & Chiva 2008; Bellini & Canonico 2008; Eriksson et al. 2017; To & Ko 2016). This is because effective knowledge creation is not likely to be achieved through a formal hierarchy and centralised controlled structure (Lin et al. 2015b); it is far more likely to be achieved through a synthesis of different individuals' perspectives drawn from the organisation's diverse functional units, that is, through a collaborative learning process (De Luca & Atuahene-Gima 2007; Grant 1996).

The relationship between intra-organisational collaboration and knowledge creation has been discussed by both academics and practitioners (Bellini & Canonico 2008; Lin et al. 2015b). For example, Mir & Rahaman (2003) through a case study explained how the collaboration between the diverse organisational functional units aided in creating and understanding knowledge within the organisation. The knowledge is eventually created through the development of common trust, continuous dialogue, and regular meetings between members of the diverse functional units to share implicit perspectives (Mir & Rahaman 2003). Moreover, cross-functional collaboration aids in creating appropriate background conditions for the creation and transfer of knowledge and enhances organisational performance (Bellini & Canonico 2008).

Organisational environments that foster high levels of dialogue and participative decision making accomplish higher organisational learning capabilities (Alegre & Chiva 2008). Dialogue is characterised as cross-functional teamwork, communication facilitated by management, and open communication among workgroups. Participative decision making occurs in environments where managers regularly involve their employees in decision making process and where the organisational policies are influenced by employees who in turn have a sense of involvement in organisational decisions (Alegre & Chiva 2008).

The way organisations gain knowledge through collaboration is seen in the example of collaborative efforts between R&D and marketing teams in the high-tech industry (Churchman 1971). While R&D engineers focus on the technical aspects of the projects such as product characteristics and techniques, the marketing people bring an understanding of market demand, customers' requirements, and competitors' activities and potential responses (Courtney 2001). Once these individual team knowledges and perspectives are assembled, they are brought together to be shared and understood (Courtney 2001). This knowledge integration is a pivotal step toward creating new knowledge within organisation (Calantone & Rubera 2012; Grant 1996; Paruchuri & Awate 2017).

Furthermore, through intra-organisational collaboration, innovation project teams get access to new knowledge and obtain mutual benefits (Tsai 2002). Luo et al (2006) further explained this by introducing a dimension of intra-organisational collaboration derived from absorptive capacity (Luo et al. 2006). Absorptive capacity is the project team members' ability to recognise and value new information and to exploit it in the organisation's best interests (Cohen &

Levinthal 1990; Flatten et al. 2011). This absorptive capacity has been shown to foster organisation innovativeness (Mowery et al. 1996; Tsai 2001), knowledge sharing (Gupta & Govindarajan 2000), and learning intensity (Lane & Lubatkin 1998). Further, absorptive capacity is associated in some theories with organisational learning (Volberda et al. 2010). Research has provided empirical evidence of the positive influence that absorptive capacity exerts on knowledge transfer and organisational learning among organisations (see for example, Gupta & Govindarajan 2000; Lane & Lubatkin 1998). This positive influence is much higher when collaboration takes place between an organisation's functional units where mutual trust is higher than when external organisations are involved (Bendig et al. 2018).

The challenging nature of innovation projects necessitates expertise from diverse functional units to exchange information, generate new ideas to reduce uncertainty, solve problems and accomplish required tasks (Lin et al. 2015b). Intra-organisational collaboration reduces innovation project uncertainty through knowledge integration activities (De Luca & Atuahene-Gima 2007). Collaboration between heterogeneous teams involves effective communication in sharing ideas and information owned by teams which reinforces the integration of different disciplines (Nissen et al. 2014). Through intra-organisational collaboration, accumulated knowledge will be exploited and used to reduce innovation projects' uncertainties (Brookes et al. 2006), which in turn enhances organisational learning (Sorenson 2003).

Moreover, collaboration among organisational functional units extends their collective knowledge through organisational learning, and it is the key prerequisite for learning in innovation projects (Bendig et al. 2018). For example, R&D knowledge is highly sensitive, and collaboration ties are the only way other functional units can access it (Bendig et al. 2018). Collaboration relationships among functional units improve the flow of information and cultivate knowledge transfer routines (Schildt et al. 2012; Tsai 2002). It also allows functional units to decide the relevancy of information, compile this information, and ultimately utilise it in other contexts (García-Morales et al. 2012; Luo et al. 2006).

Effective management of cross-functional collaboration also enhances team relationship and team learning, which are crucial in accomplishing organisational innovation goals (To & Ko 2016). Scholars have suggested an increase in the participation of leaders and to include those team members who are experienced in working within a collaborative environment in order to increase the success of collaborative knowledge creation (Samaddar & Kadiyala 2006). This is because the intra-organisation collaboration ability of different units derives from the members' skills at internalising and exploiting the (relevant) knowledge they acquire through their interactions (Bendig et al. 2018). Suggested methods that increase the effectiveness of intra-organisational collaboration in learning include the use of best practice databases and networking mechanisms as well as encouraging the cross-fertilisation of knowledge through bringing together teams who are working on the same issues (Lin et al. 2015b). It is further suggested that organisations acquire employees with the diverse skills and knowledge required for solving a wide range of problems while sharing knowledge and experiences among each other (de Weerd-Nederhof et al. 2002).

Previous studies agree on the positive effect that intra-organisational collaboration has on organisational learning through effective communication among a heterogeneous project team. This is achieved through fostering a high level of dialog, encouraging a participative decision-making environment and ensuring the effective exchange of information and ideas among different team members.

## 3.11 Organisational Learning and Innovation Project Uncertainty

Organisational learning is as important as individual learning for adjusting to uncertainty and for survival in a competitive environment (Dodgson 1993). The need for learning is a natural response to the need for adaptation and adjustment in a turbulent environment (Dodgson 1993), and it is a central part of large innovative organisations' strategies in coping with uncertain conditions (Tortorella et al. 2020). The knowledge achieved through organisational learning is considered an enabler of problem definition and alternative generation, evaluation, and decision in innovation projects (De Toni & Pessot 2021; Tortorella et al. 2020).

Constant changes in the external environment, for example in technology and the market, force organisations to transform their innovation process to accommodate continuous learning (De Toni & Pessot 2021). The higher the uncertainty in innovation projects (products, services or methods), the greater the depth and breadth of learning required (Frishammar et al. 2012; García-Morales et al. 2012). An organisation with a high level of organisational learning will be capable of anticipating customer and market need and using advanced technology to innovate (Fanousse et al. 2021b).

Organisational learning enables organisations to be more flexible and efficient when responding to technology and market changes (Tortorella et al. 2020; Ying et al. 2021). This results in the organisation being less likely to miss opportunities that emerging and changing market demand generates (García-Morales et al. 2012; Stevens 2014). Likewise, this makes them more able to analyse their competitors' strengths and weaknesses, and therefore yields a higher innovative capability than their competitors (Calantone et al. 2002). Additionally, organisational learning contributes to the adoption of options with the highest probability of success in innovation projects where rationality is challenging due to uncertainty (Stevens 2014).

Furthermore, information dissemination, an essential part of organisational learning, is a key requirement for the successful completion of a project because it aids in reducing different sources of uncertainty (Fanousse et al. 2021b). The sharing of information and knowledge promotes the exploitation of internal organisational knowledge (Chang et al. 2013). The transformation and interpretation of shared information is an essential part of any innovation (Jiménez-Jiménez & Sanz-Valle 2011) because the information, knowledge and experiences shared between employees combine to generate new insights and facilitate optimal decision-making (Nonaka & Takeuchi 1995). Through organisational learning the development, acquisition, transformation and exploitation of new knowledge is enabled and this in return reduces complexities in innovation projects (Jiménez-Jiménez & Sanz-Valle 2011).

Retaining the knowledge gained through previous experience in the organisational memory is key for organisational learning and leads to the effective management of the early stages of innovation projects where uncertainty is highest (Ying et al. 2021). Organisations that are capable of learning are more likely to sense events and trends in the marketplace, and accordingly have a greater capacity for resilience and for being responsive to new challenges (Tortorella et al. 2020). Hence, current research recommends organisations analyse their current organisational learning approach and priorities before innovation projects are initiated. (Tortorella et al. 2020).

Organisations with a solid existing knowledge base are better served by research and development investments because they do not waste time acquiring information that is not relevant or useful to the project (Brockman & Morgan 2003; Nelson 1982). Additionally, existing knowledge reduces unpredictability of the time needed to complete tasks and, in the quality, and reliability of tasks completed (March 1991). It also supports teams within the organisation in obtaining the shared interpretation of the new information by improving their processing abilities (Brockman & Morgan 2003; Cohen & Levinthal 1990).

## 3.12 Conclusion

To summarise, the review revealed three sources of uncertainty that contribute to the high rate of failure in innovation projects: task, market, and technological. Reducing innovation project uncertainty is linked to high performance in innovation projects. The review situated intra-organisational collaboration as an essential organisational practice in innovation projects. Additionally, it confirmed the importance of considering the multi-dimensional nature of an intra-organisational collaboration concept. Accordingly, five dimensions of intra-organisational collaboration were defined: collaborative leadership, collaborative relationship, trust formation, communication and sharing information, and commitment. The review also revealed that the five dimensions overlap and operate dialectically for enriching organisational learning, which in return contributes to reducing innovation project uncertainty.

The literature review revealed that extant research on managing innovation projects lacks empirical evidence for those effective organisational practices that reduce innovation project uncertainty that result in successful project performance. There are few attempts in the literature to empirically investigate the impact of intra-organisational collaboration, with its multi-dimensional nature, for reducing innovation project uncertainty and enhancing performance. The role of organisational learning that results from intra-organisational collaboration has also not been empirically examined in the innovation project context in the literature. This thesis responds to this knowledge gap by empirically examining the impact of intra-organisational collaboration as an organisational practice has on reducing innovation project uncertainty and promoting innovation project performance, whilst considering the role of organisational learning. This literature review chapter discussed the relevant literature of this research project; the following chapter will introduce the conceptual framework and the hypothesised relationships for this research.

# Chapter 4: Conceptual Framework

## 4.1 Overview

This chapter introduces the conceptual framework, derived from the literature and presents the hypothesised relationships to be examined in this study. The conceptual framework looked at the direct and indirect impacts of intra-organisational collaboration on innovation project uncertainty reduction and innovation project performance. Additionally, the role of organisational learning that is enabled by intra-organisational collaboration in facilitating the reduction of innovation project uncertainty is considered in the conceptual model. Therefore, this chapter discusses the conceptual model, the hypotheses derived from the model (Section 4.2, and 4.3.1 to 4.3.7), and concludes with a summary of the chapter (Section 4.4).

## 4.2 Conceptual Framework

Based on a systematic literature review, this research developed a comprehensive conceptual framework that assesses the direct impact of intra-organisational collaboration on innovation project uncertainty reduction (task, market, technological), and its indirect impact on innovation project uncertainty reduction through organisational learning (see Figure 4.1). Additionally, the conceptual framework demonstrates the direct impact of intra-organisational collaboration on innovation project performance, and how this impact is facilitated through innovation project uncertainty reduction.

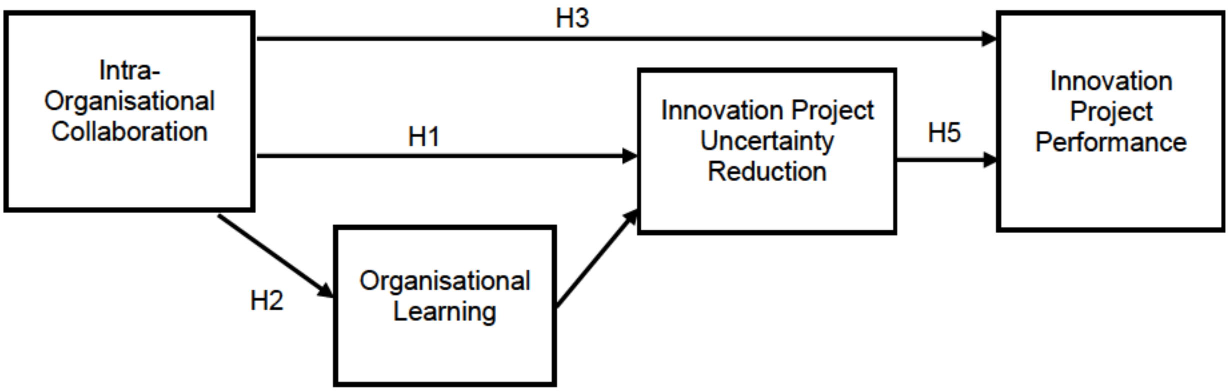


Figure 4.1 Conceptual Framework with the Hypotheses

As discussed earlier in Chapter 2, this research framework is grounded in the logic of organisational information-processing theory, and organisational learning theory (Fiol & Lyles 1985; Tushman & Nadler 1978). Organisational information processing theory is the main theoretical lens through which scholars have investigated innovation, collaboration and uncertainty (Cuijpers et al. 2011; Peng et al. 2014; Tatikonda & Rosenthal 2000b, West 2000). Organisational information-processing theory suggests organisations build internal design/ structures that has a congruence with a given task uncertainty; the higher the degree of task uncertainty, the more flexibility is needed in the internal organisation structure (Daft & Lengel 1986; Tushman & Nadler 1978). This is because flexible design/structure allows for the processing of more information which enables the reduction of uncertainty and improves innovation project performance (Cuijpers et al. 2011).

This study proposes that intra-organisational collaboration provides the means for effective information gathering and the development of appropriate processing systems that are able to cope with the high level of uncertainty inherent in innovation projects. Organisational information-processing theory is thus a suitable framework for studying the effect of intra-organisation collaboration on uncertainty reduction in innovation projects because it not only allows forecasting the impacts of intra-organisational collaboration, but also accounts for the mechanisms underlying these impacts (Daft & Lengel 1986; Tushman & Nadler 1978).

Secondly, this study also uses organisational learning theory. Organisational learning theory suggests that organisational learning facilitates uncertainty reduction through intra-organisational collaboration. Intra-organisational collaboration capability enables employees' skills to identify, absorb, transform, and implement valuable knowledge across functional departments (Luo et al. 2006). This knowledge is important when developing innovation as it yields connections between different pieces of information, thus reducing uncertainty (Strese et al. 2016). The two theories have been explained in detail in Chapter 2.

Building on organisational information-processing theory and organisational learning theory, this study asserts that organisations use intra-organisational collaboration as an instrument to enable knowledge processing mechanisms, and organisational learning with the aim to reduce the innovation project uncertainties and enhance innovation project performance. Utilising this conceptual framework, this thesis answers the following research questions stated earlier in Chapter 1:

1. How does intra-organisational collaboration lead to innovation project uncertainty reduction?
    a. How does intra-organisational collaboration lead to organisational learning?
    b. How does organisational learning as the most important outcome of intra-organisational collaboration comes into play in the relationship between intra-organisational collaboration and innovation project uncertainty reduction?
2. How does intra-organisational collaboration lead to enhanced innovation project performance?
3. Does innovation project uncertainty reduction (task, market, and technological) mediate the relationship between intra-organisational collaboration and innovation project performance?
4. Do organisation size, age, industry and experience in innovation project confound the relationships between intra-organisational collaboration, organisational learning and both innovation project uncertainty reduction and performance?

Accordingly, this research investigates the mediating role of organisational learning in the relationship between intra-organisational collaboration and innovation project uncertainty reduction, as well as the mediating role of innovation project uncertainty reduction in the relationship between intra-organisational collaboration and innovation project performance. By demonstrating the conceptual framework along with its theoretical basis, the following section describes the development of hypotheses.

## 4.3 Development of Hypotheses

This section introduces the six hypotheses derived from the conceptual framework (see Figure 4.1). The hypotheses are concerned with the direct and indirect impact of intra-organisational collaboration on innovation project uncertainty reduction and project performance. The hypotheses are further concerned with the mediating role of organisational learning and innovation project uncertainty reduction in the above relationships. The following sections describe the development of each hypothesis.

### 4.3.1 Intra-organisational Collaboration and Innovation Project Uncertainty Reduction

Innovation project uncertainty is an inherent characteristic, and primary cause of high failure rates of innovation projects (García-Quevedo et al. 2018). Extant research emphasises the importance of intra-organisational collaboration in reducing innovation project uncertainty through information and knowledge sharing (Um & Kim 2018; VanVactor 2012; Yan & Dooley 2013).

As the level of uncertainty increases so do the potentials for negative impacts on the shared goals and clarity of project objectives among teams (Zhang & Doll 2001). This leads to several difficulties in the subsequent stages of the innovation process, including frequent deviation from project specifications (Thanasopon et al. 2016), lack of understanding and ineffective management strategies (De Brentani & Reid 2012). To avoid such challenges, organisational departments are required to forge intra-organisational collaboration practices that include collaborative relationships and leadership, communicating and sharing information, trust formation, and commitment. When such practices are in place, the organisation can cope with difficulties in practical matters, deal with challenges arising in the project, and reduce potential errors (Peng et al. 2014; Um & Kim 2018).

Collaboration has been found to be paramount in reducing project failures (Bendig et al. 2018; Cooper 2019; Cserháti & Szabó 2014; Rodríguez et al. 2008). Project members that were unable to close important information gaps were reportedly more likely to face severe consequences and project failures (Moenaert et al. 1995; Murmann 1994). Further, if uncertainty is not sufficiently reduced, it forces project members to take larger risks, which increase the probability of failure (Weick 1995). Accordingly, a high level of uncertainty can yield major difficulties in innovation projects (Frishammar et al. 2010). Such situations call for organisations to embed collaborative practices within their functional departments to handle and cope with innovation project uncertainty (Peng et al. 2014).

Most of the previous studies corroborated the importance of the collaborative practices in reducing project failures, however; research still lacks empirical evidence on the impact of intra-organisational collaboration on uncertainty in innovation projects. Furthermore, none of the previous studies considered the multi-dimensional nature of intra-organisational collaboration when examining its impact on uncertainty reduction (see for example, Bendig et al. 2018; Cooper 2019; Cserháti & Szabó 2014; Rodríguez et al. 2008). Therefore, this study proposes that intra-organisational collaboration reduces the uncertainty in innovation projects.

*H1: Intra-organisational collaboration positively affects innovation project uncertainty reduction.*

### 4.3.2 Intra-organisational Collaboration and Organisational Learning

There is a growing body of evidence that provides strong support for the relationship between intra-organisational collaboration and reinforcement of explorative learning within an organisation (Alegre & Chiva 2008; Eriksson et al. 2017; To & Ko 2016). The relationship also between collaboration and knowledge sharing is supported in literature (Ernst et al. 2010). Organisational learning involves information acquisition, dissemination, and knowledge interpretation (Argote et al. 2021; Dung et al. 2021), and relies on the extent to which organisational members collaboratively share knowledge (De Luca & Atuahene-Gima 2007). It has been established that effective knowledge creation is not expected to be realised through a formal hierarchy and centralised controlled structure (Lin et al. 2015b), rather is accomplished through a synthesis of various individuals' perspectives drawn from the diverse functional units of the organisation, for instance, through a collaborative organisational learning process (De Luca & Atuahene-Gima 2007; Grant 1996). The development of new capabilities and knowledge within an organisation enables organisational learning (García-Morales et al. 2012).

This is achieved when collaborative interactions within an organisation produce both explicit and tacit knowledge (Nonaka & Takeuchi 1995). However, research still lacks empirical evidence of the relationship between intra-organisational collaboration and organisational learning whilst considering the multi-dimensional nature of intra-organisational collaboration. Therefore, this research hypothesises that intra-organisational collaboration leads to organisational learning.

*H2: Intra-organisational collaboration positively affects organisational learning.*

### 4.3.3 Intra-organisational Collaboration and Innovation Project Performance

Strong innovation project performance is reflected in the commercial benefits an organisation obtains from scaling up an innovation into the market or from employing it within the organisation (Czarnitzki & Hottenrott 2009; Kirner et al. 2009; Prajogo & Ahmed 2006). The nature of innovation projects involves multidisciplinary processes and necessitates the involvement of heterogeneous functional units (Olson et al. 2001). This process requires high interaction, information sharing, and close collaboration among heterogeneous functional units in order to be established effectively (Griffin & Hauser 1996). To achieve this, organisational departments are required to forge intra-organisational collaboration practices including collaborative relationships and leadership, communicating and sharing information, trust formation, and commitment. As a result, the project team’s ability to manage technological complicated tasks is promoted (Zhang & Tang 2017), and the integration of knowledge in a multi-functional work environment as well as the generation of the novel ideas is enhanced (Jugend et al. 2018).

The need for intra-organisational collaboration practices increases where the innovation projects involve reciprocal task interdependencies between departments (Galbraith 1973; Tushman & Nadler 1978). Several research studies on the performance of innovation projects in various industries support the need for a positive relationship between collaboration and performance (Cao & Zhang 2011; Ernst et al. 2010; Olson et al. 2001) as well as product success (Troy et al. 2008). Also, research studies on the performance of NPD in several industries confirmed the importance of intra-organisational collaboration as a key factor for success in innovation projects (Bendig et al. 2018; Cooper 2019; Cserháti & Szabó 2014; Rodríguez et al. 2008). None of the previous studies considered the multi-dimensional nature of intra-organisational collaboration when testing its effect on innovation project performance. This study accordingly addresses this gap and suggests that intra-organisational collaboration enhances innovation project performance whilst considering the multi-dimensional nature of intra-organisational collaboration.

*H3: Intra-organisational collaboration positively affects innovation project performance.*

### 4.3.4 The Mediating Role of Organisational Learning

Uncertainty reflects a knowledge gap that is inherent in innovation projects (Galbraith 1974). To close the knowledge gap and consequently reduce uncertainty, requires increased information processing (Tushman & Nadler 1978). This can be achieved through the main components of organisational learning processes, which include information acquisition, information dissemination, knowledge interpretation, and organisational memory (Argote et al. 2021; Dung et al. 2021; Sinkula 1994; Slater & Narver 1995).

The importance of information acquisition for innovation has been stressed by many researchers (Cohen & Levinthal 1990; Nonaka & Takeuchi 1995). The acquisition of information strongly relies on the organisation's memory, and the capacity of the organisation to absorb and apply new ideas to innovation (Cohen & Levinthal 1990; Salavou & Lioukas 2003). Further, information dissemination is required for the successful completion of an innovation project as it aids in utilising the internal information and, consequently forms a sense of shared meaning (Dung et al. 2021).

Knowledge interpretation is an essential part of any innovation, which cannot occur without information dissemination within organisation (Tippins & Sohi 2003). This occurs when employees collaborate and share their knowledge and experiences and reach a consensus on the meaning of the information; such shared information can lead to new insights being generated (Nonaka & Takeuchi 1995). Through organisational learning, the development of new knowledge can take place and this in turn reduces innovation project uncertainty (Jiménez-Jiménez & Sanz-Valle 2011).

The importance of organisational learning in reducing innovation project uncertainty has been emphasised in literature (Dung et al. 2021; Tortorella et al. 2020). Yet, none of the previous studies empirically examined the mediation role of organisational learning in the relationship between intra-organisational collaboration and uncertainty reduction in innovation projects. Therefore, this study proposes that organisational learning resulting from intra-organisational collaboration facilitates uncertainty reduction in innovation projects.

*H4: Intra-organisational collaboration is positively associated with uncertainty reduction in innovation projects through organisational learning.*

### 4.3.5 Uncertainty Reduction and Innovation Project Performance

The concept of reducing innovation project uncertainty is acknowledged within the literature as fundamental to the innovation process, as well a key objective for enhancing innovation performance (Krane & Olsson 2014; Liu & Hart 2011; Souder & Moenaert 1992). This is because a high level of uncertainty in innovation projects is associated with a negative impact on the clarity of project objectives, the team's shared goal, and the strategic fit (Zhang & Doll 2001). Hence, uncertainty reduction has been strongly associated with innovation projects success (Lievens & Moenaert 2000; Verworn 2009; Verworn et al. 2008), and is considered a proxy for innovation project success (Thanasopon et al. 2016).

However, most of these studies studied the impact of uncertainty reduction on enhancing performance and project success in a specific industry such as construction and NPD industries (Lievens & Moenaert 2000; Moenaert et al. 1995; Verworn 2009; Verworn et al. 2008). Research still lacks studies on the impact of reducing uncertainty in innovation projects in more comprehensive and generalisable way by considering different industries. Additionally, there is no study in the literature that examined the impact of innovation project uncertainty on innovation project performance whilst considering the most three dominant sources of innovation project uncertainty: market, technological, and task. Accordingly, this study examines the impact of uncertainty reduction on innovation project performance.

*H5: Uncertainty reduction is positively associated with innovation project performance.*

### 4.3.6 The Mediating Role of Innovation Project Uncertainty Reduction

As mentioned in the previous section, reducing innovation project uncertainty is situated within the literature as a key objective to enhance innovation performance and paramount to the whole innovation process (Krane & Olsson 2014; Liu & Hart 2011; Souder & Moenaert 1992). Extant research includes studies that suggested uncertainty management techniques and inter-organisational collaboration to reduce innovation project uncertainties and enhance performance (Gkypali et al. 2017). However, research still lacks a thorough understanding about how project performance can be promoted by reducing innovation project uncertainty through intra-organisational collaboration. Hence, this study proposes that innovation project uncertainty reduction (across market, technological, and task) resulting from intra-organisational collaboration enables the enhancement of innovation project performance.

*H6: Intra-organisational collaboration is positively associated with innovation project performance through uncertainty reduction.*

### 4.3.7 Control Variables: Organisation Size, Age, Industry and Experience in Innovation Projects

In order to study the relationships between intra-organisational collaboration, organisational learning, innovation project uncertainty reduction and innovation project performance in greater depth, this research will control the effects on the relationships of some internal and external variables: organisation age, size, industry, and experience in innovation projects. The literature commonly cites these variables as antecedents of innovation, organisational learning and performance and some studies note that they can affect the studied relationships in this research (Jiménez-Jiménez & Sanz-Valle 2011).

The literature suggests that organisation size positively impacts innovation and performance since the biggest firms are associated with more resources to collaborate, learn and invest in innovation (Damanpour 1992; Fawcett et al. 2019; González-Benito et al. 2016; Kimberly & Evanisko 1981; Singh & Fleming 2010). Furthermore, organisation size is commonly used as a control variable in studies of both innovation and performance (Damanpour & Evan 1984; Damanpour & Schneider 2006; Kimberly & Evanisko 1981).

The literature also suggests that organisation age has an impact on intra-organisational collaboration, organisational learning, and performance (Aiken & Hage 1971; Hitt et al. 1997; Sørensen & Stuart 2000). This is because the organisational competencies and experience that age confers on organisations, support more effective collaboration (Singh & Fleming 2010) and efficient operation and development, including those related to innovation (Sørensen & Stuart 2000). This implies that the immature organisational routines of young companies may not be conducive to innovation development. Accordingly, size and age may improve the impact of intra-organisational collaboration and organisational learning on both innovation project uncertainty reduction and performance.

Furthermore, a broad industry perspective is also included as the impact of internal factors on innovation and performance differs across sectors (Damanpor 1996; Vega-Jurado et al. 2008). Research has incorporated industry as a control variable when studying organisational learning, innovation, and performance (Jiménez-Jiménez & Sanz-Valle 2011). In this vein, the findings of some studies reveal a greater correlation between process innovation, and business performance for manufacturing organisations than for service organisations. Finally, experience in innovation projects has been added as a control variable to ensure that this variable does not affect any of the relationships in the studied model. Thus, the control variables of this study are organisation size and age, industry, and experience in innovation project.

## 4.4 Conclusion

This chapter introduces the conceptual framework derived from a comprehensive review of the literature. Additionally, this chapter discusses the development of the six hypotheses of this thesis and the theoretical evidence behind each of them. Hypotheses 1, 2 and 3 reflect the direct impact of intra-organisational collaboration on innovation project uncertainty reduction, organisational learning and innovation project performance. Moreover, hypothesis 4 reflects the indirect impact of intra-organisational collaboration on innovation project uncertainty reduction through organisational learning. Further, hypotheses 5 and 6 reflect the direct relationship of innovation project uncertainty reduction on innovation project performance and the indirect effect of intra-organisational collaboration on innovation project performance through innovation project uncertainty reduction, respectively. Finally, this study controls the effects of organisation age, size, industry, and experience in innovation projects for the studied relationships. The following chapter discusses the methodology and research design employed in this thesis to empirically examine the six hypotheses.

# Chapter 5: Methodology and Research Design

## 5.1 Overview

This chapter discusses the methodology employed in this research, in relation to the research objectives and conceptual framework presented in the earlier chapters of this thesis. As discussed in Chapter 4, the conceptual framework depicted in Figure 4.1 enables a scientific empirical investigation into the relationships required for reducing uncertainty in innovation projects and enhancing innovation project performance.

This methodology chapter firstly provides a discussion on the positivism approach adopted and a brief explanation of the quantitative research approach and (Section 5.2 and 5.3). The chapter then proceeds to a discussion of the unit of analysis (Section 5.3.1), the selection of key informants (Section 5.3.2), and the population and sample of the study (Section 5.3.3). The common method bias problem and the way how it is minimised is explained (Section 5.3.4.1), followed by presentation of the measurement of constructs (Sections 5.3.4.2.1 and 5.3.4.2.6). A discussion of the content validity and pilot test (Sections 5.3.5 and 5.3.6), and presentation of the data collection (Section 5.3.7) follows. Finally, the chapter presents a brief discussion of the SEM tool used for the data analysis (Section 5.3.8), and the ethical considerations (Section 5.4).

## 5.2 Methodological Approach

Positivism is a research approach that takes the ontological belief that truth and reality is free and independent of the viewer and observer as its base (Aliyu et al. 2014). Positivists believe that the world conforms to permanent and unchangeable laws and rules of causation and events (Aliyu et al. 2014). The positivist approach seeks to cleanse scientific knowledge of speculative and subjective viewpoints (Crossan 2003). It strives to achieve this through mathematics and formal methods to provide analysis about the observed world using a process of induction to establish generalisations and laws (Crossan 2003).

The positivist approach studies social facts in a systematic and scientific way (Collins 2018). Positivists regard the behaviours and actions of people as scientifically observable, making social facts objectively measurable and quantifiable (Ryan 2018), this allows other researchers to replicate research to check findings. Positivists emphasise impartiality, measurement, objectivity, and repeatability, to build a realist, independent, and objective analysis and view of the universe (Aliyu et al. 2014).

The principle of a positivist approach as suggested by Bond (1993), Easterby-Smith et al. (2012), and Hughes & Sharrock (2016) requires that researchers should be independent from the study with no provisions for human interests within the study. Accordingly, the choice of what to study, and how to study should be independent of human beliefs and interests, determined instead by objective criteria. The researcher’s role is limited to data collection and interpretation with minimal interaction with the research participants when conducting research, and research results are usually observable and quantifiable (Bond 1993; Wilson 2014).

In a positivist approach, research should be quantitative so that it can be the basis for valid generalisations and laws and the purpose of study should be to recognise causal explanations of behaviours (Bond 1993; Easterby-Smith et al. 2012; Hughes & Sharrock 2016). Concepts also need to be operationalised in a way that enables facts to be measured quantitatively. Furthermore, problems are better understood if they are minimised to the simplest possible elements (Bond 1993; Easterby-Smith et al. 2012; Hughes & Sharrock 2016).

Positivist methods include experiment, comparative method, surveys (closed questionnaires), and non-participant observation (Gerrish & Lacey 2010; Ryan 2018). Positivist methods can demonstrate cause and effect or correlation relationships and produce quantitative data which is objective and scientific (Ryan 2018).

The main aim of this study is to examine whether there is impact (or not) between the independent and dependent variables of this research. Additionally, the concepts must be objectively quantifiable in order to generate a rule that can be generalised whilst allowing other researchers to replicate the research. or these reasons, positivism is the appropriate epistemological approach for this study. Accordingly, the research was conducted in an independent and objective manner, having minimal interaction with the research participants in order to produce objective and scientific results.

## 5.3 Quantitative Research Design

Quantitative techniques employ structured data collection methods to generate a large representative sample from which the study findings can be extrapolated to the entire population (Davis 1998). A quantitative research approach is particularly strong for studying large groups of people and generalising the conclusion to broader groups beyond the sample being studied (Holton & Burnett 2005). A qualitative research approach achieves rigorous detailed understandings about a specific group or sample, but cannot be generalised to a whole population (Holton & Burnett 2005).

A quantitative research approach incorporates a spectrum of methods for systematic investigation of social phenomena through statistical or numerical data (Watson 2015). It provides a concise answer to the research question by collecting and analysing data and assumes that the phenomena under research can be measured (Watson 2015). It is most usually used to analyse data for trends and relationships and to validate the measurements created (Watson 2015). The findings of the empirical study may be generalised if only the context is relevant to the area of the study and the sample selected is representative of the population (Polit & Beck 2010; Watson 2015). The following sections discuss the unit of analysis, informant selection, population and sample of the study, measurements of constructs, content validity, pilot test, data collection, data analysis approach, and ethical considerations.

### 5.3.1 Unit of Analysis

The unit of analysis refers to the entity the study is analysing and can include an individual, a group, or even an entire program (Pentland & Feldman 2005). As mentioned earlier, the two theories: organisational information processing theory and organisational learning theory (discussed in sections 2.2, and 2.3 in chapter 2) have been used to analyse innovation projects at the organisation level as a unit of analysis in different industries. The literature review in chapter 3 demonstrates collaborative practices taking place in innovation projects and the output of these practices in terms of organisational learning, uncertainty reduction, and enhanced innovation project performance at organisational level. The unit of analysis to be studied in this research is the innovation project at the organisation level; study examples were drawn from different industries.

### 5.3.2 Selection of Key Informants

It was imperative to select knowledgeable key informants with experience in innovation projects to increase the quality of the information gathered (Kim & Frazier 1997). Verification of their experience details was initially achieved via LinkedIn (professional) groups 'Innovation Management, Project Management Professionals PMP ©', and 'Australian IT & Digital Groups'. Key informants were carefully selected, and the survey link was shared with the digital group members. Second, a screening question was included at the beginning of the survey to ensure that only innovation professionals with innovation project experience would have access to the survey questions. Respondents who did not meet this criterion were unable to proceed with the remaining questions and were instead directed to the end page of the survey. To increase the quality of the data collected, the key informants selected for this study were project managers, project directors, project engineers with experience in innovation projects (Kim & Frazier 1997). The detailed characteristics of these research participants are presented in Chapter 6.

### 5.3.3 Population and Sample of the Study

The study's context is different industries in both developed and developing countries through which to examine innovation projects at the organisation level. The rationale for undertaking a multi-country study was to include a large diversity of views and experiences to validate the proposed model. This diverse base enables the development of standard practices and guidelines for innovation project professionals working across both developed and developing countries.

With regard to sample size for statistical analysis using structural equation modelling, Tabachnick & Fidell (2001) recommended 200 as fair, and 300 as good. Hair et al. (1998) and Hoelter (1983) also recommended a sample size of 200 to test a model using SEM noting that 200 is a critical sample size to achieve a valid result using any common estimation process. Several closely related innovation projects studies (see for example, Alegre & Chiva 2008; Gkypali et al. 2017; Suprapto et al. 2015; Um & Kim 2018; Verworn 2009) have used sample sizes ranging from a low 113 to a high 342 with a range of response rates of 21% to 72.8%. These studies also utilised SEM in analysing their data. Therefore, this study aimed to collect a sample of above 200 responses to satisfy the statistical analysis recommendations of SEM and to guarantee a valid analysis result (Hoelter 1983).

The population sample was comprised of innovation project professionals sourced from the LinkedIn platform. LinkedIn was chosen as the recruitment platform as it is a social and professional networking site that allowed the recruitment of professionals from across the world and provided a new data source for deepening the analysis of these highly skilled individuals (Baruffaldi et al. 2017).

Convenience sampling is appropriate for quantitative research, is easy to use and affordable and was therefore the sampling strategy used in this study (Etikan et al. 2016). Convenience sampling is accidental sampling where members of the target population that are accessible, available and willing to participate are included in the study (Etikan et al. 2016). Convenience sampling methods can be used in qualitative as well as quantitative research, although it is most used in quantitative research (Etikan et al. 2016). It emphasises generalisability that ensures the knowledge collected represents the population from which the sample was drawn (Etikan et al. 2016). The bigger the sample size the higher the statistical power of the convenience sample (Suen et al. 2014). Although convenience sampling is commonly used, it is likely to be biased, hence researchers are advised that convenience sampling should not be taken to be representative of the population (Mackey & Gass 2005). It is also associated with a problem of great concern which is the outliers (Etikan et al. 2016). The outlier problem was identified and addressed in Chapter 6 (Section 6.2.3.2) of this thesis.

Innovation project professionals from Innovation Management, Project Management Professionals PMP ©, and Australian IT & Digital Groups in LinkedIn were considered for the study sample. The Innovation Management Group was created in Nov 2007 for innovation management professionals around the globe to communicate, collaborate and share ideas, knowledge, and information. This group includes 66,845 members who are innovation management professionals with different roles such as chief innovation officers, innovation consultants, creativity training leads, ideation facilitators, and innovation champions (LinkedIn 2007b). Project Management Professionals PMP © was created in April 2008 for Project Management Professionals (Certified and non-certified) world-wide to communicate and share ideas related to project management. The group includes 110,705 project professionals with different roles including project managers and project directors (LinkedIn 2008). Australian IT & Digital Group was created in Nov 2007 for the IT and Digital community in Australia to connect and share the latest information on technology trends, leadership, and vendor/product news. The group includes 132,996 IT professional from Australia (LinkedIn 2007a). The common characteristics between the three groups is that they include professionals from around the globe with innovation project management experience.

### 5.3.4 Measurement of Constructs

#### 5.3.4.1 Common Method Bias Problem

Common method bias is the magnitude of the differences between the observed and the true relationships between constructs (Doty & Glick 1998). It is considered a problem because it is one of the main sources of measurement error which threatens the validity of the conclusions about the relationships between measures (Spector 1987). One of the major sources of common method bias is method variance and it refers to (Fiske 1982; pp. 81-84):

> "Variance that is attributable to the measurement method rather than to the construct of interest. The term method refers to the form of measurement at different levels of abstraction, such as the content of specific items, scale type, response format, and the general context".

As discussed by Podsakoff et al. (2003), common method variance can have a considerable effect on the observed relationships among predictor and criterion variables in organisational and behavioural studies. Common method variance may happen in this research because data for both the dependent and independent variables were obtained from the same person using the same medium (survey). To address and reduce the common method bias on the studied data. The following procedural remedies have been used based on the recommendations of Podsakoff et al. (2003):

*Protecting respondent anonymity and lessening evaluation concern.*

The study questionnaire was anonymous to eliminate respondents' evaluation apprehension and to encourage them to respond freely. This helped reduce the probability that respondents edit their responses to be more socially desirable, lenient, acquiescent, and consistent with how they think the researcher expect them to respond.

*Improving scale items*

To ensure the validity of our measurements, all measurement items of each survey construct were adopted from the existing literature. A pilot study with 25 innovation project professionals was also conducted prior to data collection to detect potential problems with the survey design such as vague concepts, double-barrelled questions, or complicated syntax. This pilot test sought to ensure that questions were simple, specific, and concise. Based on the pilot test, the questionnaire was launched.

In order to test for common method bias, Harman's single-factor test was conducted. It is one of the most widely used methods to address the issue of common method variance (Podsakoff & Organ 1986). In this method, all variables are loaded into an exploratory factor analysis and unrotated factor solution is examined to decide the number of factors to account for the variance in the studied variables. Common method bias test result is discussed in Chapter 6.

#### 5.3.4.2 Measures of Constructs

In this study, all measures of constructs were adopted from relevant extant studies. The following sections present the measures used to represent each construct included in the conceptual model: intra-organisational collaboration, innovation project uncertainty reduction, organisational learning and innovation project performance.

***Intra-organisational Collaboration***

Intra-organisational collaboration is a construct that comprises a range of dimensions within high-performing cross-functional teams (Lin et al. 2015). Intra-organisational collaboration has been conceptualised in previous studies as a one-dimensional construct that includes measures of collaborative relationship and communicating and sharing information (see for example, Gupta et al. 1986; Li & Calantone 1998; Moenaert & Souder 1990). Nevertheless, as suggested by Lin et al. (2015b) this conceptualisation overlooks other essential components of intra-organisational collaboration. For example, Commitment was absent in the previous studies' scale of intra-organisational collaboration, whilst it was indicated as a pivotal dimension of intra-organisational collaboration by Morgan & Hunt (1994). Furthermore, leadership and trust were absent from Gupta et al.'s (1986) Li & Calantone's (1998) and Moenaert & Souder 's (1990) scale of intra-organisational collaboration, but was incorporated in the intra-organisational collaboration construct by Lin et al. (2015b). To establish a comprehensive conceptualisation of intra-organisational collaboration, previous studies are integrated, and consequently intra-organisational collaboration is conceptualised as a reflective second-order construct with five dimensions (subconstructs): collaborative leadership, collaborative relationships, trust formation, communicating and sharing information, and commitment (Fanousse et al. 2021b).

**Collaborative relationship** – A collaborative relationship refers to the positive work relationships between cross functional team members and is measured via five items adopted from Fawcett et al. (2019). The question used in the questionnaire to explore collaborative relationships included the following:

To what extent do you agree that the following occurred while you were working on the project:

1. There were positive work relationships between cross functional team members
2. The team resolved conflicts collaboratively
3. The team members trust each other because day-to-day promises are entirely met
4. The team worked toward a mutual goal and knew that they needed each other
5. The team worked collaboratively while dealing with any power differences

**Collaborative leadership -** Collaborative leadership is the extent to which a leader is successful in leading team members and measured with Lin et al. (2015b) by five items indicators. The question used to determine this was:

To what extent do you agree that your project leader/manager was successful in:

1. Reconciling different views and building a consensus.
2. Articulating and promoting a shared vision.
3. Balancing the strategic and the operational delivery
4. Encouraging and inspiring others
5. Dealing comfortably with ambiguity and complexity

**Communication and sharing information -** Communication and sharing information is the degree to which information is transferred between project members and measured with four items adopted from Lin et al. (2015b). The questionnaire items with the question are listed below:

To what extent do you agree that your project team members were:

1. Maintaining open and collaborative communication and exchanging opinions
2. Taking the path of least resistance to communicate wherever possible
3. Investing sufficient time and attention in communication and information-sharing processes
4. Ensuring that information reach its targeted stakeholders in a timely manner

**Trust formation -** Trust formation is the long-term social psychological process formed between team members as a result of their interactions and is measured with four items adopted from Park & Lee (2014). The questionnaire items with the question are listed below:

To what extent do you agree that each of your project team members was:

1. Honest about problems when they arose
2. Supportive when making decision
3. Willing to provide assistance
4. Sincere
5. Completely trustworthy
6. Confident in the abilities of other cross functional team members

**Commitment** – Commitment is a lasting desire to sustain a valued relationship (Moorman et al. 1992), and considered a key factor in the development and success of long-term collaborative relationships (Morgan & Hunt 1994). It is measured with four items adopted from Rodríguez et al. (2008). The questionnaire items with the question are listed below:

To what extent do you agree that while working on the project you were committed to:

1. The work relationship with other project members
2. Considering other project members as a part of the same team
3. Caring for the working relationship with other team members
4. Spending time working other team members

***Organisational Learning***

Organisational learning is operationalised as the process through which the organisation builds new knowledge and insights from the employees' knowledge and experiences. Organisational learning is measured through four items, the first two were adopted from Kale et al. (2000), and the second two were adopted from Edmondson (1999). Other studies combined these two studies such as García-Morales et al. (2012). The questionnaire items with the question are listed below:

To what extent do you believe that over the last three years:

1. Your organisation has acquired and shared new and relevant knowledge that provided competitive advantage
2. Your organisation members have acquired some critical capacities and skills that have provided competitive advantage
3. Your organisational improvements have been influenced fundamentally by new knowledge entering the organisation

4. Your organisation is a learning organisation (a company that facilitates the learning of its members and continuously transforms itself)

***Task Uncertainty Reduction***

Task uncertainty reduction refers to the reduction of uncertainties related to tasks to be completed to deliver the project outcome and is measured with six items adopted from Yan & Dooley (2013). The questionnaire items with the question are listed below:

To what extent do you agree that you and other innovation project team members were able to cope with/manage the:

1. Fluctuation in users' requirements
2. Availability of information to perform the task
3. Uncertain events during the development of the project
4. The dependence level of one task on other to obtain resources such as materials, people, or information needed
5. The dependence level of one subtask on another subtask to complete the overall task
6. The need to check one member's job with other team member's job for the successful completion of major tasks

***Market Uncertainty Reduction***

Market uncertainty reduction refers to the reduction of uncertainties related to customer, market, as well as competitors, and is measured with five items adopted from Lievens & Moenaert (2000). The questionnaire items with the question are listed below:

To what extent do you agree that you and your other innovation project team members were informed about:

1. The customer's needs (user requirements)
2. The potential customer/client or market
3. The behaviour of the user or potential customer/client
4. The Technological strategy of the competitors
5. The marketing strategy of the competitors

***Technological Uncertainty Reduction***

Technological uncertainty reduction refers to reduction of uncertainties related to the newness of the technologies related to the project and is measured with six items adopted from Lievens & Moenaert (2000). The questionnaire items with the question are listed below:

To what extent do you agree that you and other innovation project team members were informed about:

1. The quality of the applied technologies (e.g., information technologies)
2. The user-friendliness of the adopted technologies in the project
3. The cost-efficiency of the technologies used in the project
4. The required Research & Development strategy for the project
5. The required technological support for the project
6. The required technical personnel for the project

***Innovation Project Performance***

Innovation performance is linked to the benefits an organisation obtains from launching an innovation into the market or from employing it within the organisation (Czarnitzki & Hottenrott 2009; Kirner et al. 2009; Prajogo & Ahmed 2006). Innovation project performance is presented as one construct measured by five measurement items adopted from Pinto et al. (2009). The questionnaire items with the question are listed below:

Based on your experience, please indicate how successful your project was in meeting the requirements below:

1. The project results, or deliverables, were in line with client objectives
2. The project operated within the pre-estimated budget
3. The project operated within the pre-defined schedule
4. Stakeholders were satisfied with the project outcomes
5. The quality of the project output accorded with the standards

While there is a lack of consensus in the extant research around the scale items for measuring the variables of this study, this study integrates these extant measures to provide a more comprehensive and meaningful representation of each variable (Nunnally 1978). Minor changes were applied on the wording of the extant measurements used to ensure they matched the various innovation experiences of all the potential survey participants. All the questionnaire items are shown in Appendix 5.1.

All constructs were measured with a 7-level Likert subjective scale (i.e., 1 = Very strongly disagree and 7 = Very strongly agree) instead of asking for any objective information (Kaynak & Kuan 1993). As suggested by Miller (1956), the 7-level Likert scale incorporates ideal precision of seven categories of absolute judgement. It is also statistically sophisticated, universally adaptable, and relatively insensitive (Malhotra 2002).

### 5.3.5 Content Validity

As suggested by Malhotra (2002), content validity entails the subjective evaluation of the scale measure and characteristics of the used variable. In this study, all construct measures were adopted from relevant extant studies in which they had been shown to be reliable and consistent (reliability not less than 0.7). The content validity of the questionnaire was assessed by a panel of three academic scholars. The questions of the questionnaire were thoroughly reviewed and slightly amended to make the questions clearer and suitable for innovation project professional respondents from different industries. For example, amending 'To what extent do you agree that your project leader/manager was successful in balancing the strategic and the operational' to 'To what extent do you agree that your project leader/manager was successful in balancing the strategic and the operational delivery' – the addition of a single word at the end of the sentence made the meaning clearer to the responders.

Additionally, the reliability and validity of measures were assessed following the suggestion of Nunnally (1978). The detailed discussion of the reliability and face validity of constructs is presented in sections (6.3.2.1 to 6.3.2.6) respectively. Furthermore, discriminant and convergent validity are thoroughly assessed and discussed in section 6.3.5 prior to testing the proposed model in this study. According to Zhu (2000; p. 190), "convergent and discriminant coefficients are used to support or refute a claim of construct validity". Convergent validity is described as "the extent to which the scale correlates positively with other measures of the same construct" while the discriminant validity is referred to "the extent to which a measure does not correlate with other constructs from which it is supposed to differ" (Malhotra 2002; p. 294). In assessing the discriminant validity, Gaski (1984) recommendation was adopted which indicated that the correlations among composite constructs must be lower than the respective standardised composite reliabilities. The Gaski Stats tool package was used to assess the discriminant validity. After assessing the content validity of the questionnaire, a pilot test was conducted.

### 5.3.6 Pilot Test

A number of strategies were adopted to ensure the validity of our measurements. After assessing the content validity of the questionnaire by a panel of three academic scholars, a pilot study with 25 innovation project professionals was conducted prior to data collection. The pilot test aimed to validate the questionnaire, evaluate the practicability and feasibility of the intended study, and detect potential problems with the survey design (e.g., the availability of respondents, the process of collecting data, along with the cost and time). To define the sample size of the pilot test, the recommendations of Connelly (2008) and Treece & Treece Jr (1977) were adopted that suggested a pilot study sample should be 10% of the actual sample size. As this study was aimed to collect a total of 250 responses, 25 respondents were recruited for the pilot test. Positive feedback was received from the pilot test regarding the clarity of the questions with no issues detected. Based on the pilot test, the questionnaire was then launched.

### 5.3.7 Data Collection

The self-administered link survey approach is considered suitable for a widespread research program (Malhotra & Dash 2016). As explained by Davis (1998), the strength of this approach is reflected in the respondent confidentiality, anonymity, and free expression as well as fair temporal response. Further, this approach enables the collection of uniform data from various respondents and prevents inadequate record keeping (Malhotra & Dash 2016). Additionally, this approach is associated with minimal cost compared to other approaches. Hence, the link survey has been adopted in this study to collect data economically from different sources in a short period of time.

It is important to note the limitations of this approach, including a low response rate for different reasons such as survey fatigue. Taking this into consideration, measures were put in place to increase the response rate, reduce response bias and increase the validity of statistical inference (Churchill & Iacobucci 2006). To fulfil this objective, of the verified initial sample of 2000, 500 potential informant(s) were contacted by direct message through LinkedIn to further check the accuracy of the innovation experience of the respondents, build a rapport and solicit participation in the survey (Goodman & Dion 2001). The survey link opened with a cover letter that encouraged participation in the survey and emphasised that the study was being conducted for academic purposes only. It was also stressed that participation in the study was entirely voluntary, anonymous and confidential. Additionally, it was confirmed that access to the provided information would be limited to the university researchers only. It was predicted that this procedure would boost the number of responses.

Finally, the survey link was published in the main page of the Innovation Management Group, Project Management Professionals PMP ©, and IT & Digital Group in LinkedIn. The primary respondents to this study were project management professionals with experience in innovation projects from a range of different industries. The invitation message in the LinkedIn post in each of these groups invited project professional with experience in innovation projects to participate in the survey. Additionally, a screening question was employed to ensure that the participation criteria were met. Respondents who did not meet this criterion were unable to proceed with the remaining questions and were directed to the end page of the survey. The screening question was: How many years of experience do you have in innovation projects? The options provided were less than 3 years, 3-5 years, 5-15 years, 15-25 year, and more than 25 years.

Accordingly, innovation project professionals from the LinkedIn groups 'Innovation Management Group', 'Project Management Professionals PMP ©', and 'Australian IT & Digital Group' were invited to participate and complete the questionnaire based on their experience in one of the innovation projects they were involved in. Initially, 500 potential respondents were contacted with the questionnaire link through LinkedIn, 277 of which returned with information, achieving an effective response rate of 55.4%. Of the 277 questionnaires, 28 questionnaires were removed either because they contained missing information, defined as outliers that did not pass range checks (mean and standard deviation) or identified as insincerely reported (the data flow was not consistent). Subsequently, the final number of responses employed in the hypotheses testing consisted of 249. The detailed evaluation of missing data, assessment of normality and outliers are thoroughly reported in sections 6.2.2 and 6.2.3 respectively. The characteristics of the respondents in terms of their innovation experience, project role, organisation's age, size, industry, and sector, and types of innovation projects are discussed in Chapter 6.

### 5.3.8 Analysis of the Data

SEM is a robust quantitative data analytical technique that assesses and estimates theoretical relationships between/among latent and/or observed variables and combines regression along with factor analysis (Tabachnick & Fidell 2001). SEM is a robust tool for path analysis that is capable of processing multiple relationships and can test relationships from exploratory to confirmatory analysis (Hair et al. 1998)

SEM can estimate a series of causal relationships, and present parameter estimates along with path links among variables in the conceptual model. Further, SEM is also capable of estimating multiple regression equations all together by specifying the structural model. It also allows the modelling of latent variables by considering the measurement errors associated with observed indicators (Hair et al. 2014). Since all the variables in the proposed model are latent variables, made up of observed variables, SEM is utilised in this study for testing the study model. Additionally, previous studies in project management used SEM in analysing their data (see for example, Alegre & Chiva 2008; Eriksson et al. 2017; Gkypali et al. 2017; Suprapto et al. 2015; Um & Kim 2018; Verworn 2009).

Two methods are derived from the SEM which are Partial Least Square Structural Equation Modelling (PLS-SEM) and Covariance Based Structural Equation Modelling (CB-SEM). PLS-SEM is appropriate to the preliminary studies, where researchers develop a conceptual model and identify dependencies between concepts, and often work with smaller sample sizes and more complex models (above 100 variables) (Hair Jr et al. 2016; Riou et al. 2016). It also recommended testing formative constructs and is suitable for prediction analyses (Hair Jr et al. 2016; Riou et al. 2016). CB-SEM is a factor-based technique and is recommended as an appropriate tool to be used for confirmatory research studies. It is also suggested for analysing a model of reflective constructs when the sample size is relatively large (200 or more) and the model is not complex (less than 100 variables) (Hair Jr et al. 2016; Riou et al. 2016).

The model of this study is not complex as it contains six variables represented by six reflective constructs, the sample size is relatively large (n=249), and it is a confirmatory research study. Since this study meets the criteria defined by (Hair Jr et al. 2016) and (Riou et al. 2016) for using CB-SEM, this study employs covariance-based SEM (CB-SEM) for the data analysis by AMOS 26.0.0 to analyse the measurement and the structural models. In evaluating and reporting the results, we followed recent guidelines given by (Hair et al. 2014) for CB-SEM, and thoroughly evaluated the measurement models before assessing the structural model.

As suggested by Hair et al. (2014), there is no golden rule on what software a researcher should use when employing CB-SEM for data analysis. Various software packages are available in the market and the decision on which one to use is based on the availability of the software and training (Hair et al. 2014). Scholars such as Gallagher et al. (2008) recommended the use of AMOS for CB-SEM as it is easy and intuitive to use. Hence, AMOS 26.0.0 is utilised for the CB-SEM data analysis of this study.

The analysis using AMOS was done in two main stages and is discussed in Chapter 6 and 7: measurement and structural model testing. A measurement model testing is performed to validate the measurement of constructs and to ensure that the indicators under each construct measure are reliable (Jöreskog & Sörbom 1993). To achieve this, a confirmatory factor analysis test of the measurement of each construct, as well as of all measures together at one time, are performed. Goodness-of-fit indices will be used to assess the measurement model for each construct and for the overall model to make sure that the model is acceptable and a good fit before performing the structural model testing.  Structural model testing is then performed in order to evaluate the relationships between the latent constructs. The test is based on a regression analysis between the dependent variables in the hypothesised structural model and the independent variables (Cheng 2001). Path coefficients together with the P-values determine whether the hypothesised relationships are supported or not.

The data collected from innovation project professionals are analysed in Chapter 6 and 7 to test the construct measures and assess the hypotheses established in the conceptual model. The adopted construct measures were assessed in terms of measurement of scale reliability and validity. The findings of the data analyses are reported in the following chapters. Figure 5.1 shows a Flow Chart Diagram for the Research Design and Methodology.

## 5.4 Ethical Consideration

Ethical consideration is important to ensure that participation in research is voluntary, informed, and safe (NHMRC 2018). This research meets the requirements of National Statement on Ethical Conduct in Human Research. Ethical approval for this research has been granted by the Western Sydney University Human Research Ethics Committee (HREC) with the HREC Approval Number: H13599 (Appendix 5.2). The HREC is constituted and operates in accordance with the National Statement on Ethical Conduct in Human Research.

The study used a questionnaire as a tool for the data collection which might involve some concerns related to participants feeling discomfort to response to the survey. This can be either due to confidentiality of projects or sensitivity of data. To minimise the discomfort the research followed all the requirements of National Statement on Ethical Conduct in Human Research and Western Sydney University ethics committees. Participants were notified about the confidentiality of the provided data along with all aspects covered in the guidelines.

## 5.5 Conclusion

In summary, this chapter discussed the methodological approach adopted in this study -a quantitative approach grounded in a positivism approach. The chapter confirmed that the innovation project at an organisation level, from different industries, was the main unit of analysis for this thesis, and the key informants selected for this study were project managers, project directors, project engineers with experience in innovation projects. Additionally, the population sample was presented as innovation project professionals sourced from the LinkedIn platform. The measures for all the constructs included in the conceptual model were noted followed by a discussion of the content validity and pilot test. A questionnaire survey was used as a tool for data collection. The survey link was published in the main page of the Innovation Management Group, Project Management Professionals PMP ©, and IT & Digital Group in LinkedIn. The final number of responses employed in the hypotheses testing was 249. The chapter concluded with a discussion of the SEM approach that is adopted for the data analysis of this thesis. Figure 5.1 is a flow diagram of the research design and methodology of this study.

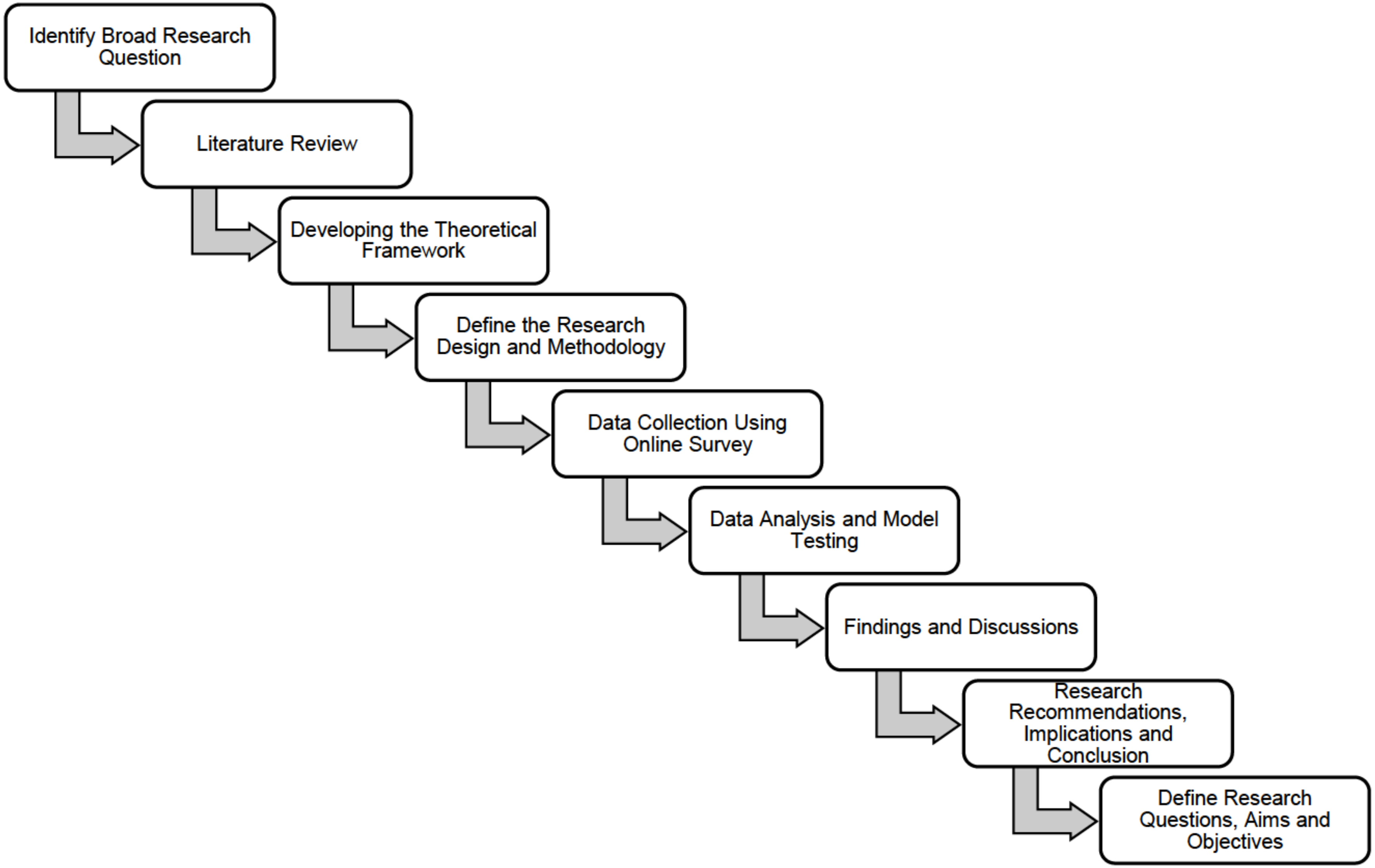


Figure 5.1 Flow Chart Diagram for the Research Design and Methodology

# Chapter 6: Preliminary Data Analysis

## 6.1 Overview

In the previous chapter, the research methodology and research design of this study were discussed. In this chapter, the sample characteristics, data screening and measurement model assessment are discussed. The findings are then presented, with a focus on the testing and validation of the measurement model.

The preliminary data analysis chapter firstly provides a description of the sample characteristics in terms of demographics and the profiles of respondents as well as their organisations' profiles (Section 6.2.1). The chapter then proceeds with a discussion of the data management procedure and handling of missing data (Section 6.2.2), as well as an assessment of normality and identification of the outlier cases (Section 6.2.3) and common bias method testing (6.2.4). This is followed by the examination of the fit indices in structural equation modelling using AMOS (Section 6.3). The development of the measurement of constructs is then discussed (Section 6.3.2), followed by an assessment of measurement model fit (Section 6.3.3), and reporting the implied correlation matrix (Section 6.3.4). Finally, the chapter closes with an assessment and brief discussion of the covergent and discriminant validities of the constructs (Section 6.3.5), and a summary of overall results of the measurement model assessment (Section 6.4).

## 6.2 Sample Demographics and Data Screening

The study sample varied widely in terms of demographic characteristics. These demographics are provided in this section as a part of the data assessment. Relevant data screening techniques such as descriptive statistics, and treatment of missing data and outliers are also presented in this section.

### 6.2.1 Sample Demographics and Respondent Profiles

The sample demographics and characteristics of respondents including their experiences and organisations' profiles are widely varied. Table 6.1 reports the respondents' country, sector, industry, organisation's size and age, innovation project types, experiences in innovation projects as well as their project role.

Table 6.1 shows that the sample included responses based on respondents' experience in various innovation project types: process innovation (47.7%), product innovation (29.4%), business model innovation (9.0%), and marketing innovation (2.2%). Process innovation takes place in any type of organisation, it is therefore expected to form the most common type of innovation. It is also unsurprising that the business model and marketing innovations have the lowest percentages as they do not occur as frequently as process and product innovation in industry (Caiazza et al. 2016).

The responses were received from both developing and developed countries with most respondents from United Arab Emirates (UAE) (33.7%) followed by Australia (21.9%), Pakistan (10.0%), Thailand (6.1%), Canada (4.3%), United States (US) (3.9%) and others. These numbers were also expected as most of the LinkedIn groups of Innovation Management, Project Management Professionals PMP ©, and Australian IT & Digital have members from the UAE and Australia.

Table 6.1 reveals that the respondents have considerable experience in innovation projects. Most of the respondents possessed between 5-15 years-experience in innovation projects (41.9%), followed by respondents with less than 3 years-experience in innovation projects (24.0%) and 3-5 years-experience (20.4%). These high levels of experience are expected when recruiting via LinkedIn. The table also shows that the project role of the respondents varies greatly, with more than one third of the respondents holding a project manager role (33.7%), followed by respondents holding project engineer role (19.0%) and 10% holding a project director role. The respondents' roles denote the high-profiles of the participants in the questionnaire, with project managers and project directors making up almost 50% of the sample; this enhanced the data quality (Kim & Frazier 1997).

The organisation characteristics of the respondents varied widely in terms of organisation size, age, and sector. Organisation size is measured and categorised as small, medium, or large based on the number of employees (Australian Bureau of Statistics 2009). The sample included the three different categories of organisation size. Most of the respondents' organisation size was greater than 200 employees (65.2%) followed by an organisation size of 20-200 employees (20.8%). Most of the organisations' age were greater than or equal to 10 years (78.9%) followed by 6-9 years organisation age (11.5%). This means that large organisations older than 10 years are likely to have more projects.

Table 6.1 shows that 61.3% of the respondents were working in private sector organisations while 34.1% were in the public sector. This is expected as private sector organisations engage in innovation more commonly than the public sector organisations (West and Lu 2009). Innovation has long been understood to be the key factor for success in private businesses as it increases competitiveness, contributes to cutting costs, improving products, and accessing new markets. More recently however, innovation has gained importance in public sector organisations as well, following acknowledgement that it improves the quality-of-service delivery and reduces costs (Windrum and Koch 2008).

Table 6.1 also shows the sample covered respondents from diverse industries with the highest responses received from the construction industry (15.4%) followed by engineering design and consultancy (14.7%), and information media and telecommunications (11.1%). The diversity of the recorded industries was expected because it is understood that innovation is not limited to a specific industry (Heunks 1998); this results in the strong generalisability of the data.

While demographic information has no impact on the level of analysis of this study, the above report provides a generalised view in terms of how innovation projects are becoming an integral part of organisations of any age, size, sector, industry, or country in order to compete effectively and ultimately. Other relevant statistical analyses of the sample are discussed in the next two sections.

Table 6.1 Sample Demographics and Respondents' Profiles

| Demographics of Respondents | | Frequency | Percent |
|---|---|---|---|
| Experience in Innovation Project | Less than 3 (years) | 67 | 24.0 |
| | 3-5 (years) | 57 | 20.4 |
| | 5-15 (years) | 117 | 41.9 |
| | 15-25 (years) | 27 | 9.7 |
| | >25 (years) | 11 | 3.9 |
| List of Countries | Algeria | 1 | .4 |
| | Andorra | 1 | .4 |
| | Australia | 61 | 21.9 |
| | Brazil | 2 | .7 |
| | Canada | 12 | 4.3 |
| | China | 7 | 2.5 |
| | Egypt | 2 | .7 |
| | Eritrea | 1 | .4 |
| | Finland | 2 | .7 |
| | Germany | 1 | .4 |
| | India | 9 | 3.2 |
| | Jordan | 6 | 2.2 |
| | Pakistan | 28 | 10.0 |
| | Philippines | 1 | .4 |
| | Qatar | 3 | 1.1 |
| | Saudi Arabia | 2 | .7 |
| | Singapore | 6 | 2.2 |
| | Spain | 1 | .4 |
| | Sri Lanka | 1 | .4 |
| | Syrian Arab Republic | 1 | .4 |
| | Thailand | 17 | 6.1 |
| | United Arab Emirates | 94 | 33.7 |
| | United Kingdom | 2 | .7 |
| | United States of America | 11 | 3.9 |
| | Yemen | 1 | .4 |
| Organisation size | < 20 (employees) | 34 | 12.2 |
| | 20 – 200 (employees) | 58 | 20.8 |
| | > 200 (employees) | 182 | 65.2 |
| Organisation Age | 0-2 (years) | 9 | 3.2 |
| | 3-5 (years) | 13 | 4.7 |
| | 6-9 (years) | 32 | 11.5 |

| Demographics of Respondents | | Frequency | Percent |
|---|---|---|---|
| | ≥10 (years) | 220 | 78.9 |
| Organisation Industry | Agriculture, Forestry and Fishing | 7 | 2.5 |
| | Manufacturing | 8 | 2.9 |
| | Electricity, Gas, Water and Waste Utility Services | 19 | 6.8 |
| | Construction | 43 | 15.4 |
| | Wholesale Trade | 3 | 1.1 |
| | Retail Trade | 5 | 1.8 |
| | Accommodation and Food Services | 2 | .7 |
| | Transport, Postal and Warehousing | 2 | .7 |
| | Information Media and Telecommunications | 31 | 11.1 |
| | Financial and Insurance Services | 11 | 3.9 |
| | Professional, Scientific and Technical Services | 17 | 6.1 |
| | Administrative and Support Services | 3 | 1.1 |
| | Public Administration and Safety | 4 | 1.4 |
| | Education and Training | 29 | 10.4 |
| | Health Care and Social Assistance | 7 | 2.5 |
| | Engineering Design and Consultancy | 41 | 14.7 |
| | Other Services | 42 | 15.1 |
| Project Role | Project Director | 28 | 10.0 |
| | Project Manager | 94 | 33.7 |
| | Project Assistant | 15 | 5.4 |
| | Project Administrator | 12 | 4.3 |
| | Project Engineer | 53 | 19.0 |
| | Business Analyst | 15 | 5.4 |
| | Developer | 5 | 1.8 |
| | Designer | 17 | 6.1 |
| | Tester | 6 | 2.2 |
| | Others | 29 | 10.4 |
| Type of Innovation Project | Process innovation (changes in the ways in which products and services are created and delivered (i.e., new process, technique, or method)) | 133 | 47.7 |
| | Product innovation (new or changes in the things (products/services) which an organisation offers) | 82 | 29.4 |
| | Marketing innovation (changes in the context in which the products/services are introduced) | 6 | 2.2 |
| | Business model innovation (changes in the underlying mental models which frame what the organisation does) | 25 | 9.0 |
| | Others, please specify | 28 | 10.0 |
| | Public Sector | 95 | 34.1 |

| Demographics of Respondents | | Frequency | Percent |
|---|---|---|---|
| Organisation Sector | Private Sector | 171 | 61.3 |
| | Others | 8 | 2.9 |
| Total Recorded | | 274 | 98.2 |
| Missing Data | | 5 | 1.8 |
| Total | | 279 | 100.0 |

### 6.2.2 Examination of Data Entry and Missing Data

The data analysis further involved an assessment of the data entry process itself and the handling of missing data. This is significant for gaining critical insight into data characteristics and analysis (Hair et al. 1998). Two reviews of the data entry process were performed to ensure a high level of accuracy. In the first review, all entries were checked as they were entered, case by case. Any response that did not include all required data was deleted immediately. In the second review, descriptive statistics were formulated including frequency distribution, mean and standard deviation. Conducting and verifying the data through descriptive statistics assured the accuracy of the data entry. This process was achieved by exporting the data from the Qualtrics application, coding the survey data and analysing it using the SPSS software. The accuracy of the data entry into the data set could be confirmed to be 100%.

During the assessment of the completeness of the questionnaire responses, it was found that five out of 279 responses contained missing data. Among those five responses, two of them had an answer for the first question leaving the remaining questions unanswered (90%). The remaining three responses had answers to all the measurement questions, but the demographic section was not completed. The first two records were deleted from the preliminary analysis as they do not add any value to the study (Hair et al. 1998), while the remaining three records were included in the study. It should be noted that the missing data in the demographic information section may have been due to respondents feeling reluctant or have confidentiality concerns to answer demographic information section (McNeeley 2012). Therefore, upon deletion of 2 uncompleted responses, 277 usable sample were retained in the data set to further examine the normality and outliers.

### 6.2.3 Assessment of Normality and Outliers

Normality in the data is a standard assumption in the estimation process (Bai & Ng 2005). When data distribution is highly skewed or demonstrates high kurtosis, it is an indication of a non-normality and this impacts the model specification or estimation (Hall & Wang 2005). Non-normality is a result of the existence of outlier cases in the data set. Tabachnick & Fidell (2001; p. 66) defined an outlier as “a case with such an extreme value on one variable (a univariate outlier) or such a strange combination of scores on two or more variables (multivariate outlier) that they distort statistics”.

#### 6.2.3.1 Normality

Accordingly, an examination of the normality of the data was made to identify outlier cases. In the first stage, descriptive statistics analysis was conducted using the mean score of all the items included in the questionnaire. Table 6.2 demonstrates the descriptive statistics of the dataset including the mean, standard deviation, skewness, and kurtosis values in relation to all the questionnaire items.

Hair et al. (2009) and Byrne (2013) describe data as being normal if Skewness is between -2 to +2 and Kurtosis is between -7 to +7. The output in Table 6.2 showed that the skewness and the kurtosis scores are within the acceptable range which confirm the normality of the dataset.

Table 6.2 Descriptive Statistics

| Descriptive Statistics | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Question | N | Minimum | Maximum | Mean | Std. Deviation | Skewness | | Kurtosis | |
| | Statistic | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Std. Error |
| Q2_1 | 277 | 2 | 7 | 5.12 | 1.015 | -0.611 | 0.146 | 1.106 | 0.292 |
| Q2_2 | 277 | 2 | 7 | 5.11 | 0.943 | -0.8 | 0.146 | 1.799 | 0.292 |
| Q2_3 | 277 | 2 | 7 | 5.23 | 1.03 | -0.628 | 0.146 | 0.848 | 0.292 |
| Q2_4 | 277 | 1 | 7 | 5.14 | 1.182 | -0.939 | 0.146 | 1.401 | 0.292 |
| Q2_5 | 277 | 1 | 7 | 5.03 | 1.145 | -0.655 | 0.146 | 0.888 | 0.292 |
| Q2_6 | 277 | 1 | 7 | 4.84 | 1.116 | -0.463 | 0.146 | 0.267 | 0.292 |
| Q3_1 | 277 | 1 | 7 | 5.47 | 1.092 | -1.528 | 0.146 | 4.113 | 0.292 |
| Q3_2 | 277 | 1 | 7 | 5.37 | 1.078 | -0.933 | 0.146 | 2.107 | 0.292 |
| Q3_3 | 277 | 1 | 7 | 5.45 | 1.098 | -0.81 | 0.146 | 1.403 | 0.292 |
| Q3_4 | 277 | 1 | 7 | 5.32 | 1.065 | -0.588 | 0.146 | 1.25 | 0.292 |
| Q4_1 | 277 | 1 | 7 | 5.26 | 1.115 | -1.033 | 0.146 | 2.093 | 0.292 |
| Q4_2 | 277 | 1 | 7 | 5.17 | 1.172 | -0.715 | 0.146 | 0.516 | 0.292 |
| Q4_3 | 277 | 1 | 7 | 5.22 | 1.073 | -0.75 | 0.146 | 1.245 | 0.292 |
| Q4_4 | 277 | 1 | 7 | 5.25 | 1.099 | -0.945 | 0.146 | 1.908 | 0.292 |
| Q5_1 | 277 | 2 | 7 | 5.12 | 1.02 | -0.53 | 0.146 | 0.759 | 0.292 |
| Q5_2 | 277 | 1 | 7 | 5.07 | 1.026 | -0.551 | 0.146 | 1.117 | 0.292 |
| Q5_3 | 277 | 2 | 7 | 4.95 | 1.09 | -0.128 | 0.146 | -0.201 | 0.292 |
| Q5_4 | 277 | 1 | 7 | 5.29 | 1.027 | -0.51 | 0.146 | 1.171 | 0.292 |
| Q5_5 | 277 | 1 | 7 | 4.96 | 1.059 | -0.554 | 0.146 | 1.114 | 0.292 |
| Q6_1 | 277 | 1 | 7 | 5.15 | 1.098 | -0.594 | 0.146 | 0.73 | 0.292 |

| Descriptive Statistics | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Question | N | Minimum | Maximum | Mean | Std. Deviation | Skewness | | Kurtosis | |
| | Statistic | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Std. Error |
| Q6_2 | 277 | 1 | 7 | 5.11 | 1.101 | -0.528 | 0.146 | 0.597 | 0.292 |
| Q6_3 | 277 | 1 | 7 | 5.09 | 1.155 | -0.754 | 0.146 | 1.159 | 0.292 |
| Q6_4 | 277 | 1 | 7 | 5.18 | 1.192 | -0.734 | 0.146 | 0.955 | 0.292 |
| Q6_5 | 277 | 1 | 7 | 4.98 | 1.179 | -0.505 | 0.146 | 0.442 | 0.292 |
| Q7_1 | 277 | 1 | 7 | 5.22 | 1.005 | -0.381 | 0.146 | 1.246 | 0.292 |
| Q7_2 | 277 | 1 | 7 | 5.12 | 1.077 | -0.565 | 0.146 | 1.101 | 0.292 |
| Q7_3 | 277 | 2 | 7 | 5.05 | 1.133 | -0.454 | 0.146 | 0.148 | 0.292 |
| Q7_4 | 277 | 2 | 7 | 5.23 | 1.051 | -0.372 | 0.146 | 0.344 | 0.292 |
| Q8_1 | 277 | 1 | 7 | 5.11 | 1.129 | -0.877 | 0.146 | 1.11 | 0.292 |
| Q8_2 | 277 | 1 | 7 | 5.08 | 1.112 | -0.643 | 0.146 | 0.461 | 0.292 |
| Q8_3 | 277 | 1 | 7 | 5.14 | 1.134 | -0.588 | 0.146 | 0.957 | 0.292 |
| Q8_4 | 277 | 1 | 7 | 5.04 | 1.326 | -0.855 | 0.146 | 0.939 | 0.292 |
| Q9_1 | 277 | 1 | 7 | 4.94 | 0.955 | -0.68 | 0.146 | 1.514 | 0.292 |
| Q9_2 | 277 | 3 | 7 | 5.15 | 0.855 | -0.507 | 0.146 | 0.579 | 0.292 |
| Q9_3 | 277 | 1 | 7 | 5 | 0.991 | -0.69 | 0.146 | 1.454 | 0.292 |
| Q9_4 | 277 | 1 | 7 | 5.16 | 0.97 | -0.595 | 0.146 | 1.678 | 0.292 |
| Q9_5 | 277 | 3 | 7 | 5.11 | 0.882 | -0.245 | 0.146 | 0.605 | 0.292 |
| Q9_6 | 277 | 2 | 7 | 5.03 | 1.01 | -0.483 | 0.146 | 0.407 | 0.292 |
| Q10_1 | 277 | 1 | 7 | 5.3 | 1.074 | -0.558 | 0.146 | 0.736 | 0.292 |
| Q10_2 | 277 | 1 | 7 | 5.22 | 1.021 | -0.679 | 0.146 | 1.534 | 0.292 |
| Q10_3 | 277 | 1 | 7 | 5.07 | 1.086 | -0.752 | 0.146 | 0.94 | 0.292 |

| Descriptive Statistics | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Question | N | Minimum | Maximum | Mean | Std. Deviation | Skewness | | Kurtosis | |
| | Statistic | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Std. Error |
| Q10_4 | 277 | 2 | 7 | 4.96 | 1.188 | -0.491 | 0.146 | -0.123 | 0.292 |
| Q10_5 | 277 | 1 | 7 | 4.85 | 1.251 | -0.404 | 0.146 | -0.079 | 0.292 |
| Q11_1 | 277 | 1 | 7 | 5.08 | 1.12 | -0.422 | 0.146 | 0.333 | 0.292 |
| Q11_2 | 277 | 2 | 7 | 5.16 | 1.071 | -0.349 | 0.146 | 0.119 | 0.292 |
| Q11_3 | 277 | 2 | 7 | 5.14 | 1.14 | -0.464 | 0.146 | 0.242 | 0.292 |
| Q11_4 | 277 | 1 | 7 | 5.01 | 1.21 | -0.448 | 0.146 | 0.342 | 0.292 |
| Q11_5 | 277 | 1 | 7 | 5.24 | 1.037 | -0.597 | 0.146 | 1.156 | 0.292 |
| Q11_6 | 277 | 2 | 7 | 5.25 | 1.091 | -0.499 | 0.146 | 0.428 | 0.292 |
| Q12_1 | 277 | 1 | 7 | 5.36 | 1.049 | -0.719 | 0.146 | 1.65 | 0.292 |
| Q12_2 | 277 | 1 | 7 | 5.04 | 1.263 | -0.694 | 0.146 | 0.463 | 0.292 |
| Q12_3 | 277 | 1 | 7 | 4.8 | 1.251 | -0.48 | 0.146 | -0.162 | 0.292 |
| Q12_4 | 277 | 1 | 7 | 5.27 | 1.051 | -0.409 | 0.146 | 0.669 | 0.292 |
| Q12_5 | 277 | 1 | 7 | 5.3 | 1.022 | -0.738 | 0.146 | 2.072 | 0.292 |
| Valid N (listwise) | 277 | | | | | | | | |

#### 6.2.3.2 Outliers

Outliers, in statistics are defined as the cases that do not follow the same model as the rest of the data (Weisberg 2005). Two ways have been used to address the outlier's problem: accommodation and identification/rejection (John 1995). The accommodation method involves modifying objective function (usually sum-squared error) to lessen the effect of outliers (Huber 2004). The identification/rejection method identifies outliers and removes them from the data (John 1995; Rousseeuw & Leroy 2005; Tabachnick & Fidell 2001); the second method was adopted in this study.

The study accordingly sought to pinpoint the specific cases with extreme values compared to the rest of the data set. This was done by identifying univariate outliers by assessing standardised z scores of ±3.29 and multivariate outliers evaluating Mahalanobis distance greater than $\chi 2(54) = 91.872$ ($P<0.001$) respectively (Tabachnick & Fidell 2001).

The Mahalanobis test revealed 28 cases as multivariate outliers. The data flow of each of the 28 cases was analysed to determine whether the values provided were consistently the same. Hence, each record was analysed to check the logical flow and consistency of the data provided by responders. The result of this analysis showed that the values were reported in these 28 cases were not consistent and confirmed that these responses were insincerely provided.

The 28 cases were found to have insignificant numbers in terms of ratios of the items (Hair et al. 1998), thus excluding them is unlikely to limit the generalisability of the findings. More importantly however, reducing the sample size of N=277 to N=249 continues to satisfy the accepted recommendation of 200 or more for structural model analysis (Hulland et al. 1996). Accordingly, these 28 cases were excluded from the dataset leaving 249 valid cases with 50 questionnaire items for 10 variables (including minimum four to maximum 6 items for each variable). The remaining dataset satisfies a strong case-to-variable ratio for confirmatory factor analysis (Hair et al. 1998, Schumacker & Lomax 1996; Tabachnick & Fidell 2001).

In the outline of the sample validation process, this section reported the demographic information of the sample, non-response bias, examination of data entry and handling of missing data, and assessment of outlier cases in the data set. The data screening and refinement process identified two responses as unusable, and these were omitted. The remaining 277 responses were further assessed to identify outlier cases. In this process, data normality was examined through the descriptive statistics and through conducting standardised z score and a Mahalanobis distance test; 28 responses were found to be univariate and multivariate outlier cases. Consequently, these 28 outlier cases were excluded from the data set and the final sample consisted of 249 responses, this satisfies the recommended sample size for confirmatory factor analysis and structural model testing.

### 6.2.4 Common Bias Method Testing

Harman’s single-factor test is the most common method used to address the issue of common method variance and thus was used in the study (Podsakoff et al. 2003). SPSS software was used, and the process of testing was guided by Gaskin (2016). All studied variables were loaded into an exploratory factor analysis and unrotated factor solution is examined to decide the number of factors to account for the variance. According to Podsakoff & Organ (1986), if more than 50% variance is extracted in the first factor, Harman's single-factor test would imply bias. The result showed 40.768% variance extracted in the first factor which indicated that the problem of the common method bias was not present (see appendix 6.1 for the detailed SPSS results).

## 6.3 Measurement Model Testing

In this section, the reliability scores for each construct measure were assessed followed by confirmatory factor analysis (CFA). The reliability tests are conducted to examine the internal consistency of the items under each construct to decide whether each observed variable should be retained or excluded. This process pursues testing the measurement model for each construct measure through CFA and then the overall measurement model to assess the validity of the measures and the unidimensionality of all constructs.

### 6.3.1 Fit Indices

The application of Structural Equation Modelling (SEM) and its three main forms has gradually increased in the business literature (McQuitty 2004). SEM is a quantitative data analysis approach in which theoretical relationships are specified, estimated, and tested among observed and latent variables (Byrne 2001). SEM is a not a single technique but rather a combination of techniques and procedures including analysis of covariance structure, factor analysis and regression. The SEM approach starts with model specification where the links and their direction are established among variables that are theoretically assumed to affect each other (Kline 2015). Model specification in SEM is simply a visual representation of substantive (theoretical) hypotheses and a measurement scheme based on relevant theory, information and eventually a developed model (Diamantopoulos et al. 2000).

Model estimation in SEM yields variances, covariances, regression weights and correlations through its iterative procedures that converge on a set of parameter estimates (Holmes-Smith et al. 2006). Throughout the model estimation, fit statistics should be examined to check whether the proposed model is a fit for the data or not, or to determine whether any modification is needed to enhance the model fit. Holmes-Smith et al. (2006) defined the basic forms of the model fit as follows:

- Absolute fit indices,
- Incremental fit or Comparative fit indices, and
- Indices of model parsimony

Each of the three model-fit forms has different fit indices and rules of thumb for the minimum level of accepted score/value for good fit (Arbuckle & Wothke 1999; Byrne 2001). Researchers have however, noted that different fit indices have problems in the evaluation process (Kline 2015), since different fit indices are reported in different articles with reviewers of the same manuscript recommending their preferred indices (Maruyama 1997; Ping Jr 2004). For instance, Kenny & McCoach (2003) state that there is no consistent standard for assessing an acceptable model and stressed that CFI, TLI, and RMSEA should be used as fit indices. Steenkamp et al. (2003) stated that $\chi 2$, CFI and TLI should be used as fit indices to test the moderating effect of their model. Others such as Knight and Cavusgil (2004) used CFI, NNFI (TLI), DELTA2 (IFI), RNI, and RMSEA to assess their model fit. McQuitty (2004) placed emphasis on goodness-of-fit indices that are less sensitive to sample size which include TLI recommended by Marsh et al. (1988), IFI, TLI, CFI recommended by Bentler (1990), and RMSEA, CFI and TLI recommended by Fan et al. (1999). Holmes-Smith et al. (2006) and Hulland et al. (1996) suggests that it is unlikely that all the fit measures could be found in one report.

Accordingly, this study is reporting a sample of fit indices from major categories to assess the level of fitness of the measurement model and the proposed structural model. Hence, this study used $\chi 2$/df (CMIN/DF), IFI, TLI, CFI, and RMSEA for assessing model fit, as these indices are the most commonly used in the literature (Hulland et al. 1996). GFI (and thus, AGFI) are not included in the model assessment as they have bias that is based on the ratio of sample size to degrees of freedom in which if degrees of freedom are large relative to sample size, the fit would look worse (Steiger 1990). Further, it has some scholars believe that in the context of SEM using AMOS, given the issues with GFI, that GFI is becoming less useful (Sharma et al. 2005). Hair et al. (1998b) and Holmes-Smith et al. (2006) recommended the use of at least one fitness index from each category of model fit. Accordingly, Table 6.3 demonstrates the SEM fit indices reported in this study. The other reasons behind considering $\chi2$/df (CMIN/DF), IFI, TLI, CFI, and RMSEA as fit measures are also further explained.

Table 6.3 SEM Fit Indices

| **Level of Model Fit** | **Overall Model Fit** | | | | |
|---|---|---|---|---|---|
| | **Model Fit** | **Model Comparison** | | | |
| **Fit Measures** | **CMIN/DF** | **RMSEA** | **IFI** | **TLI** | **CFI** |
| Acceptable Scale for Good as well as Adequate Fit | ≤ 2 | < 0.05 (Good Fit)<br>> 0.08 (Adequate Fit)<br>0.08– 0.10 (Marginal Fit) | ≥0.90 | ≥0.90 | ≥0.90 |

Source: Adopted from Byrne (2001), Holmes-Smith et al. (2004), Hulland et al. (1996), Kline (2005), and MacCallum et al. (1996)

The $\chi2$ (Chi-square) is a measure of the difference between the implied variances and covariances matrix ($\Sigma$) and the estimated sample variances and covariances matrix (*S*). This statistic test examines whether the matrix of $\Sigma$ is significantly different from the sample matrix *S*. To assess this, the probability of achieving $\chi2$ (usually $\alpha = 0.05$) is used to determine whether to accept the null hypothesis if there is no significant difference between $\Sigma$ and *S* or to reject it. This is achieved through its associated degree of freedom (df) and probability of significant difference. A probability greater than 0.05 indicates the specified model that provided an impetus to the parameter estimates is a feasible representation of data that it proposes to represent (Holmes-Smith et al. 2006).

However, Kenny & McCoach (2003) argued that $\chi2$ is very sensitive in relation to the sample size and model complexity, and a more complex model yields bigger $\chi2$ that is more likely to reject the specified model. Gulliksen & Tukey (1958 p. 96) stated that "if the sample size is large, the $\chi2$ test will show that the data are significantly different from those expected on a given theory even though the difference may be so very slight as to be negligible or unimportant on other criteria". Considering these complexities, some researchers have used "normed" $\chi2$ where $\chi2$ is measured per degree of freedom with an index of model parsimony (Holmes-Smith et al. 2006). Thus, the equation for normed $\chi2$ is: Normed $\chi2 = \chi2$/df. A value of normed $\chi2$ greater than 1 and less than 2 suggests a very good model fit (Byrne 2001; Hair et al. 1998, Holmes-Smith et al. 2006).

In the baseline comparisons, the commonly used fit indices to assess the relative improvement in fit to the model are the incremental fit index (IFI) proposed by Bollen (1989), the Tucker Lewis Index (TLI) known as the non-normed fit index (NNFI) by Tucker & Lewis (1973), and comparative fit index (CFI) proposed by Bentler (1990). In the baseline comparisons, the proposed model is compared to some baseline model fit criteria to assess the model fit in which all the indices attempt to assess how much better the estimated model fits with the sample data. The NFI, IFI, CFI indices values are meant to lie between zero and one. If the indices values are close to one (e.g., 0.90 to 0.95), this indicates adequate fit, and when the values exceed 0.95, a 'very well' fit model is indicated (Hulland et al. 1996). In contrast, indices values close to zero suggests that the specified model is not better than the independence model. Thus, when assessing incremental fitness of the model a value between 0.90 and 1.00 is considered adequate fit (Holmes-Smith et al. 2006; Kline 2015). Therefore, considering the limitation of $\chi 2$ statistics in assessing structural model fit, highlighted by researchers (Bentler 1990), CFI, TLI and IFI from a baseline comparison are used to assess and report the model fit.

The Root Mean Squared Error of Approximation (RMSEA) is recognised as an excellent choice among the evaluation fit indices due to its unique and powerful properties. First, it has been recognised as the most informative criteria in covariance structure modelling (Byrne 2001). Second, it is described as a population-based index because being a parsimony-adjusted index, it considers the error of approximation, which is not affected by sample size and eases the strict requirement on $\chi 2$ that the model possesses exactly in the population (Holmes-Smith et al. 2006; Kline 2015). As suggested by Browne & Cudeck (1993) and Byrne (2001), RMSEA value $< 0.05$ suggest a good fit, while RMSEA values $\geq 0.08$ suggest reasonable errors of approximation in the population. MacCallum et al. (1996) further argued that RMSEA values from 0.06 to 0.10 suggest a mediocre fit, and values greater than 0.10 are a poor fit. Likewise, Hulland et al. (1996) stated that RMSEA values between 0.05 and 0.10 are sometimes deemed an adequate fit. Others concluded that an acceptable value of RMSEA to be $< 0.10$ (Coetzee & van Dyk 2018; Hamtiaux et al. 2013; Park et al. 2012; Rossanty & Putra Nasution 2018). Accordingly, CMIN/DF ($\chi 2$/df), RMSEA, IFI, TLI, and CFI are used to evaluate the initial measurement models and the final structural model in the sections to follow.

### 6.3.2 Initial Measurement Model Fit and Modification

This section demonstrates key findings of the initial measurement model fit and confirmatory factor analysis (CFA). In this study, no EFA was carried out. This is because the adapted instruments have been established and validated by previous researchers, and the characteristics of industry where the instruments were developed are similar to those of this study. CFA is fundamental as it tests the unidimensionality of data set measures and confirms the underlying structure based on the theoretical ground (Brahma 2009). It further recommends modification in the measurement model for theory testing and level of fit assessment.

Modification indices (MIs) and standardised factor loading (standardised regression weights) in AMOS CFA test output were used to assess the dimensionality of the measurement and to verify the model fit. Modification indices (MIs) consist of variances, covariances, as well as regression weights. Modification indices (MIs) and standardised factor loading were assessed to decide on the direction of modification for a better model fit such as freeing or relating parameters between or among variables.

Researchers including Anderson and Gerbing (1988) mention that relating or deleting the indicators from the model are the favoured fundamental ways to re-specify the model. Thus, the best way to get a better fit model is to delete or add new path indicators to the model. Any of these changes in measurement items yields changes in the parameters' values and model fit statistics. Accordingly, taking account of these dilemmas, the measurement models test for each construct measure are discussed in the following sections.

#### 6.3.2.1 Intra-organisational Collaboration Construct

As discussed in chapter 5 (see section 5.3.4.2.1), in this study, previous studies are combined to provide an overarching conceptualisation of intra-organisational collaboration. Subsequently, intra-organisational collaboration is conceptualised as a reflective second-order construct with five dimensions (subconstructs): collaborative leadership, collaborative relationships, trust formation, communicating and sharing information, and commitment (Fanousse et al. 2021b). The following sections (section 6.3.2.1.1 to 6.3.2.1.6) present the CFA test for each of the five sub-constructs and section 6.3.2.1.7 demonstrates the CFA model for intra-organisational collaboration as a reflective second-order construct with five dimensions

***Trust***

Trust was measured using six items as indicated in Table 6.4 and was subjected to a CFA test using AMOS. The CFA output is provided in Table 6.4. The fit indices suggested a mixed picture regarding the adequacy of the fit with inadequate fit suggested by the values of $\chi 2$ and RMSEA while CFI, TLI, IFI indicated an adequate fit.

In assessing the standardised factor loading, it was found that the standardised regression weight for 'trust3' ('To what extent do you agree that while working on the project each of your project team members was - Willing to provide assistance') and 'trust6' were the lowest compared to the other loadings (0.697, 0.698), respectively. However, looking at the findings of the modification indices (MIs), a few significant error covariances associated with trust 3, trust 4 and trust 5 were indicated. The suggested errors covariances for trust 5 and 4 were more than trust 3. MIs with expected changes in statistics associated with the error covariances showed misspecification between ‘trust 5’ and ‘trust 2’, ‘trust 3’ and ‘trust 4’, as well as ‘trust 6’. Thus, ‘trust 5’ is the first to be deleted.

Additionally, ‘trust4’ was shown to have a misspecification with ‘trust 3’, and ‘trust 5’. Although ‘trust 5’ exhibited an acceptable loading of 0.861, which was the highest factor loading among other measures, it was considered for deletion because its measurement error is correlated with the measurement errors of four items. The correlation suggested between the measurement errors could suggest that these items are measuring the same thing thus deleting ‘trust 5’ would avoid duplicates measures and improve the overall measurement model fit.

Upon deletion of ‘trust 5’, all fit indices showed improvement with reduced $\chi2$ value from 43.109 (df = 9 and p = 0.000) to 14.729 (df = 5 and p = 0.012). A decision was then made to delete ‘trust4’ based on the MI’ in order to achieve a better model fit. The deletion of ‘trust4’, (as shown in Table 6.4) showed major improvement with reduced $\chi2$ value from 14.729 (df = 5 and p = 0.012) to 4.819 (df = 2 and p = 0.090). Although these only marginally effected the overall fit statistics, the recommended modifications had a great impact on the overall measurement model as well.

Measurement items ‘trust 4’ and ‘trust 5’ are important measures of trust and have been used in some studies (for example, Park & Lee 2014), but other researchers such as Morgan & Hunt (1994) have ignored their inclusion in their seminal work. Thus, the deletion of the two items and using the remaining four items in measuring trust would not affect the content and face validity of the measurement.

The Critical Ratio (CR) value is generated by dividing an estimate by its standard error. The critical ratio resembles a normal distribution if the sample size is sufficient. In such a case, a value of 1.96 suggests two-sided significance at the "standard" 5% level. When the CR is > 1.96 for a regression weight, that indicates a significant path at the 0.05 level or better (that is, the estimated path parameter is significant). All the reported CR for the factor loadings in Table 6.4 are > 1.96, which means estimates are significant.

Table 6.4 Summary of Initial and Final Findings (CFA): Trust

| Quest. Item | Item wording | Initial Standardised Loading | Final | |
|---|---|---|---|---|
| | | | Standardised Loadings | C.R. (t) |
| Trust1 | To what extent do you agree that while working on the project each of your project team members was - Honest about problems when they arose | 0.725 | 0.710 | |
| Trust2 | To what extent do you agree that while working on the project each of your project team members was - Supportive when making decision | 0.810 | 0.896 | 11.462 |
| Trust3 | To what extent do you agree that while working on the project each of your project team members was - Willing to provide assistance | 0.697 | 0.699 | 10.060 |
| Trust4 | To what extent do you agree that while working on the project each of your project team members was - Sincere | 0.770 | Removed | |
| Trust5 | To what extent do you agree that while working on the project each of your project team members was - Completely trustworthy | 0.861 | Removed | |
| Trust6 | To what extent do you agree that while working on the project each of your project team members was - Confident in the abilities of other cross functional team members | 0.698 | 0.699 | 9.278 |

**Achieved Fit Indices**

| | CMIN/DF (χ2/df) | RMSEA | IFI | TLI | CFI |
|---|---|---|---|---|---|
| Initial | 4.790 (43.109/9) | 0.124 | 0.957 | 0.928 | 0.957 |
| Final | 2.409 (4.819/2) | 0.075 | 0.992 | 0.977 | 0.992 |
| Cronbach's Alpha 0.823, Composite Construct Reliability 0.840 | | | | | |

The composite construct reliability for the four-items measure is 0.840 which is above the acceptable level as suggested in literature (Hair et al. 1998). This supports the four retained items - 'trust 1', 'trust 2', 'trust 3', and 'trust 6', as being reliable and valid for trust construct.

***Commitment***

Commitment was measured using four items and was subjected to a CFA test using AMOS to verify their dimensionality and to determine whether the model was an adequate fit to the data. The CFA output is provided in Table 6.5, initial CFA analysis indicated that the model required no modification. As demonstrated in Table 6.5, all items exhibited high loading scores with CR > 1.96 and the model is a perfect to data.

Table 6.5 Summary of Initial Findings (CFA): Commitment

| Quest. Item | Item wording | Initial Standardised Loading | C.R. (t) |
|---|---|---|---|
| Commitment1 | To what extent do you agree that while working on the project you were committed to - The work relationship with other project members | 0.831 | |
| Commitment2 | To what extent do you agree that while working on the project you were committed to - Considering other project members as a part of the same team | 0.817 | 14.576 |
| Commitment3 | To what extent do you agree that while working on the project you were committed to - Caring for the working relationship with other team members | 0.862 | 15.541 |
| Commitment4 | To what extent do you agree that while working on the project you were committed to - Spending time working with other team members | 0.760 | 13.228 |

| Achieved Fit Indices | | | | | |
|---|---|---|---|---|---|
| **CMIN/DF ($\chi$2/df)** | **RMSEA** | **GFI** | **IFI** | **TLI** | **CFI** |
| 1.164 (2.328/2) | 0.026 | 0.995 | 0.999 | 0.998 | 0.999 |
| Cronbach's Alpha 0.889, Composite Construct Reliability 0.890 | | | | | |

The four-item factor measuring commitment is widely used in the literature (see for example, Moorman et al. 1992; Pinto & Pinto 1990; Rodríguez et al. 2008; Wilson & Vlosky 1998). Consequently, the commitment measure is a reliable and valid measure for representing the commitment construct. The composite construct reliability is 0.890, which is also above the acceptable level (Hair et al. 1998).

### *Collaborative Relationship*

Collaborative relationship was measured using five items and was subjected to a CFA test using AMOS to verify their dimensionality and to determine whether the model was an adequate fit to the data. The CFA output is provided in Table 6.6. Initial CFA analysis indicated that the model required no modification. As demonstrated in Table 6.6, all items exhibited high loading scores with CR > 1.96. The model is an adequate fit to data based on the values of IFI, TLI and CFI and $\chi$2 and RMSEA values, thus all five items are retained.

Table 6.6 Summary of Initial Findings (CFA): Collaborative Relationship

| Quest. Item | Item wording | Initial Standardised Loading | C.R. (t) |
|---|---|---|---|
| Collaborative relationship1 | To what extent do you agree that the following occurred while you were working on the project - There were positive work relationships between cross functional team members | 0.759 | |
| Collaborative relationship2 | To what extent do you agree that the following occurred while you were working on the project - The team resolved conflicts collaboratively | 0.828 | 13.196 |
| Collaborative relationship3 | To what extent do you agree that the following occurred while you were working on the project - The team members trust each other because day-to-day promises are entirely met | 0.816 | 12.983 |
| Collaborative relationship4 | To what extent do you agree that the following occurred while you were working on the project - The team members trust each other because day-to-day promises are entirely met | 0.766 | 12.118 |
| Collaborative relationship5 | To what extent do you agree that the following occurred while you were working on the project - The team members trust each other because day-to-day promises are entirely met | 0.792 | 12.572 |

| **Achieved Fit Indices** | | | | |
|---|---|---|---|---|
| **CMIN/DF ($\chi 2$/df)** | **RMSEA** | **IFI** | **TLI** | **CFI** |
| 1.617 (8.085/5) | 0.050 | 0.995 | 0.991 | 0.995 |
| Cronbach's Alpha 0.894, Composite Construct Reliability 0.894 | | | | |

The five-item factor measuring collaborative relationship was used in previous studies (for example, Fawcett et al. 2019). Consequently, the collaborative relationship measure is a reliable and valid measure for representing the collaborative relationship construct. The composite construct reliability is 0.894, which is also above the acceptable level (Hair et al. 1998).

***Collaborative Leadership***

Collaborative leadership was measured using five items and was subjected to a CFA test using AMOS to verify dimensionality and to determine whether the model was an adequate fit to the data. The CFA output is provided in Table 6.7, initial CFA analysis indicated that the initial model required no modification.

Table 6.7 Summary of Initial Findings (CFA): Collaborative Leadership

| Quest. Item | Item wording | Initial Standardised Loading | Final | |
|---|---|---|---|---|
| | | | Standardised Loadings | C.R. (t) |
| Collaborative leadership1 | To what extent do you agree that your project leader/manager was successful in - Reconciling different views and building a consensus | 0.834 | 0.801 | |
| Collaborative leadership2 | To what extent do you agree that your project leader/manager was successful in - Articulating and promoting a shared vision | 0.848 | 0.817 | 16.360 |
| Collaborative leadership3 | To what extent do you agree that your project leader/manager was successful in - Balancing the strategic and the operational delivery | 0.824 | 0.834 | 14.060 |
| Collaborative leadership4 | To what extent do you agree that your project leader/manager was successful in - Encouraging and inspiring others | 0.815 | 0.830 | 14.004 |
| Collaborative leadership5 | To what extent do you agree that your project leader/manager was successful in - Dealing comfortably with ambiguity and complexity | 0.740 | 0.753 | 12.474 |

**Achieved Fit Indices**

| | CMIN/DF (χ2/df) | RMSEA | IFI | TLI | CFI |
|---|---|---|---|---|---|
| Initial | 3.432 (17.158/5) | 0.099 | 0.984 | 0.968 | 0.984 |
| Final | 2.205 (8.820/4) | 0.070 | 0.994 | 0.984 | 0.994 |
| Cronbach's Alpha 0.820, Composite Construct Reliability 0.903 | | | | | |

As demonstrated in Table 6.7, all items exhibited high loading scores and the initial model is an adequate fit to data based on the values of IFI, TLI and CFI, although χ2 and RMSEA values indicate inadequate fit. An attempt to delete 'Collaborative leadership5' which has the lowest factor loading worsened the model fit as it generated χ2 value 11.012 (df = 2 and p = .004) and RMSEA 0.135.

Additionally, MIs suggested a need to free the covariance parameter between the measurement error of 'Collaborative leadership1' and measurement errors of 'Collaborative leadership2' and 'Collaborative leadership3' in order to enhance the model fit. Upon freeing the covariance parameter between the measurement error of 'collaborative leadership 1' and measurement errors of 'collaborative leadership 2', all fit indices showed an acceptable fit with reduced χ2 value from 17.158 (df = 5 and p = 0.000) with CMIN/df 3.432 to 8.820 (df = 4 and p = 0.066) with CMIN/df 2.205 as shown in Table 9.

The five-item factor measuring collaborative leadership was used in previous studies (for example, Lin et al. 2015b). Consequently, the collaborative leadership measure is a reliable and valid measure for representing the collaborative leadership construct. The composite construct reliability is 0.903, which is also above the acceptable level (Hair et al. 1998).

***Communicating and Sharing Information***

Communicating and sharing information was measured using four items and was subjected to a CFA test using AMOS to verify their dimensionality and to determine whether the model was an adequate fit to the data. The CFA analysis is shown in Table 6.8, indicating that the model required no modification. All items exhibited high loading scores and the model is adequate fit to data based on the values of IFI, TLI and CFI. The values of $\chi2$ and RMSEA indicate marginal and acceptable fit (Coetzee & van Dyk 2018; Hamtiaux et al. 2013; Park et al. 2012; Rossanty & Putra Nasution 2018).

Table 6.8 Summary of Initial Findings (CFA): Communicating and Sharing Information

| Quest. Item | Item wording | Initial Standardised Loading | C.R. (t) |
|---|---|---|---|
| Communicating and sharing information1 | To what extent do you agree that your project team members while working on the project were - Maintaining open and collaborative communication and exchanging opinions | 0.864 | |
| Communicating and sharing information2 | To what extent do you agree that your project team members while working on the project were - Taking the path of least resistance to communicate wherever possible | 0.764 | 13.745 |
| Communicating and sharing information3 | To what extent do you agree that your project team members while working on the project were - Investing sufficient time and attention in communication and information-sharing processes | 0.846 | 15.754 |
| Communicating and sharing information4 | To what extent do you agree that your project team members while working on the project were - Ensuring that information reach its targeted stakeholders in a timely manner | 0.766 | 13.799 |

| Achieved Fit Indices | | | | |
|---|---|---|---|---|
| **CMIN/DF ($\chi$2/df)** | **RMSEA** | **IFI** | **TLI** | **CFI** |
| 3.216 (6.432/2) | 0.095 | 0.992 | 0.975 | 0.992 |
| Cronbach’s Alpha 0.883, Composite Construct Reliability 0.883 | | | | |

### *Intra-organisational Collaboration as a Second-order Factor*

The second-order CFA model is a form of structural equation model used to evaluate the factorial validity of scores for measuring an instrument and is structured in two levels (a measurement and structural level) (Black et al. 2015). It assumes a second-order factor that has direct causal paths to multiple first-order factors, which in turn have direct causal paths to observed variables (also known as manifest variables or indicators) (Byrne 2013; Kline 2015).

The multi-faceted nature of intra-organisational collaboration has been corroborated by recent and seminal works (Cao & Zhang 2011; Cooper 2019; Kahn 1996; Ko et al. 2011; Lin et al. 2015b, Um & Kim 2018; Yan & Dooley 2013). Lin et al. (2015b) presented intra-organisational collaboration as a latent variable and measured it by four constructs. In line with the literature, intra-organisational collaboration is represented in this study as a second-order factor to reflect an overarching intra-organisational construct, with direct causal paths to five first-order factors (subscales).

Intra-organisational collaboration is represented as a reflective second-order factor rather than a formative one. Because reflective indicators are interchangeable, adding or deleting indicators does not change the essential nature of the underlying construct (Diamantopoulos & Winklhofer 2001), while in a formative construct, removing an indicator is removing an essential part of the construct (Bollen & Lennox 1991). Building on this, removing any of the five constructs that represent intra-organisational collaboration does not affect the nature of the construct, thus, intra-organisational collaboration is represented as a reflective-reflective second-order construct.

The five subscales that represent facets of the intra-organisational collaboration construct are trust, commitment, collaborative relationship, collaborative leadership, and communicating and sharing information. Each of these scales is a reflective construct and is directly measured by observed variables. Figure 6.1 offers a schematic depiction of intra-organisational collaboration as a second-order CFA model.

The assessment of the measurement quality of second-order constructs is done in two stages. The first stage examines the appropriateness of the first-order constructs and this was already done for all the five constructs of intra-organisational collaboration using quality criteria for reflective constructs (Becker et al. 2012). The second stage assessed the second-order construct against the relations among first-order constructs and the second-order construct, in which the first-order constructs act as indicators of the second-order construct (Becker et al. 2012).

The quality criteria for reflective items at this higher order level was applied. Accordingly, intra-organisational collaboration as a second order construct using five latent variables was subjected to a CFA test using AMOS to verify its unidimensionality, validity and reliability prior to modelling the structural model and SEM. The CFA output are provided in Table 6.9.

As indicated in Table 6.9, CFA analysis showed that the model that represents intra-organisational collaboration as a second-order factor required no modification. All items exhibited high loading scores and the model is an adequate fit to data based on the values of $\chi2$, RMSEA, IFI, TLI and CFI. The composite construct reliability is 0.919, which is also above the acceptable level.

Table 6.9 Summary of Initial Findings (CFA): Intra-organisational Collaboration

| First-order Construct | Initial Standardised Loading | C.R. (t) |
|---|---|---|
| Trust | 0.836 | |
| Commitment | 0.688 | 7.816 |
| Collaborative Relationship | 0.881 | 9.250 |
| Collaborative Leadership | 0.872 | 9.412 |
| Communicating and sharing information | 0.878 | 9.060 |

| Achieved Fit Indices | | | | |
|---|---|---|---|---|
| **CMIN/DF ($\chi2$/df)** | **RMSEA** | **IFI** | **TLI** | **CFI** |
| 1.506 (305.802/203) | 0.045 | 0.972 | 0.968 | 0.972 |
| Composite Construct Reliability 0.919 | | | | |

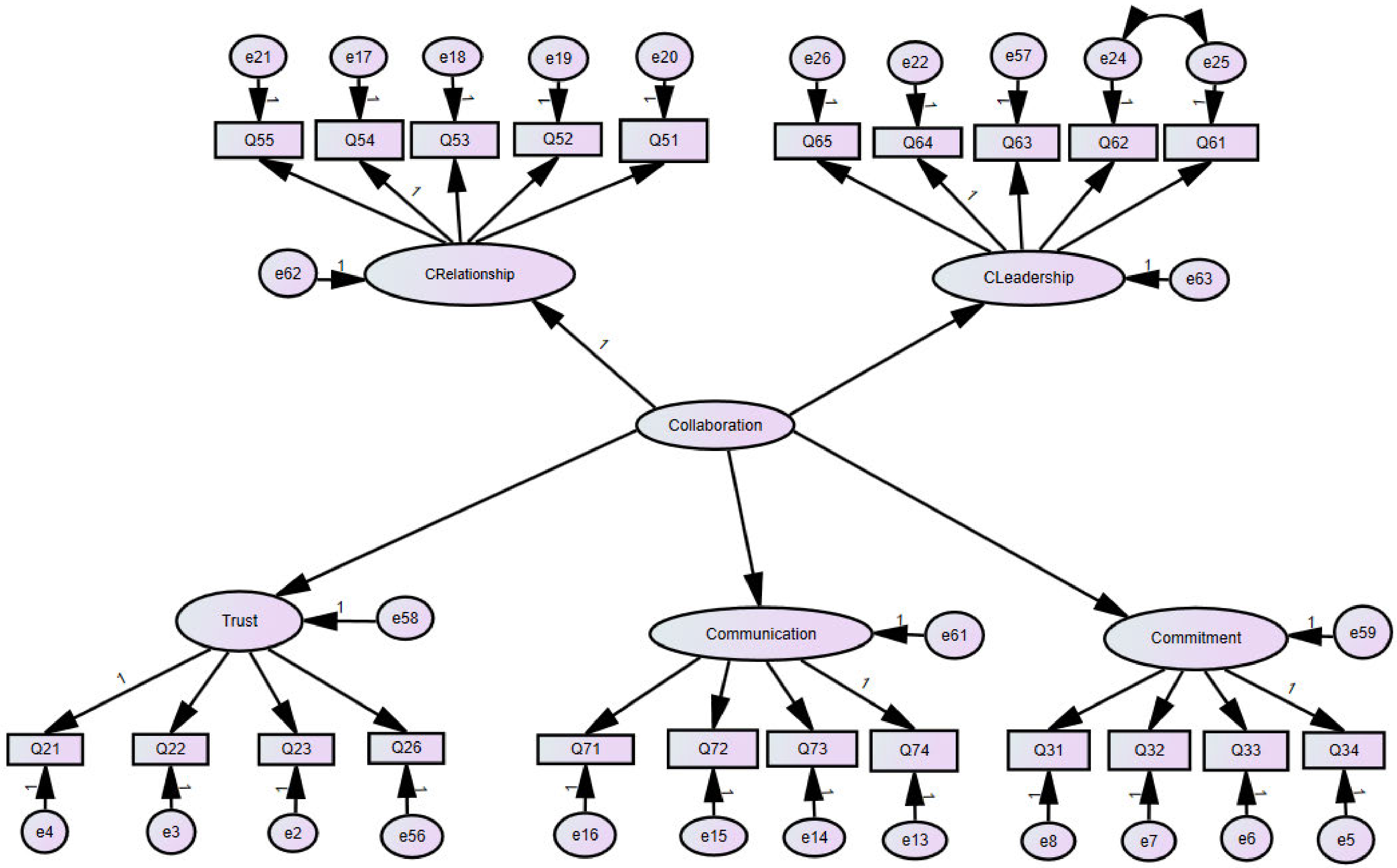


Figure 6.1 Measurement Model of Intra-organisational Collaboration[8]

[8] The questions are presented in Appendix 5.1: Survey Questions Items with the Sources

### 6.3.2.2 Organisational Learning

Organisational learning was measured using four items and was subjected to a CFA test using AMOS to verify their dimensionality and to determine whether the model was an adequate fit to the data. The CFA output is provided in Table 6.10.

Initial CFA analysis indicated that all items exhibited high loading scores and that the model is an adequate fit to data based on the values of IFI, TLI and CFI; however, $\chi 2$ and RMSEA values indicate an inadequate fit. Additionally, MIs suggested the need to free the covariance parameter between the measurement error of 'organisational learning 3' and measurement error of 'Organisational learning 4' to enhance the model fit. Upon freeing the covariance parameter between the suggested measurement errors, all fit indices showed a perfect fit with reduced $\chi 2$ value from 11.324 (df = 2 and p = 0.000) with CMIN/df 5.662 to 2.001 (df = 1 and p = 0.157) with CMIN/df 2.001 as shown in Table 6.10.

The four-item factor measuring organisational learning was used in previous studies (see for example, Edmondson 1999; Kale et al. 2000; García-Morales et al. 2012). Consequently, the organisational learning measure is a reliable and valid measure for representing organisational learning construct. The composite construct reliability is 0.884, which is also above the acceptable level.

Table 6.10 Summary of Initial Findings (CFA): Organisational Learning

| Quest. Item | Item wording | Initial Standardised Loading | Final | |
|---|---|---|---|---|
| | | | **Standardised Loadings** | **C.R. (t)** |
| Organisational learning1 | To what extent do you believe that over the last three years - Your organisation has acquired and shared new and relevant knowledge that provided competitive advantage | 0.824 | 0.828 | |
| Organisational learning2 | To what extent do you believe that over the last three years - Your organisation members have acquired some critical capacities and skills that have provided competitive advantage | 0.892 | 0.912 | 15.928 |
| Organisational learning3 | To what extent do you believe that over the last three years - Your organisational improvements have been influenced fundamentally by new knowledge entering the organisation | 0.809 | 0.782 | 13.768 |

| Quest. Item | Item wording | Initial Standardised Loading | Final | |
|---|---|---|---|---|
| | | | Standardised Loadings | C.R. (t) |
| Organisational learning4 | To what extent do you believe that over the last three years - Your organisation is a learning organisation (a company that facilitates the learning of its members and continuously transforms itself) | 0.745 | 0.710 | 12.058 |

| Achieved Fit Indices | | | | | |
|---|---|---|---|---|---|
| | CMIN/DF (χ2/df) | RMSEA | IFI | TLI | CFI |
| Initial | 5.662 (11.324/2) | 0.137 | 0.984 | 0.951 | 0.984 |
| Final | 2.001 (2.001/1) | 0.064 | 0.998 | 0.989 | 0.998 |
| Cronbach's Alpha 0.887, Composite Construct Reliability 0.884 | | | | | |

#### 6.3.2.3 Task Uncertainty Reduction

Task uncertainty reduction was measured using six items and was subjected to a CFA test using AMOS to verify their dimensionality and to determine whether the model was an adequate fit to the data. The CFA output is provided in Table 6.11. Initial CFA analysis indicated that the initial model required modification. As demonstrated in Table 6.11, only 2 items exhibited high loading scores and the initial model is an inadequate fit to data based on the values of $\chi 2$, RMSEA, and TLI.

In assessing the standardised factor loading, it was found that the standardised regression weight for 'Task uncertainty 6' ('To what extent do you agree that you and other innovation project team members while working on the project were able to cope with the - The need to check one member's job with other team member's job for the successful completion of major tasks') was the lowest compared to the other loadings (0.518). Also, the SMC is equal to 0.268, which indicated that only 26.8% of the variance of 'Task uncertainty 6' is explained by the construct.

Additionally, the output indicated that 'Task uncertainty 1' ('To what extent do you agree that you and other innovation project team members while working on the project were able to cope with the - Fluctuation in users' requirements') also has a low factor loading (0.610). The SMC is equal to 0.372, which indicated that only 37.2% of the variance of 'Task uncertainty 1' is explained by the construct.

This was also supported by the findings of the MIs, which indicated a few significant error covariances associated with ‘Task uncertainty 1’. Upon deletion of ‘Task uncertainty 6’ and ‘Task uncertainty 1’, all fit indices showed significant improvement which exhibited accepted loadings with reduced $\chi 2$ value from 48.263 (df = 9 and p = 0.000) to 2.794 (df = 2 and p = 0.247) (see Table 6.11).

Although these marginally effect the overall fit statistics, the recommended modifications have a great impact on the overall measurement model. Measurement items ‘Task uncertainty1’ and ‘Task uncertainty6’ are important measures of task uncertainty reduction and have been used in previous studies. However, researchers such as Rai & Al-Hindi (2000) did not include ‘Task uncertainty 6’ in their task uncertainty reduction measure, and Yan & Dooley (2013) did not include ‘Task uncertainty 1’ in their measure. This confirmed the deletion of the two items and retaining the remaining four items in measuring task uncertainty reduction would not affect the content and face validity of the measurement.

Table 6.11 Summary of Initial Findings (CFA): Task Uncertainty

| **Quest. Item** | **Item wording** | **Initial Standardised Loading** | **Final** | |
|---|---|---|---|---|
| | | | **Standardised Loadings** | **C.R. (t)** |
| Task uncertainty1 | To what extent do you agree that you and other innovation project team members while working on the project were able to cope with the - Fluctuation in users’ requirements | 0.610 | Removed | |
| Task uncertainty2 | To what extent do you agree that you and other innovation project team members while working on the project were able to cope with the - Availability of information to perform the task | 0.655 | 0.584 | |
| Task uncertainty3 | To what extent do you agree that you and other innovation project team members while working on the project were able to cope with the - Uncertain events during the development of the project | 0.631 | 0.601 | 7.598 |
| Task uncertainty4 | To what extent do you agree that you and other innovation project team members while working on the project were able to cope with the - The dependence level of one task on other tasks to obtain resources such as materials, people, or information needed | 0.844 | 0.911 | 9.168 |

| Quest. Item | Item wording | Initial Standardised Loading | Final | |
|---|---|---|---|---|
| | | | Standardised Loadings | C.R. (t) |
| Task uncertainty5 | To what extent do you agree that you and other innovation project team members while working on the project were able to cope with the - The dependence level of one subtask on another subtask to complete the overall task | 0.763 | 0.765 | 8.927 |
| Task uncertainty6 | To what extent do you agree that you and other innovation project team members while working on the project were able to cope with the - The need to check one member's job with other team member's job for the successful completion of major tasks | 0.518 | Removed | |

**Achieved Fit Indices**

| | CMIN/DF (χ2/df) | RMSEA | IFI | TLI | CFI |
|---|---|---|---|---|---|
| Initial | 5.363 (48.263/9) | 0.133 | 0.926 | 0.876 | 0.925 |
| Final | 1.397 (2.794/2) | 0.040 | 0.998 | 0.993 | 0.998 |
| Cronbach's Alpha 0.806, Composite Construct Reliability 0.813 | | | | | |

The four items measuring task uncertainty reduction were used in previous studies (see for example, Rai & Al-Hindi 2000; Swink 1999; Van de Ven 1986; Yan & Dooley 2013). Consequently, the task uncertainty reduction measure is a reliable and valid measure for representing the task uncertainty reduction construct. The composite construct reliability is 0.813, which is also above the acceptable level.

#### 6.3.2.4 Market Uncertainty Reduction

Market uncertainty reduction was measured using five items and was subjected to a CFA test using AMOS to verify their dimensionality and to determine whether the model was an inadequate fit to the data. The CFA output is provided in Table 6.12. Initial CFA analysis indicated that the initial model required modification.

As demonstrated in Table 6.12, all items exhibited high loading scores and that the model is an inadequate fit to data based on the values of χ2, RMSEA, IFI, TLI, CFI. Assessing the MIs, which indicated significant errors in covariances associated with 'Market uncertainty 5', suggested the need to free the parameters between the measurement error of 'Market uncertainty 5' and the measurement error of 'Market uncertainty 4'.

Upon freeing the covariance parameter between the measurement error 'Market uncertainty 5' and the measurement error of 'Market uncertainty 4', all fit indices showed significant improvement, exhibiting accepted loadings with reduced $\chi 2$ value from 21.846 (df =5 and p = 0.000) to 7.173 (df = 4 and p = 0.127) with the RMSEA, IFI, TLI, and CFI were significantly improved (as shown in Table 6.12).

The four items measuring market uncertainty reduction were used in the seminal work of Lievens & Moenaert (2000). Consequently, the market uncertainty measure is a reliable and valid measure for representing the market uncertainty reduction construct. The composite construct reliability is 0.852, which is also above the acceptable level.

Table 6.12 Summary of Initial Findings (CFA): Market Uncertainty

| Quest. Item | Item wording | Initial Standardised Loading | Final | |
|---|---|---|---|---|
| | | | Standardised Loadings | C.R. (t) |
| Market uncertainty 1 | To what extent do you agree that you and your other innovation project team members while working on the project were informed about - The customer's needs (user requirements) | 0.763 | 0.794 | |
| Market uncertainty 2 | To what extent do you agree that you and your other innovation project team members while working on the project were informed about - The potential customer/client or market | 0.843 | 0.889 | 13.958 |
| Market uncertainty 3 | To what extent do you agree that you and your other innovation project team members while working on the project were informed about - The behaviour of the user or potential customer/client | 0.741 | 0.737 | 11.933 |
| Market uncertainty 4 | To what extent do you agree that you and your other innovation project team members while working on the project were informed about - The technological strategy of the competitors | 0.733 | 0.640 | 10.137 |
| Market uncertainty 5 | To what extent do you agree that you and your other innovation project team members while working on the project were informed about - The marketing strategy of the competitors | 0.681 | 0.578 | 9.023 |

| Achieved Fit Indices | | | | | |
|---|---|---|---|---|---|
| | CMIN/DF ($\chi 2$/df) | RMSEA | IFI | TLI | CFI |
| Initial | 21.846 (109.230/5) | 0.290 | 0.840 | 0.678 | 0.839 |
| Final | 1.793 (7.173/4) | 0.057 | 0.995 | 0.988 | 0.995 |
| Cronbach's Alpa 0.865 and Composite Construct Reliability 0.852 | | | | | |

### 6.3.2.5 Technological Uncertainty Reduction

Technological uncertainty reduction was measured using six items and was subjected to a CFA test using AMOS to verify their dimensionality and to determine whether the model was an adequate fit to the data. The CFA output is provided in Table 6.13. Initial CFA analysis indicated that the initial model required modification.

As demonstrated in Table 6.13, all items exhibited high loading scores, but the initial model is an inadequate fit to data based on the values of $\chi 2$, RMSEA, and TLI. An assessment of the MIs revealed that 'Technological Uncertainty 5' ('To what extent do you agree that you and other innovation project team members while working on the project were informed about - The required technological support for the project') had a misspecification with 'Technological uncertainty 1', 'Technological uncertainty 3', 'Technological uncertainty 4', and 'Technological uncertainty 6'. Although, 'Technological uncertainty 5' exhibited an acceptable loading of 0.874, which is the greatest factor loading among all the other items, it was considered for deletion because its measurement error is correlated with the measurement errors of four items.

Additionally, the MIs revealed that 'Technological Uncertainty 2' ('To what extent do you agree that you and other innovation project team members while working on the project were informed about - The user-friendliness of the adopted technologies in the project') had a misspecification with 'Technological uncertainty 1', and 'Technological uncertainty 4'. Although, 'Technological uncertainty 2' exhibited an acceptable loading of 0.828, which is the second greatest factor loading among all the other items, it was also considered for deletion because its measurement error is correlated with the measurement errors of two items.

The correlation between the measurement errors could suggest that these items are measuring the same thing. Therefore, deleting 'Technological uncertainty 5' and 'Technological uncertainty 2' avoids duplicate measures and improves the overall measurement model fit. It should be noted that it was decided not to delete 'Technological uncertainty 3' which has the lowest factor loading compared to the other items because deleting 'Technological uncertainty 3' worsens the fit indices with $\chi 2$ value of 62.583 (df = 5, p = 0.000), CMIN/DF 12.517. Thus, 'Technological uncertainty 3' was retained.

Accordingly, the decision was made to delete 'Technological uncertainty 2' and 'Technological uncertainty 5' based on the MIs output. An ad hoc attempt was also made to test the model fit by only excluding 'Technological uncertainty 5', the fit indices improved but were still an inadequate fit to the data with χ2 value of 21.162 (df = 5, p = 0.001), CMIN/DF 4.232, and RMSEA 0.114 though IFI, TLI, and CFI indices indicated adequate fit with 0.978, 0.955 and 0.978, respectively.

Upon deletion of 'Technological uncertainty 2' and 'Technological uncertainty 5', (as shown in Table 6.13) all the fit indices showed significant improvement which exhibited accepted loadings with reduced χ2 value from 77.188 (df = 9 and p = 0.000), CMIN/DF 8.576 to 2.916 (df = 2 and p = 0.233), CMIN/DF 1.458. Although these modifications marginally effect the overall fit statistics, they have a great impact on the overall measurement model.

The four items measuring technological uncertainty reduction were used in the seminal work of Lievens & Moenaert (2000). Consequently, technological uncertainty reduction measure is a reliable and valid measure for representing technological uncertainty reduction construct. The composite construct reliability is 0.867, which is also above the acceptable level.

Table 6.13 Summary of Initial Findings (CFA): Technological Uncertainty

| Quest. Item | Item wording | Initial Standardised Loading | Final | |
|---|---|---|---|---|
| | | | Standardised Loadings | C.R. (t) |
| Technological uncertainty1 | To what extent do you agree that you and other innovation project team members while working on the project were informed about - The quality of the applied technologies | 0.791 | 0.775 | |
| Technological uncertainty2 | To what extent do you agree that you and other innovation project team members while working on the project were informed about - The user-friendliness of the adopted technologies in the project | 0.828 | Removed | |
| Technological uncertainty3 | To what extent do you agree that you and other innovation project team members while working on the project were informed about - The cost-efficiency of the technologies used in the project | 0.779 | 0.811 | 12.645 |
| Technological uncertainty4 | To what extent do you agree that you and other innovation project team members while working on the project were informed about - The required Research & Development strategy for the project | 0.807 | 0.805 | 12.556 |
| Technological uncertainty5 | To what extent do you agree that you and other innovation project team members while working on the project were informed about - The required technological support for the project | 0.874 | Removed | |

| Quest. Item | Item wording | Initial Standardised Loading | Final | |
|---|---|---|---|---|
| | | | Standardised Loadings | C.R. (t) |
| Technological uncertainty6 | To what extent do you agree that you and other innovation project team members while working on the project were informed about - The required technical personnel for the project | 0.795 | 0.758 | 11.823 |

| Achieved Fit Indices | | | | | |
|---|---|---|---|---|---|
| | CMIN/DF (χ2/df) | RMSEA | IFI | TLI | CFI |
| Initial | 8.576 (77.188/9) | 0.175 | 0.935 | 0.892 | 0.935 |
| Final | 1.458 (2.916/2) | 0.043 | 0.998 | 0.994 | 0.998 |
| Cronbach's Alpha 0.867 and Composite Construct Reliability 0.867 | | | | | |

### 6.3.2.6 Innovation Project Performance

Innovation project performance was measured using five items and was subjected to a CFA test using AMOS to verify their dimensionality and to determine whether the initial model was an adequate fit to the data. The CFA output is provided in Table 6.14. Initial CFA analysis indicated that the initial model required modification.

As demonstrated in Table 6.14, all items exhibited high loading scores, except for 'Innovation Project Performance 3' and that the model is an inadequate fit to data based on the values of χ2, RMSEA, IFI, TLI, and CFI. Although 'Innovation Project Performance 3' ('The project operated within the pre-defined schedule') has the lowest factor loading of 0.699 compared to the other items under the innovation project performance construct, it cannot be deleted as it is an important measure in the construct. In fact, all the measures used are important and have been used in several studies, thus, all the items were retained.

Table 6.14 Summary of Initial Findings (CFA): Innovation Project Performance

| Quest. Item | Item wording | Initial Standardised Loading | Final | |
|---|---|---|---|---|
| | | | Standardised Loadings | C.R. (t) |
| Innovation Project Performance1 | The project results, or deliverables, were in line with client objectives | 0.752 | 0.752 | |
| Innovation Project Performance 2 | The project operated within the pre-estimated budget | 0.725 | 0.600 | 9.610 |
| Innovation Project Performance 3 | The project operated within the pre-defined schedule | 0.699 | 0.586 | 8.827 |
| Innovation Project Performance 4 | Stakeholders were satisfied with the project outcomes | 0.825 | 0.867 | 12.811 |

| Quest. Item | Item wording | Initial Standardised Loading | Final | |
|---|---|---|---|---|
| | | | Standardised Loadings | C.R. (t) |
| Innovation Project Performance 5 | The quality of the project output accorded with the standards | 0.775 | 0.818 | 12.398 |

| Achieved Fit Indices | | | | | |
|---|---|---|---|---|---|
| | CMIN/DF ($\chi2$/df) | RMSEA | IFI | TLI | CFI |
| Initial | 28.665 (143.323/5) | 0.334 | 0.800 | 0.597 | 0.798 |
| Final | 1.560 (4.680/3) | 0.048 | 0.998 | 0.992 | 0.998 |
| Cronbach's Alpha 0.867 and Composite Construct Reliability 0.850 | | | | | |

When assessing the MIs, the need to free the covariance parameter between the measurement error of 'innovation project performance 2' and 'innovation project performance 3' was suggested. After freeing the covariance parameter between them, the Mis further suggested the need to free the covariance parameter between the measurement error of 'innovation project performance 1' and 'innovation project performance 2'. Upon applying the Mis suggestions, (as shown in Table 6.14) all the fit indices showed perfect fit with reduced $\chi2$ value from 143.323 (df = 5 and p = 0.000), CMIN/DF 28.665 to 4.680 (df = 3 and p = 0.197), CMIN/DF 1.560.

The five-items factor measuring innovation project performance was used in previous studies (for example, Lu et al. 2015; Pinto et al. 2009). Consequently, innovation project performance is a reliable and valid measure for representing innovation project performance. The composite construct reliability is 0.850, which is also above the acceptable level.

### 6.3.3 Overall Measurement Model Fit

At this point, an individual measurement model fit test has been applied to all dependent and independent variables included in this study. In this process six items have been excluded from the individual models to achieve a better fit to the data. In this section, a test has been conducted to the overall measurement model to check its fit to the data adequacy. It tested the covariance structures for all latent variables (independent and dependent) included in this study.

Initially, all 50 items were assessed in the overall measurement model. The values for the fit indices for the initial model are presented in the first column of Table 6.15. The final overall measurement model with the 44 items was also tested, and the values of the fit indices are presented in the second column of Table 6.15.

Table 6.15 Summary of Overall (Initial and Final) Measurement Model

| Fit Indices | Overall Measurement Model | |
|---|---|---|
| | Initial (50 items) | Final (44 items) |
| $\chi 2$ | 1819.295 | 1339.237 |
| CMIN/df | 1.617 | 1.572 |
| IFI | 0.922 | 0.935 |
| TLI | 0.914 | 0.927 |
| CFI | 0.921 | 0.935 |
| RMSEA | 0.050 | 0.048 |

The values of the fit statistics justify the exclusion of the six items from the construct measures. The deletion of the items reduced $\chi 2$ values by 480.058 and enhanced IFI, TLI, CFI, and RMSEA values. Thus, the retained 44 items in construct measures suggest reasonable congruity between the measurement model and the data.

### 6.3.4 Bivariate Correlations between Latent Variables

To obtain fundamental theoretical precision from the data, first, the implied correlation matrix to the constructs in the first-order construct of the intra-organisational collabortion was generated. This matrix helped to check the convergent and discriminant validity for the five constructs in the first-order level of intra-organisational collaboration (shown in Table 6.16). First, the covariance matrix reported in Table 6.16 shows that there is a strong correlation among the five constructs, reflected by the construct of intra-organisational collaboration. However, the moderate to high level of correlation among the first-order constructs is expected confirms that they are distinct from each other (Campbell & Fiske 1959). The correlation between the first-order constructs is below the threshold of 0.85, reflecting the non-existence of redundancy among the constructs measuring intra-organisational collaboration (Campbell & Fiske 1959).

Second, an assessment of the correlations between construct meausres in the overall measurement model with the 44 retained items was conducted through SEM. The correlation matrix is in fact the implied correlation matrix which will help in assessing the convergent and discriminant validity of the measures by comparing composite reliablility scores (shown in Table 6.17) and correlation between factors.

It should be noted that this implied matrix was generated by using the online tool (in excel) provided by James Gaskin because AMOS cannot generate the implied matrix if a second-order construct is present in the model (Gaskin 2016). The covariance matrix reported in Table 6.17

shows that intra-organisational collaboration as an Independent Variable (IV) is significantly correlated with all Dependent Variables (DV's) in this study and has a moderate level of correlation. This moderate level of correlation among variables is expected to justify the discriminant validity of the measures (Campbell & Fiske 1959). It is also expected from these correlations that the model will perform well when testing the theory. Some of these correlations could be underlined when intrepreting the final hypotheses of the SEM model results in Chapter 7.

### 6.3.5 Validity of the Constructs

The validation process of the research survey instruments includes: content validity and construct validity, which are assessed to validate the uniqueness of the used measures. Content validity is the subjective evaluation of the measures associated with the face validity for informal and common sense assessment of the scales and meaures by the expert judges (Ariño 2003; Hardesty & Bearden 2004; Malhotra 2002). The research instruments of this study have been adopted from prevous studies and seminal works and this has been addressed in the previous sections. The face validity of measures has also been discussed in measurement sections (6.3.2.1 to 6.3.2.6) respectively.

As discussed in the methodology and research design chapter, convergent and discriminant validity are used to assess the construct validity (Zhu 2000). Convergent validity is described as "the extent to which the scale correlates positively with other measures of the same construct" while the discriminant validity refers to "the extent to which a measure does not correlate with other constructs from which it is supposed to differ" (Malhotra 2002 p. 294).

To assess convergent and discriminant validity of the constructs, inter-item correlations, standardised item apha, correlation coefficients, measurement of construct in CFA, and standardised loading are analysed. In assessing the convergent validity, the inter-item correlations showed that all retained items of each construct are positively correlated with moderate to high coefficients. Additionally, CFA output reported from Tables 6 to 16 clearly indicated the unidimensionality of the measures of construct measures and their convergent validity achievement.

In assessing the discriminant validity, Gaski's (1984) recommendation was adopted. This demonstrated that the correlations among composite constructs must be lower than the respective standardised composite reliablities. Accordingly, composite reliablity scores (see Table 6.18) were compared to the construct correlation (see Table 6.17), and it was concluded that no correlation coefficient among composite constructs exceeded any of the standarised composite reliabilites. The lowest reported standarised composite reliability is 0.813 while the highest coefficient correlation among composite construct was 0.751. The moderate correlations among constructs are expected and they satisfy discriminant validity of the measures. This confirmed that the measurement scales discriminate among measures that are supposed to be differemt (Campbell & Fiske 1959).

The second approach used to assess the discriminant validity is the Fornell-Larcker criterion where the square root of the average variance extracted (AVE) of each construct must be greater than the construct correlation with other latent variables. Using this approach, as shown in Table 6.17, the AVE of each latent variable is higher than its correlation with other latent variables (Fornell & Larcker 1981; White et al. 2003).

Discriminant validity was also tested separately on all the five constructs that measured intra-organisational collaboration as a second order factor while doing the CFA test using ‘validity and reliability test’ plugins developed by James Gaskin (Gaskin 2016). The CFA output is shown in Table 6.16. As indicated in Table 6.16, there are no validity concerns as the AVE is larger than the squared inter-construct correlation estimates. This shows that the indicators of each construct have more in common with the construct that they are associated with than they do with other constructs, which provides evidence of discriminant validity (Kline 2015). Thus, all the five constructs are distinct constructs but are related and can be accounted for by a common second-order construct.

Table 6.16 Summary of Findings (CFA-Validity and Reliability Test): Intra-organisational Collaboration

| | CR | AVE | MSV | MaxR(H) | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Trust | 0.832 | 0.554 | 0.524 | 0.841 | **0.744** | | | | |
| 2. Commitment | 0.890 | 0.669 | 0.415 | 0.895 | 0.644*** | **0.818** | | | |
| 3. Communication and Sharing Information | 0.883 | 0.655 | 0.624 | 0.895 | 0.724*** | 0.601*** | **0.810** | | |
| 4. Collaborative Relationship | 0.894 | 0.628 | 0.624 | 0.895 | 0.724*** | 0.554*** | 0.790*** | **0.793** | |
| 5. Collaborative Leadership | 0.904 | 0.654 | 0.610 | 0.906 | 0.719 | 0.609 | 0.756 | 0.781 | **0.809** |

Significant of correlation *** $p < 0.001$, N=249

Table 6.17 Implied Correlation Matrix

| | CR | AVE | MSV | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Intra-organisational Collaboration | 0.917 | 0.691 | 0.560 | **0.832** | | | | | |
| 2. Organisational Learning | 0.889 | 0.667 | 0.560 | 0.748*** | **0.817** | | | | |
| 3. Task Uncertainty Reduction | 0.816 | 0.531 | 0.491 | 0.673*** | 0.620 | **0.729** | | | |
| 4. Market Uncertainty Reduction | 0.858 | 0.551 | 0.491 | 0.567*** | 0.524 | 0.701*** | **0.742** | | |
| 5. Technological Uncertainty Reduction | 0.867 | 0.619 | 0.479 | 0.600*** | 0.609 | 0.691*** | 0.680*** | **0.787** | |
| 6. Innovation Project Performance | 0.854 | 0.543 | 0.530 | 0.728*** | 0.668 | 0.643*** | 0.672*** | 0.692*** | **0.737** |

Significant of correlation *** $p < 0.001$, N=249

## 6.4 Overall Results of Measurement Development

In summary, the measurement validation process together with the measurement model in CFA have been tested and reported in different sections. As a part of the measurement model validation process, a measurement model fit through CFA in AMOS was performed. The results showed that the reliablity scores were between 0.806 and 0.894, and the composite reliabity scores for all constructs were between 0.813 and 0.919.

Items that were contributed most to the lack of fit were eliminated through following Finn & Kayande (2004) in CFA. Accordingly, a total of six items were eliminated throughout the process of measurement refinement - two items in trust, two items in task uncertainty reduction, one item in market uncertainty reduction, and two items in technological uncertainty reduction were eliminated from the measures. . Finally, the measurement model for all constructs and the overall measurement model were assessed and found to meet a satisfactory level of fit to the models (summarised in Table 6.18).

Table 6.18 Summary of the Measurement Models Fit Statistics

| Fit Measures / Measurement Models | Overall Model Fit | | | | | Composite Reliablity |
|---|---|---|---|---|---|---|
| | Model Fit | | Model Comparison | | | |
| | CMIN/DF | RMSEA | IFI | TLI | CFI | |
| Intra-organisational Collaboration | 1.506 | 0.045 | 0.972 | 0.968 | 0.972 | 0.919 |
| Organisational Learning | 2.001 | 0.064 | 0.998 | 0.989 | 0.998 | 0.884 |
| Task Uncertainty Reduction | 1.397 | 0.040 | 0.998 | 0.993 | 0.998 | 0.813 |
| Market Uncertainty Reduction | 1.793 | 0.057 | 0.995 | 0.988 | 0.995 | 0.852 |
| Technological Uncertainty Reduction | 1.458 | 0.043 | 0.998 | 0.994 | 0.998 | 0.867 |
| Innovation Project Performance | 1.560 | 0.048 | 0.998 | 0.992 | 0.998 | 0.850 |

Furthermore, the dimensionality of the measures was assessed by testing and comparing the initial (using 50 items), and the final measurement model (using retained 44 items). The findings show that the retained 44 items in construct measures suggest reasonable congruity between the measurement model and the data. Additionally, removing the six items improved the values of the fit statistics (as shown in Table 6.15). The following chapter will test, analyse and discuss the structural model.

# Chapter 7: Structural Model Assessment and Hypotheses Testing

## 7.1 Overview

In the previous chapter, the sample validation and measurement models for measures of constructs were assessed. In this chapter, using 44 reliable and validated measurement items for six latent constructs, the structural model is developed and tested to assess the model fit.  First, a comparison between the levels of model fit between the measurement and SEM models is undertaken in each step to provide clearer theory-driven results. Second, SEM outputs of the structural model are reported.

To achieve the above, this Chapter firstly introduces and tests the structural model (Section 7.2). The chapter then provides a brief overview of the direct and indirect effects of the antecedents of innovation project performance (Section 7.3). This is followed by the testing and reporting of hypotheses testing (Section 7.4, and Sections 7.4.1 to 7.4.7).  The control variables: organisation size, age, industry and experience in innovation project are then tested (Section 7.5), and finally, the chapter reports the $R^2$ for all dependent variables with a summary (Section 7.6 and 7.7) concluding the chapter.

## 7.2 Structural Model Testing

As discussed in chapter 4, the importance of intra-organisational collaboration in increasing information processing within organisations has been established by a range of scholars (Gupta & Maltz 2015; Rodríguez et al. 2008; Spieth & Joachim 2017). Within this existing body of research, the significant role of intra-organisational collaboration in increasing the information processing within the organisation to reduce knowledge gaps (uncertainties) in innovation projects and to enhance innovation performance is corroborated (Gupta & Maltz 2015; Rodríguez et al. 2008; Spieth & Joachim 2017; Tushman & Nadler 1978). Additionally, the importance of reducing innovation project uncertainty in enhancing innovation project performance has also been emphasised (see for example, Alam 2006; Van Riel et al. 2004; Verworn et al. 2008; Verworn 2009). These studies are however, yet to empirically examine the impact of intra-orgaisational collaboration in reducing task, market, and technological uncertainties, and enhancing innovation performance

Moreover, previous research has emphasised the importance of intra-organisational collaboration in reinforcing organisational learning (Alegre & Chiva 2008; Bellini & Canonico 2008; Eriksson et al. 2017; To & Ko 2016), and creating appropriate background conditions for the creation and transfer of knowledge to ultimately and enhance organisational performance (Bellini & Canonico 2008). Increasing knowledge creation and transfer within organisations aids in filling the knowledge gaps (uncertainties) that are inherent in innovation projects (Tushman & Nadler 1978).

There is however, a dearth of research that has empirically examined the impact of intra-orgaisational collaboration in reducing task, market, and technical uncertainties or research into enhancing innovation performance. None of these perspectives have empirically examined this relationship while considering the role of organisational learning as a mediator between intra-organisational collaboration and innovation project uncertainty reduction. Building on the literature to fill this identified gap, a conceptual model has been derived for use in this study.

The conceptual model (outlined in Chapter 4) sought to identify the impact of intra-organisational collaboration on the reduction of task, market, and technological uncertainty for the enhancement of innovation project performance. This model also explores the role of organisational learning as a mediator in this relationship. In this section, using 44 reliable and validated measurement items for 6 latent constructs, the proposed conceptual model is tested to assess the model fit.

### 7.2.1 Testing the Conceptual Model and Fit Indices

The conceptual model consists of one independent latent variable - intra-organisational collaboration as a reflective-reflective second-order construct, and five dependent constructs - organisational learning, task uncertainty reduction, market uncertainty reduction, technological uncetainty reduction, and innovation project performance. The full model including all the indicators was tested. The fit indices of the initial SEM test for the conceptual model are presented in Table 7.1.

Table 7.1 Conceptual Model: SEM Test Output, Fit Indices and Desired Level of Fit

| **Level of Model Fit** | **Overall Model Fit** | | | | |
|---|---|---|---|---|---|
| | **Model Fit** | | **Model Comparison** | | |
| **Fit Measures** | **CMIN/DF** | **RMSEA** | **IFI** | **TLI** | **CFI** |
| Acceptable Scale for Good as well as Adequate Fit | ≤ 2 | <0.1 | ≥0.90 | ≥0.90 | ≥0.90 |
| Composed Model Fit | 1.672 | 0.052 | 0.921 | 0.915 | 0.921 |
| χ2(df) in Structural Model | | 1473.417 (881) | | | |
| χ2(df) in Measurement Model | | 1339.237 (852) | | | |

The fit indices of the model satisfy the desired level of fit, and the model is shown in Figure 7.1 with estimated standardised regression coefficients in the path links in the structural model. Statistically significant and non-significant paths are presented in black and blue respectively. The structural model from AMOS is presented in Appendix 7.1.

In summary, the conceptual model for this study reflects the relationship between intra-organisational collaboration, innovation project uncertainty reduction, organisational learning, and innovation project performance. The fit indices of the model have been assessed and found to satisfy the desired level of fit. This model is then further tested to empirically study the impact of intra-organisational collaboration in reducing task, market, and technological uncertainties, for enhancing innovation project performance and to explore the role of organisational learning as mediator in this relationship. This is achieved through testing and reporting the hypotheses of this study through the conceptual model.

Moreover, the conceptual model demonstrates direct and indirect effects between intra-organisational collaboration and organisational learning, task, market, technological uncertainty reduction, and innovation project performance. The direct effects are presented as the estimated standardised regression coefficients (see Figure 7.1).

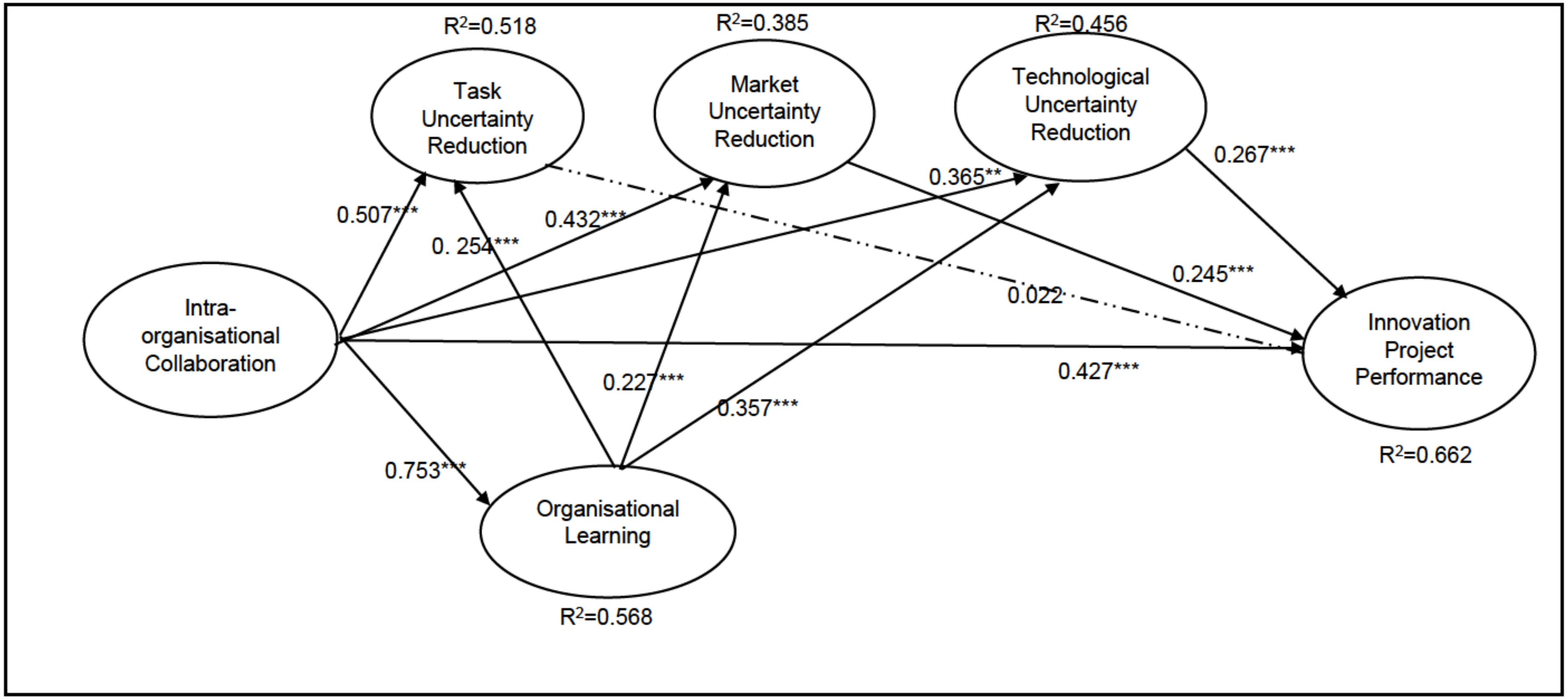


Figure 7.1 Structural Model with Standardised β value

## 7.3 Antecedents of Innovation Project Performance

The main aim of this research is to provide evidence of the impact of intra-organisational collaboration on innovation project uncertainty reduction and innovation project performance. This thesis also seeks to assess the role of organisational learning as an enabler in this relationship. The proposed model integrated five direct/indirect antecedents of innovation project performance, all uniquely predicting innovation project performance where one of them has intervening effects in the proposed model.

The conceptual model, shown in Figure 7.1 includes a standardised regression coefficient beta for all paths. However, assessing the indirect effects of the constructs on innovation project performance is paramount for explaining the causal effects of those paths in the model. Thus, all standardised indirect and unstandardised effects of the constructs are shown in Table 7.2. The path terms used in the tables are:

- COLLABORATION = Intra-organisational collaboration
- OL = Organisational learning
- TASK = Task uncertainty reduction
- MARKET = Market uncertainty reduction
- TECH = Technological uncertainty reduction
- PERFROM = Innovation project performance

The AMOS plugins provided by Gaskin et al. (2020) were used to generate the unstandardised and standardised estimates of the indirect effect paths in the tested model. Additionally, to confirm the mediation result, a bootstrapping procedure was performed with 1000 bootstrap samples and bias corrected to 95% (results shown in Appendix 7.2). The output included standardised direct and indirect effects with their significance level. The results were compared and shown to be equivalent.

Table 7.2 shows the 95% confidence interval for the effect. The 95% CI for the indirect effect is shown in the upper and lower bound of the interval. If 0 (the null) falls within the interval, it fails to reject the null. In this case, 0 falls outside the confidence interval for records 3, 5, and 6, thus the null hypothesis failed to be rejected and it is inferred that these indirect effects are statistically significant. On the other hand, 0 falls inside the confidence interval for records 1,2, and 4, thus the null is accepted, and it is inferred that these indirect effects are statistically insignificant. The significance is also shown through the p-value which is also demonstrated in Table 7.2.

Accordingly, the indirect effects of intra-organisational collaboration on task and market uncertainty reduction through organisational learning are not significantly different from zero at the 0.05 level. However, the indirect effects of intra-organisational collaboration on technological uncertainty reduction through organisational learning (0.269) is found to be significantly different from zero at the 0.1 (p=0.071).

Additionally, the indirect effect of intra-organisational collaboration on innovaton project performance through task uncertainty is not significantly different from zero at the 0.05 level. However, the indirect effects of intra-organisational collaboration on innovaton project performance through market and technological uncertainty reduction (0.106, 0.097) are found to be significantly different from zero at the 0.05 (p= 0.046 and 0.048) respectively.

Table 7.2 Indirect Effect Paths (Unstandardised and Standardised Estimates)

| Path No. | Indirect Path | Unstandardized Estimate | Lower | Upper | P-Value | Standardized Estimate |
|---|---|---|---|---|---|---|
| 1 | COLLABORATION --> OL --> TASK | 0.175 | -0.036 | 0.483 | 0.148 | 0.193 |
| 2 | COLLABORATION --> OL --> MARKET | 0.229 | -0.094 | 0.666 | 0.219 | 0.171 |
| 3 | COLLABORATION --> OL --> TECH | 0.379 | 0.057 | 0.840 | 0.071 | 0.269† |
| 4 | COLLABORATION --> TASK --> PERFROM | 0.014 | -0.134 | 0.171 | 0.622 | 0.011 |
| 5 | COLLABORATION --> MARKET --> PERFROM | 0.139 | 0.034 | 0.362 | 0.046 | 0.106* |
| 6 | COLLABORATION --> TECH --> PERFROM | 0.128 | 0.030 | 0.315 | 0.048 | 0.097* |

Significance of Estimates: *** p < 0.001, ** p < 0.010, * p < 0.050, † p < 0.100

## 7.4 Hypotheses Testing and Results

To answer the research questions posed in Chapter 1 (Section 1.4), the conceptual framework and set of hypotheses that were developed were explicated in Chapter 4 and are now assessed in this section using SEM output generated through AMOS. Accordingly, the detailed SEM results for the hypothesised path results of the study model are reported in this section to test the hypotheses. All the hypotheses with direct and indirect relationships are compiled and reported in Table 7.3 and 7.4.

Table 7.3 SEM Output for the Hypotheses with Direct Effect Paths in the Structural Model

| Hypotheses | Paths | SEM Output | | | | Result |
|---|---|---|---|---|---|---|
| | | Standardised (β) | S.E. | C.R. (t) | P | |
| **H1: Intra-organisational collaboration is positively associated with uncertainty reduction in innovation projects.** | | | | | | |
| **H1a**: Intra-organisational collaboration is positively associated with task uncertainty reduction in innovation projects. | COLLABORATION → TASK | 0.507 | 0.101 | 4.518 | *** | Supported |
| **H1b:** Intra-organisational collaboration is positively associated with uncertainty market reduction in innovation projects. | COLLABORATION → MARKET | 0.432 | 0.147 | 3.919 | *** | Supported |
| **H1c**: Intra-organisational collaboration is positively associated with technological uncertainty reduction in innovation projects. | COLLABORATION → TECH | 0.365 | 0.147 | 3.501 | *** | Supported |
| **H2:** Intra-organisational collaboration is positively associated with organisational learning. | COLLABORATION → OL | 0.753 | 0.142 | 8.105 | *** | Supported |
| **H3:** Intra-organisational collaboration is positively associated with innovation project performance. | COLLABORATION → PERFROM | 0.427 | 0.141 | 3.987 | *** | Supported |
| **H5: Uncertainty reduction is positively associated with innovation project performance.** | | | | | | |
| **H5a**: Task uncertainty reduction is positively associated with innovation project performance | TASK → PERFROM | 0.022 | 0.114 | 0.279 | 0.781 | Not Supported |
| **H5b**: Market uncertainty reduction is positively associated with innovation project performance | MARKET → PERFROM | 0.245 | 0.067 | 3.604 | *** | Supported |
| **H5c**: Technological uncertainty reduction is positively associated with innovation project performance | TECH → PERFROM | 0.267 | 0.067 | 3.722 | *** | Supported |

Table 7.4 SEM Output for the Hypotheses with Indirect Effect Paths in the Structural Model

| Hypotheses | Paths | SEM Output | | | | Result |
|---|---|---|---|---|---|---|
| | | Standardised (β) | Lower | Upper | P | |
| **H4: Intra-organisational collaboration is positively associated with uncertainty reduction in innovation projects through organisational learning.** | | | | | | |
| **H4a**: Organisational learning mediates the relationship between intra-organisational collaboration and task uncertainty reduction in innovation projects. | COLLABORATION → OL → TASK | 0.193 | -0.036 | 0.483 | 0.148 | Not Supported |
| **H4b**: Organisational learning mediates the relationship between intra-organisational collaboration and market uncertainty reduction in innovation projects. | COLLABORATION → OL → MARKET | 0.171 | -0.094 | 0.666 | 0.219 | Not Supported |
| **H4c**: Organisational learning mediates the relationship between intra-organisational collaboration and technological uncertainty reduction in innovation projects. | COLLABORATION → OL → TECH | 0.269† | 0.057 | 0.840 | 0.071 | Supported |
| **H6: Intra-organisational collaboration is positively associated with innovation project performance through uncertainty reduction.** | | | | | | |
| **H6a**: Task uncertainty reduction mediate the relationship between intra-organisational collaboration and innovation project performance. | COLLABORATION → TASK → PERFROM | 0.011 | -0.134 | 0.171 | 0.622 | Not Supported |
| **H6b**: Market uncertainty reduction mediate the relationship between intra-organisational collaboration and innovation project performance. | COLLABORATION →MARKET → PERFROM | 0.106* | 0.034 | 0.362 | 0.046 | Supported |
| **H6c**: Technological uncertainty reduction mediate the relationship between intra-organisational collaboration and innovation project performance. | COLLABORATION → TECH → PERFROM | 0.097* | 0.030 | 0.315 | 0.048 | Supported |

The reported SEM findings in Table 7.3 and 7.4 are assessed based on estimated path coefficient β value with critical ratio (C.R equivalent to t-value), and p-value to validate the hypothesised direct relationships. The estimated path coefficient β value with the p-value findings are assessed to validate the hypothesised indirect relationships (mediation effects). The standard decision rules (t-value greater than or equal to 1.96, and p value is $\leq 0.05$) is applied here to decide the significance of the path coefficient among DV and IV (Byrne 2001). It is noted that some researchers in this field, including (Anderson & Weitz 1992; Kim & Frazier 1997; Kwon & Suh 2004) state the p value $\leq 0.01$ as a marginal level of significance.

### 7.4.1 The Direct Effects of Intra-organisational Collaboration on Uncertainty Reduction in Innovation Projects

Three hypotheses have been derived as there are three key sources of innovation project uncertainties: task, market and technological. The following will report on the examined direct relationship between intra-organisational collaboration and the reduction of each uncertainty based on the SEM output.

#### 7.4.1.1 *Hypothesis 1a*: *Intra-organisational Collaboration and Task Uncertainty Reduction in Innovation Projects*

The coefficients for the direct path between intra-organisational collaboration and task uncertainty reduction (estimated standardised *β value 0.507, t-value 4.518 with* $p \leq 0.001$) strongly support hypothesis 1a. This is an indication that higher degree of intra-organisational collaboration in the organisation has a direct positive effect on the task uncertainty reduction in innovation projects.

#### 7.4.1.2 Hypothesis 1b: Intra-organisational Collaboration and Market Uncertainty Reduction in Innovation Projects

The relationship between intra-organisational collaboration and market uncertainty reduction received significant positive support in the model. The estimated coefficient path manifested standardised *β value 0.432, t-value 3.919 with p value* $\leq 0.001$. Accordingly, hypothesis 1b is supported with statistically significant results in the model. This provides evidence that a higher degree of intra-organisational collaboration has a direct positive effect on the market uncertainty reduction in innovation projects across organisation.

#### 7.4.1.3 *Hypothesis 1c: Intra-organisational Collaboration and Technological Uncertainty Reduction in Innovation Projects*

The relationship between intra-organisational collaboration and technological uncertainty reduction received significant positive support in the model. The estimated coefficient path manifested standardised β value 0.365, t-value 3.501 with p value = 0.001. Accordingly, hypothesis 1c is supported with statistically significant results in the model. This provides evidence that a higher degree of intra-organisational collaboration in the organisation has a direct positive effect on the technological uncertainty reduction in innovation projects.

### 7.4.2 The Direct Effects of Intra-organisational Collaboration on Organisational Learning

The relationship between intra-organisational collaboration and organisational learning received significant positive support in the model. The estimated coefficient path manifested standardised *β value 0.753, t-value 8.105 with p value ≤ 0.001.* Accordingly, hypothesis 2 is supported with statistically significant results in the model. The results indicate that intra-organisational collaboration with its five dimensions is fundamental to yield organisational learning in the organisation.

### 7.4.3 The Direct Effects of Intra-organisational Collaboration on Innovation Project Performance

The relationship between intra-organisational collaboration and innovation project performance received significant positive support in the model. The estimated coefficient path manifested standardised *β value 0.427, t-value 3.987 with p value ≤ 0.001.* Accordingly, hypothesis 3 is supported with statistically significant results in the model. The results indicate that intra-organisational collaboration with its five dimensions is fundamental for improving innovation project performance.

### 7.4.4 The Mediation Effects of Organisational Learning in the Relationship between Intra-organisational Collaboration and Uncertainty Reduction in Innovation Projects

Three hypotheses have been derived based on the three key sources of innovation project uncertainties: task, market and technological. The following paragraphs examine the indirect relationship between intra-organisational collaboration and the reduction of each uncertainty achieved through organisational learning based on the SEM outputs.

#### 7.4.4.1 *Hypothesis 4a: Organisational Learning Mediates the Relationship between Intra-organisational Collaboration and Task Uncertainty Reduction in Innovation Projects*

The standardised estimated path coefficient for the relationship is positive with standardised β value 0.193. The 95% CI for the indirect effect is shown in the upper and lower bound of the interval. If 0 (the null) falls within the interval, the null hypothesis failed to be rejected. In our case, Table 7.4 shows that 0 falls inside the confidence interval for records as the lower and upper bound are -0.036 and 0.483, respectively. Thus, the null hypothesis failed to be rejected and it is inferred that this indirect effect of intra-organisational collaboration on task uncertainty reduction through organisational learning is statistically not significant.

#### 7.4.4.2 *Hypothesis 4b: Organisational Learning Mediates the Relationship Between Intra-organisational Collaboration and Market Uncertainty Reduction in Innovation Projects*

The standardised estimated path coefficient for the relationship is positive with standardised β value 0.171. As shown in Table 7.4, 0 falls inside the confidence interval for records as the lower and upper bound are -0.094 and 0.666, respectively. Thus, the null hypothesis failed to be rejected and it is inferred that this indirect effect of intra-organisational collaboration on market uncertainty reduction through organisational learning is statistically not significant.

#### 7.4.4.3 *Hypothesis 4c: Organisational Learning Mediates the Relationship between Intra-Organisational Collaboration and Technological Uncertainty Reduction in Innovation Projects*

The mediation relationship that the organisational learning played between intra-organisational collaboration and technological uncertainty reduction received significant positive support in the model. The estimated coefficient path manifested standardised *β value 0.269.* Additionally, Table 7.4 shows that 0 falls outside the confidence interval for records as the lower and upper bound are 0.057 and 0.840, respectively. Thus, the null is rejected, and it is inferred that this indirect effect of intra-organisational collaboration on technological uncertainty reduction through organisational learning is statistically significant. To further analyse the type of mediation, Table 7.5 captures the path regression coefficient of the paths between intra-organisational collaboration, organisational learning, and technological uncertainty reduction and their significance.

Table 7.5 The Path Regression Coefficient and its Significance for Hypothesis 4c

| Path | | | Standardised (β) | S.E. | C.R. | P-Value | Result |
|---|---|---|---|---|---|---|---|
| COLLABORATION | → | TECH | 0.365 | 0.141 | 3.501 | 0.000 | Significant |
| COLLABORATION | → | OL | 0.753 | 0.142 | 8.105 | 0.000 | Significant |
| OL | → | TECH | 0.357 | 0.094 | 3.494 | 0.000 | Significant |

Table 7.5 shows that intra-organisational collaboration has a significant direct effect on technological uncertainty reduction (The direct effects were reduced after the mediator entered the model). Also, intra-organisational collaboration has a significant direct effect on organisational learning, and organisational learning has a significant direct effect on technological uncertainty reduction. This also implies that the organisational learning construct mediates the relationship between intra-organisational collaboration and technological uncertainty reduction. The type of mediation is 'partial mediation' since the direct effect of intra-organisational collaboration on technological uncertainty reduction is still significant with organisational learning in the model. In this case, intra-organisational collaboration has both a significant **direct effect** on technological uncertainty reduction and an **indirect effect** on technological uncertainty reduction through organisational learning.

### 7.4.5 The Direct Effects of Innovation Project Uncertainty Reduction on Innovation Project Performance

Three hypotheses were derived based on the three key sources of innovation project uncertainties: task, market and technological. The following section examines the direct relationship between each uncertainty and innovation project performance based on the SEM output.

#### 7.4.5.1 *Hypothesis 5a: Task Uncertainty Reduction and Innovation Project Performance*

The standardised estimated path coefficient for the relationship is positive with standardised β value 0.022, but it is not statistically significant as the p value = 0.781 for hypothesis 5a. The findings reject the hypothesised positive relationship between task uncertainty reduction and innovation project performance.

#### 7.4.5.2 *Hypothesis 5b: Market Uncertainty Reduction and Innovation Project Performance*

The relationship between market uncertainty reduction and innovation project performance received significant positive support in the model. The estimated coefficient path manifested standardised *β value 0.245, t-value 3.604 with p value ≤ 0.001.* Accordingly, hypothesis 5b is supported with statistically significant results in the model. The results indicate that market uncertainty reduction enhances innovation project performance.

#### 7.4.5.3 *Hypothesis 5c: Technological Uncertainty Reduction and Innovation Project Performance*

The relationship between technological uncertainty reduction and innovation project performance received significant positive support in the model. The estimated coefficient path manifested standardised *β value 0.267, t-value 3.722 with p value ≤ 0.001.* Accordingly, hypothesis 5c is supported that technological uncertainty reduction enhances innovation project performance with statistically significant results in the model.

### 7.4.6 The Mediation Effects of Innovation Project Uncertainty Reduction on the Relationship between Intra-organisational Collaboration and Innovation Project Performance

Three hypotheses have been derived based on the three key sources of innovation project uncertainties: task, market and technological. The following section examines the indirect relationship between intra-organisational collaboration and innovation project performance through the reduction of each uncertainty based on the SEM output.

#### 7.4.6.1 *Hypothesis 6a: Task Uncertainty Reduction Mediates the Relationship between Intra-organisational Collaboration and Innovation Project Performance*

The standardised estimated path coefficient for the mediation relationship is close to zero with standardised β value 0.011, and as shown in Table 7.4, 0 falls inside the confidence interval for records as the lower and upper bound are -0.134 and 0.171, respectively. Thus, the null hypothesis failed to be rejected and it is inferred that this indirect effect of intra-organisational collaboration on innovation project performance through task uncertainty reduction is statistically not significant.

#### 7.4.6.2 *Hypothesis 6b: Market Uncertainty Reduction Mediates the Relationship between Intra-organisational Collaboration and Innovation Project Performance*

The mediation relationship that the market uncertainty reduction played between intra-organisational collaboration and innovation project performance received significant positive support in the model. The estimated coefficient path manifested standardised β value 0.106 with $p$ value $< 0.05$, and as shown in Table 7.4, 0 falls outside the confidence interval for records as the lower and upper bound are 0.034 and 0.362, respectively. Thus, the null hypothesis is rejected, and it is inferred that this indirect effect of intra-organisational collaboration on innovation project performance through market uncertainty reduction is statistically significant. To further analyse the type of mediation, Table 7.6 captures the path regression coefficient of the paths between intra-organisational collaboration, market uncertainty reduction, and innovation project performance, and their significance.

Table 7.6 The Path Regression Coefficient and its Significance for Hypothesis 6b

| Path | | | Standardised (β) | S.E. | C.R. | P-Value | Result |
|---|---|---|---|---|---|---|---|
| COLLABORATION | → | PERFROM | 0.427 | 0.141 | 3.987 | 0.000 | Significant |
| COLLABORATION | → | MARKET | 0.432 | 0.147 | 3.919 | 0.000 | Significant |
| MARKET | → | PERFROM | 0.245 | 0.067 | 3.604 | 0.000 | Significant |

Table 7.6 shows that intra-organisational collaboration has a significant direct effect on innovation project performance (the direct effects has reduced after the mediator entered the model). Intra-organisational collaboration has a significant direct effect on market uncertainty reduction, and market uncertainty reduction has a significant direct effect on innovation project performance. This also implies that the market uncertainty reduction construct does mediate the relationship between intra-organisational collaboration and innovation project performance.

The type of mediation is 'partial mediation' since the direct effect of intra-organisational collaboration on innovation project performance is still significant with market uncertainty reduction in the model. In this case intra-organisational collaboration has both a significant **direct effect** on innovation project performance and **indirect effect** on innovation project performance through market uncertainty reduction.

#### 7.4.6.3 *Hypothesis 6c: Technological Uncertainty Reduction Mediates the Relationship Between Intra-organisational Collaboration and Innovation Project Performance.*

The standardised estimated path coefficient for the relationship is close to zero with standardised β value 0.097, and as shown in Table 7.4, 0 falls outside the confidence interval for records as the lower and upper bound are 0.030 and 0.315, respectively. Thus, the null hypothesis is rejected, and it is inferred that this indirect effect of intra-organisational collaboration on innovation project performance through technological uncertainty reduction is statistically significant. To further analyse the type of mediation, Table 7.7 captures the path regression coefficient of the paths between intra-organisational collaboration, technological uncertainty reduction, and innovation project performance, and their significance.

Table 7.7 The Path Regression Coefficient and its Significance for Hypothesis 6c

| Path | | | Standardised (β) | S.E. | C.R. | P-Value | Result |
|---|---|---|---|---|---|---|---|
| COLLABORATION | → | PERFROM | 0.427 | 0.141 | 3.987 | 0.000 | Significant |
| COLLABORATION | → | TECH | 0.365 | 0.147 | 3.501 | 0.000 | Significant |
| TECH | → | PERFROM | 0.267 | 0.066 | 4.008 | 0.000 | Significant |

Table 7.7 shows that intra-organisational collaboration has a significant direct effect on innovation project performance (the direct effects reduced after the mediator entered the model). In addition, intra-organisational collaboration has a significant direct effect on technological uncertainty reduction, and technological uncertainty reduction has a significant direct effect on innovation project performance. This also implies that the technological uncertainty reduction construct mediates the relationship between intra-organisational collaboration and innovation project performance.

The type of mediation is 'partial mediation' since the direct effect of intra-organisational collaboration on innovation project performance is still significant with technological uncertainty reduction in the model. In this case intra-organisational collaboration has both a significant **direct effect** on innovation project performance and **indirect effect** on innovation project performance through technological uncertainty reduction.

## 7.5 Testing for Control Variables: Organisation Size, Age, Industry, and Experience in Innovation Project

All the relationships between the control variables (organisation size, age, industry, and experience in innovation project) and dependent (dependent) variables (organisational learning, task uncertainty reduction, market uncertainty reduction, technological uncertainty reduction, and innovation project performance) are statistically insignificant. As shown in Table 7.8, the p value is > 0.05 for all the relationships. Accordingly, organisation size, age, industry and experience in innovation project do not affect the relationships in the complex model.

Table 7.8 Testing for Control Variables

| Sub Hypotheses | Paths | Standardised (β) | S.E. | C.R. (t) | P |
|---|---|---|---|---|---|
| Organisation Size (Controlling for Organisation Size) | Org Size → OL | -0.059 | 0.072 | -0.811 | 0.417 |
| | Org Size → TASK | -0.031 | 0.045 | -0.680 | 0.496 |
| | Org Size → MARKET | -0.028 | 0.071 | -0.389 | 0.697 |
| | Org Size → TECH | 0.058 | 0.072 | -0.809 | 0.419 |

| Sub Hypotheses | Paths | Standardised (β) | S.E. | C.R. (t) | P |
|---|---|---|---|---|---|
| | Org Size → PERFROM | -0.123 | 0.058 | -1.736 | 0.083 |
| Organisation Age (Controlling for Organisation Age) | Org Age → OL | -0.069 | 0.075 | -0.919 | 0.358 |
| | Org Age → TASK | 0.032 | 0.047 | 0.692 | 0.489 |
| | Org Age → MARKET | 0.010 | 0.074 | 0.129 | 0.897 |
| | Org Age → TECH | -0.099 | 0.075 | -1.325 | 0.185 |
| | Org Age → PERFROM | 0.037 | 0.060 | 0.617 | 0.537 |
| Industry (Controlling for Industry) | Industry → OL | 0.005 | 0.007 | 0.636 | 0.525 |
| | Industry → TASK | -0.002 | 0.005 | -0.493 | 0.622 |
| | Industry → MARKET | -0.001 | 0.007 | -0.143 | 0.886 |
| | Industry → TECH | -0.010 | 0.007 | -1.322 | 0.186 |
| | Industry → PERFROM | -0.007 | 0.006 | -1.211 | 0.226 |
| Experience in Innovation Project | Experience → OL | 0.022 | 0.042 | 0.532 | 0.595 |
| | Experience →TASK | -0.027 | 0.026 | -1.039 | 0.299 |
| | Experience → MARKET | -0.029 | 0.041 | 0.695 | 0.487 |
| | Experience → TECH | -0.045 | 0.041 | -1.090 | 0.276 |
| | Experience →PERFORM | 0.053 | 0.033 | 1.587 | 0.112 |

## 7.6 Reporting $R^2$ for all Dependent Variables

Finally, $R^2$ values for all dependent (dependent) variables are reported in Table 7.9. Table 7.9 shows that more than 50% of the variances for task uncertainty reduction, organisational learning, and innovation project performance are explained by the variables in the model. Additionally, 38.5% and 45.6% of the variances for market uncertainty reduction and technological uncertainty reduction are explained by the variables in the model, respectively.

Table 7.9 $R^2$ Values for all Dependent Variables

| Dependent Variable | $R^2$ |
|---|---|
| Task Uncertainty Reduction | 0.518 |
| Market Uncertainty Reduction | 0.385 |
| Technological Uncertainty Reduction | 0.456 |
| Organisational Learning | 0.568 |
| Innovation Project Performance | 0.662 |

## 7.7 Summary

In this chapter, using 44 reliable and validated measurement items for six latent constructs, the model was derived, and tested to assess the model fit. After testing and confirming that the model met the model fit acceptance criteria, the decision was made to use it for the research hypotheses testing.

The model was tested using SEM to assess all the hypotheses and the results were reported. Ten out of fourteen hypotheses in the model were found to be statistically significant. The remaining four hypotheses were found to be non-significant. Additionally, it was found that the control variables organisation size, age, industry, and experience in innovation project do not affect the relationships in the complex model. The following chapter will discuss the finding of the hypotheses testing.

# Chapter 8: Discussion

## 8.1 Overview

In the previous chapter, the SEM results were demonstrated for the six main hypotheses of this research. In this chapter, all the paths in the structural model are discussed in terms of their theoretical implications. This Chapter firstly discusses the reported results for all the tested hypotheses as well as the control variables testing (Section 8.2 and Sections 8.2.1 to 8.2.7). The chapter closes with a summary (Section 8.3).

## 8.2 Discussion of Results

In the following sections, the results pertaining to each of the main hypotheses are discussed. Additionally, the results are linked to previous studies.

### 8.2.1 Intra-organisational Collaboration and Uncertainty Reduction in Innovation Projects (Task, Market and Technological)

First, the results showed that intra-organisational collaboration with its five dimensions reduce task uncertainty in innovation projects. This study thus lends support to a series of conceptual as well as theoretical assertions. While this brings new empirical evidence to the literature, it is consistent with the theoretical argument that innovation projects with higher task uncertainty require higher information processing which can be achieved through intensive communication and sharing information between cross functional team members (Tushman & Nadler 1978). This is also aligned with the findings of Gemser & Leenders (2011) that stressed the importance of information processing and knowledge generation for the successful execution of risky tasks in innovation projects.

The results also validate the argument that intra-organisational collaboration aids innovation project team members to process more information for a better understanding of uncertain tasks and the interdependencies among them (Jiménez-Jiménez & Sanz-Valle 2011; Moenaert et al. 1995; Montoya-Weiss & O'Driscoll 2000; Yan & Dooley 2013). The challenging nature of innovation projects necessitates the need for expertise input from diverse functional units to exchange information, generate new ideas to solve problems and accomplish needed tasks (Lin et al. 2015b). The findings also accord with Yan & Dooley's (2013) assertion that intra-organisational collaboration facilitates a greater understanding of an uncertain task environment and adds value for integrating activities since task interdependencies are more easily identified in a timely manner.

Secondly, the study found that intra-organisational collaboration with its five dimensions reduce relevant market uncertainty in relation to innovation projects. The results corroborate the findings of a previous study that emphasised the importance of intra-organisational collaboration in enabling the transmission of complex and often tacit customer preferences into actual customer solutions (Eisenhardt & Tabrizi 1995; Ghosh et al. 2006). For example, through communicating and sharing information among manufacturing and marketing units within the organisation. This communication and sharing information enables a clear common understanding of customer needs and requirements across both teams. Sharing knowledge within functional units improves their forecasting of market demands and potential changes (Bendoly et al. 2012; Kwon & Suh 2004). Such knowledge sharing is fundamental to reduce the mismatch between what is needed in the market and what is developed.

The findings reflect the results of Gupta et al. (1986) who showed that the knowledge gap related to customer demand necessitates greater integration among marketing and R&D in order to meet customer requirements. Such a gap can only be closed through effective communication and information processing among these functional units (Li & Calantone 1998; Tsai & Hsu 2014). The findings are consistent with that of Cao & Zhang (2011) and Yan & Dooley (2013) who argued that intra-organisational collaboration facilitates information sharing and processing that is conducive to the accurate prediction of demand and market changes, and aids in the reduction of potential errors. The findings also reflect the ideas of Jalonen (2012), who suggested that high information processing increases the chance that innovation meets customer and market needs, as customer and market information can be processed.

Thirdly, the results state that intra-organisational collaboration with its five dimensions have a positive effect on technological uncertainty reduction in innovation projects. The findings align with those of previous studies such as De Luca & Atuahene-Gima (2007), who suggest that intra-organisational collaboration reduces technological uncertainty through the increase of information processing. The results corroborate the ideas of Kwon & Suh (2004) and Love & Roper (2009), who showed that intra-organisational collaboration benefits innovation performance, particularly in the technical stages of product design, product development, and product engineering. The findings are also accord with recent studies indicating the significance of intra-organisational collaboration in strengthening responsiveness in a timely manner which accelerates the technical problem-solving process (Um & Kim 2018). These findings also point to the opportunity for innovation project team members to enhance their abilities to handle technologically complicated tasks through intra-organisational collaboration (Zhang & Tang 2017).

A possible explanation for the positive relationship between intra-organisational collaboration and technologial uncertainty reduction, may be the integration of technical capabilities among the organisational functional units that enhances their technical knowledge and understanding (De Luca & Atuahene-Gima 2007). Additionally, the results may be explained by the fact that intra-organisational collaboration enhances a team’s ability to handle technologically complicated tasks and to understand product design and development (Zhang & Tang 2017). It also promotes the formation of novel ideas and integration of knowledge in a multi-functional work environment (Jugend et al. 2018).

In summary, this research provides empirical evidence of the effectiveness of intra-organisational collaboration with its five dimensions in reducing task, market, and technological uncertainty in innovation projects. The findings are consistent with previous theoretical studies that suggested collaboration is crucial to fill the task, market and technological knowledge gaps inherent in innovation projects. However, most of the previous studies have assumed the positive impact of intra-organisational collaboration on task, market and technological uncertainty reduction with no empirical evidence. This study provides empirical evidence of the positive impact of intra-organisational collaboration in enhancing a project team's understanding of technical and market requirements, and reducing the time for problem-solving and task completion. This study complements the previous theoretical studies with empirical evidence.

### 8.2.2 Intra-organisational Collaboration and Organisational Learning

The study found that intra-organisational collaboration enables organisational learning in organisations. This study thus lends support to a series of existing conceptual and theoretical assertions. This brings new empirical evidence to the literature in the context of innovation projects, as it validates the existing theoretical position on the importance of collaborative practices in enhancing organisational learning. It is therefore consistent with the conceptual argument that intra-organisational collaboration reinforces explorative learning and perfection (Alegre & Chiva 2008; Bellini & Canonico 2008; Eriksson et al. 2017; To & Ko 2016).

The results also support Mir & Rahaman's (2003) explanation of how collaboration between diverse organisational functional units aids in creating new knowledge and understandings within the organisation. The findings confirm that through intra-organisational collaboration, the flow of information and knowledge transfer routines are improved (Schildt et al. 2012; Tsai 2002), while accumulated knowledge is exploited and used in the innovation process (Brookes et al. 2006). The findings are also consistent with those of Bellini & Canonico (2008) who stated that intra-organisational collaboration aids in creating the appropriate background conditions for the transfer and creation of knowledge.

The results complement the majority of the conceptual arguments such as Sorenson (2003) who argued that intra-organisational collaboration enhances organisational learning with empirical validation. A project environment that is based on collaborative relationships, leadership, trust, commitment, communication and sharing of information between diverse functional units is conducive to acquiring capacities and skills, hence enhancing organisational learning (Fanousse et al. 2021b). A possible explanation for the results may be that effective knowledge creation is not likely to be achieved through a formal hierarchy and centralised controlled structure (Lin et al. 2015b), rather, it can be achieved through the synthesis of different individuals' perspectives from the diverse functional units (De Luca & Atuahene-Gima 2007; Grant 1996). Additionally, the collaborative interactions within organisations enhance the knowledge transfer that expand both tacit and explicit knowledge (de Vasconcelos Gomes et al. 2021; Lakemond et al. 2016). This is in turn enhances the organisational knowledge base (Gkypali et al. 2017).

### 8.2.3 Intra-organisational Collaboration and Innovation Project Performance

The results showed that intra-organisational collaboration enhances the performance of innovation projects. The findings support the majority of previous empirical work that proved that intra-organisational collaboration enhances innovation project performance (see for example, Cao & Zhang 2011; De Luca & Atuahene-Gima 2007; Ernst et al. 2010; Hise et al. 1990; Olson et al. 2001; Troy et al. 2008; Zeller 2002). The focus of all these previous studies was NPD or process innovation projects context, in which intra-organisational collaboration was studied as a first-order construct. The current study expands the context to include product, process, marketing, and business model innovation from different industries and considers the multi-dimensional nature of intra-organisational collaboration through a second-order construct.

The findings of this study support recent and seminal research regarding the significance of intra-organisational collaboration as a key success factor in innovation projects (see for example, Bendig et al. 2018; Cooper 2019; de Vasconcelos Gomes et al. 2021; Lakemond et al. 2016). The findings are also aligned with Becker and Lilemark’s (2006) work, which showed that the strong motivation of intra-organisational collaboration in innovation projects is an expected benefit in innovation performance.

A possible explanation for this might be that innovation projects require multidisciplinary processes which necessitates the involvement of heterogeneous functional units, high levels of interaction, and information sharing to be established effectively (Lu et al. 2017; Olson et al. 2001). Another possible explanation is that the need for intra-organisational collaboration increases in cases where the innovation projects involve reciprocal task interdependencies between departments (Galbraith 1973; Tushman & Nadler 1978). Additionally, the five dimensions of intra-organisational collaboration pave the way for more successful innovation projects since trust improves the quality of information sharing, commitment cultivates the learning within the organisation, and collaborative leaders build teams with positive synergy and synchronised resources and decisions (Fanousse et al. 2021b). A collaborative relationship also serves as a catalyst for superior business acumen between multiple stakeholders within an organisation, and communication and sharing information increases the rate of success of innovation projects (Cooper 2019). Intra-organisational collaboration boosts the quality of the project team's teamwork and cohesiveness, which in turn enhances the performance of high complexity projects (Cserháti & Szabó 2014; Gölgeci et al. 2019; Suprapto et al. 2015).

### 8.2.4 The Mediation Role of Organisational Learning in the Relationship Between Intra-organisational Collaboration and Innovation Project Uncertainty Reduction (Task, Market and Technological)

First, the results showed that the organisational learning construct does not mediate the relationship between intra-organisational collaboration and task uncertainty reduction. This study could not confirm the theoretical expectation of Brookes et al. (2006) who suggested that through intra-organisational collaboration, accumulated knowledge will be exploited and used to reduce innovation project uncertainty. Furthermore, this empirical finding is not aligned with the seminal theoretical works of Galbraith (1974) and Tushman & Nadler (1978) who hold that the collaboration between the different functional units within the organisation is required to generate the knowledge that fills the task knowledge gaps in innovation projects. It should be noted here that most of these theoretical expectations and discussions have not been empirically tested and validated. A possible explanation for this result is that existing capacities and skills sometimes cannot help in performing novel tasks in innovation projects since novel tasks require continuous learning (Leuteritz et al. 2017). The spontaneous learning and knowledge generated from trial-and-error in innovation projects are fundamental to cope with novel task uncertainty (Dotson 2016).

Secondly, the findings did not support the theoretical position that organisational learning mediates the relationship between intra-organisational collaboration and market uncertainty reduction. The findings are therefore contrary to previous studies which have suggested that intra-organisational collaboration can reduce market uncertainty (information gap about the competitors and customers) through knowledge sharing and exploitation (Bendoly et al. 2012; Gupta et al. 1986; Li & Calantone 1998; Lievens & Moenaert 2000; Tsai & Hsu 2014). Previous studies have also suggested that the only way to close the market information gap is through knowledge sharing and exploitation among functional units such as marketing and R&D (Li & Calantone 1998; Tsai & Hsu 2014). However, this research calls this into question. There are several explanations for this result. It is possible that organisational learning might be effective in reducing market uncertainty if it stems from the knowledge gathered from external collaboration rather than internal collaboration (Bustinza et al. 2019) - through external collaboration, risks are shared and reduced (Sampson 2007). Another possible explanation is that market uncertainty necessitates an experiential 'trial-and-error' learning approach to conceptualisation and implementation which might be more effective in reducing market uncertainty than organisational learning (Sosna et al. 2010).

Thirdly, the results demonstrate that organisational learning mediates the relationship between intra-organisational collaboration and technological uncertainty reduction in innovation projects. The result brings new empirical evidence to the literature in the context of innovation projects. It is however, consistent with the conceptual argument that organisational learning results from intra-organisational collaboration facilitating the reduction of technological uncertainty in innovation projects (Gkypali et al. 2017). The findings corroborate the ideas of Lievens & Moenaert (2000), who suggested that project team members, through communication and sharing information, can reduce technology uncertainty by building joint knowledge. The findings are also consistent with the theoretical expectations of Brookes et al. (2006), who suggested that intra-organisational collaboration enhances the learning process that is essential for managing technological complexities. The findings also reinforce the theoretical position of de Vasconcelos Gomes et al. (2021) that intra-organisational collaboration enhances the internal learning and knowledge base of the firm, which in return improves the organisation's technological innovation potential. All the theoretical expectations and discussions on the mediating role of organisational learning in the relationship between intra-organisational collaboration and technological uncertainty reduction however, lacked empirical evidence. This is now generated through this study.

A possible explanation for this result is that intra-organisational collaboration enhances a team's ability to handle technologically complicated tasks (Zhang & Tang 2017) through the formation of novel ideas and integration of knowledge in a multi-functional work environment (Jugend et al. 2018). The challenging nature of innovation projects necessitates the input of expertise from diverse functional units to exchange information, generate new ideas to solve problems and accomplish required tasks (Lin et al. 2015b). Another possible explanation is that intra-organisational collaboration allows functional units to decide the relevancy of the accessed information, compile the relevant information, and to finally exploit it in different contexts (García-Morales et al. 2012; Luo et al. 2006; Zhao 2021).

### 8.2.5 Uncertainty Reduction (Task, Market and Technological) and Innovation Project Performance

First, the results did not support the hypothesis that task uncertainty reduction enhances innovation project performance. This result is not aligned with Galbraith (1974) and Tushman & Nadler (1978), who suggested that reducing the task knowledge gap yields a higher performance. A possible explanation for this might be that reducing task uncertainty will help in accomplishing innovation project tasks and the overall project (Lin et al. 2015b), but it might not necessarily improve the project performance or the success rate of innovation projects. There are lots of examples of projects that failed in spite of accomplishing all the tasks involved in the project. For example, *Google Glass* was a failure as a mass-market product despite accomplishing all the tasks involved. Its failure was simply due to the public not being happy with its uses and risks regarding privacy (Hong 2013; Klein et al. 2020; Zuraikat 2020). Another example is Microsoft Zune that was launched in 2006 but failed because of poor marketing strategies (Brown 2019). Another possible explanation might be that in reducing task uncertainty team performance is reduced, whereas highly challenging tasks increase team performance and this positively affects project performance in terms of time, cost and quality (Kim & Burton 2002).

To Further understand this result, a path was added from task uncertainty reduction to market and technological uncertainty reduction and results showed statistically significant results. The estimated coefficient paths manifested standardised $\beta$ value 0.624 and 0.533 respectively, with p value $\leq$ 0.001. Therefore, the non-significant results of the relationship between task uncertainty reduction and innovation project performance could be explained by the idea that reducing task uncertainty might not directly enhance project performance but it reduces market and technological uncertainty, which would eventually enhance the performance (see Appendix 8.2).

Secondly, the findings supported the hypothesis that market uncertainty reduction enhances innovation project performance. These findings support the theoretical and empirical position of previous studies that the reduction of market uncertainty in innovation projects enhances innovation project performance. For example, this finding supports the argument of Bendoly et al. (2012) and Li & Calantone (1998) that decreasing the mismatch between what is needed in the market and what is developed enhances the NPD performance. Additionally, the findings corroborate the findings of previous work that empirically proved the positive relationship between market uncertainty reduction in innovation projects and overall project success (Alam 2006; Moenaert et al. 1995; Van Riel et al. 2004; Verworn et al. 2008; Verworn 2009). All these past findings are however, based on NPD or process innovation projects while this research considered other types of innovation projects.

A possible explanation for this result is that market uncertainty effects both product launch proficiency as well as market forecast accuracy, and moderates prototype development and the frequency of design change (Souder et al. 1998). Thus, the findings of this research and those of previous empirical studies (Alam 2006; Moenaert et al. 1995; Van Riel et al. 2004; Verworn 2009; Verworn et al. 2008) confirm that reducing market uncertainty in innovation projects is crucial for promoting performance and success.

Thirdly, the findings direct relationship between technological uncertainty reduction and innovation project performance agreed with the theoretical and empirical position of previous studies. For example, the findings support previous work that empirically proved the positive relationship between technological uncertainty reduction and overall project success in NPD projects (Alam 2006; Moenaert et al. 1995; Van Riel et al. 2004; Verworn et al. 2008; Verworn 2009). This study expands the context to include other types of innovation projects in addition to product innovation (process, marketing and business model innovation).

A possible explanation for the above finding is that a high level of technological uncertainty, in for example the frequency of change in the design process, exerts a negative influence during innovation projects (Souder et al. 1998). Another possible explanation is that technological uncertainty yields major difficulties in innovation projects (Frishammar et al. 2010). Additionally, if technological uncertainty is not sufficiently reduced, it forces project members to take larger risks that increase the probability of failure (Weick 1995). Thus, based on the findings of this research and the findings of previous empirical studies (Alam 2006; Moenaert et al. 1995; Van Riel et al. 2004; Verworn 2009; Verworn et al. 2008), reducing technological uncertainty in innovation projects is crucial for promoting performance and success.

In a nutshell, the findings did not support the idea that task uncertainty reduction enhances innovation project performance, however, they did support the idea that market and technological uncertainty reduction do. These findings are not surprising as they are consistent with previous studies who prioritised the reduction of market and technological uncertainty to enhance the success of innovation projects (see for example, Alam 2006; Clark & Fujimoto 1991; Souder & Moenaert 1992; Van Riel et al. 2004; Verworn et al. 2008; Verworn 2009). Additionally, recent works by de Vasconcelos Gomes et al. (2021) and Gomes et al. (2018) emphasised the importance to the innovation's success of overcoming market and technological uncertainty.

### 8.2.6 The Mediation Role of Innovation Project Uncertainty Reduction in the Relationship between Intra-organisational Collaboration and Innovation Project Performance

First, the findings did not support the mediating role of task uncertainty reduction in the relationship between intra-organisational collaboration and innovation project performance. The findings are inconsistent with the conceptual arguments of Galbraith (1974), Moenaert et al. (1995), and Tushman & Nadler (1978), who theorised that reducing the task knowledge gap through the collaboration of the organisational functional units yields a higher performance. The result of the current study was expected based on the previous results which did not support the direct relationship between task uncertainty reduction and innovation project performance. As explained in section 8.2.5, reducing task uncertainty that results from intra-organisational collaboration, is required to accomplish the tasks (Lin et al. 2015b), yet does not guarantee a higher performance in innovation project.

Secondly, the results supported the hypothesis that market uncertainty reduction mediates the relationship between intra-organisational collaboration and innovation project performance. While there is no extant empirical support in the literature for this indirect relationship, these results relate to the theoretical position that market uncertainty reduction that results from intra-organisational collaboration, in fact facilitates the enhancement of innovation project performance (Galbraith 1974; Tushman & Nadler 1978). The results also corroborate the idea that high information processing results from collaboration aids in anticipating market uncertainty (de Vasconcelos Gomes et al. 2021; Eisenhardt & Tabrizi 1995).

The findings confirm the suggestions of previous studies regarding the importance of establishing a project environment that involves effective information sharing among cross-functional teams (Gupta & Maltz 2015; Rodríguez et al. 2008; Spieth & Joachim 2017). This is because such an environment encourages early uncertainty detection and effective management of identified uncertainties in complex projects (Oehmen et al. 2014). This, as a result, enhances the performance of innovation projects. A possible explanation for this might be that high levels of information processing resulting from collaboration, increase the chance that the innovation will meet customer and market needs, since customer and market information can be processed (Jalonen 2012; Souder & Moenaert 1992). Additionally, the high level of market uncertainty causes delays, reduced willingness to invest in R&D or expansion of incompatible innovation capabilities (Gomes et al. 2018). Hence, the earlier the identification of the risks, the less time and cost consumption are required for mitigation (Cuijpers et al. 2011).

Thirdly, the results supported the hypothesis that technological uncertainty reduction mediates the relationship between intra-organisational collaboration and innovation project performance. While there is no extant empirical research in the literature that has studied this indirect relationship, the findings are consistent with previous studies which have suggested that technological uncertainty reduction leads to enhancing the performance of innovation projects (see for example,  Alam 2006; Clark & Fujimoto 1991; Souder & Moenaert 1992; Van Riel et al. 2004; Verworn et al. 2008; Verworn 2009). A possible explanation for these results is that collaboration strengthens responsiveness in a timely manner which accelerates the problem-solving process and enables products to be launched faster than competitors can achieve (Um & Kim 2018). Additionally, intra-organisational collaboration ensures that marketing, technical, and other functional capabilities are integrated to develop a result that accords with customer needs, which is an important indicator of project performance (De Luca & Atuahene-Gima 2007).

### 8.2.7 Control Variables: Organisation Size, Age, Industry and Experience in Innovation Projects

The findings showed that organisation size, age, industry and experience in innovation projects do not affect the relationships in the complex model. This means using organisation size, age, industry and experience in innovation project, as control variables does not confound the relationships between intra-organisational collaboration, organisational learning and both innovation project uncertainty reduction and performance.

## 8.3 Summary

In this chapter the findings of testing the developed hypotheses were analysed and discussed. The analysis of testing the hypotheses in the model showed that innovation project uncertainty reduction (task, market, and technological) is a dependent variable that is impacted directly by intra-organisational collaboration. Additionally, the testing found that technological uncertainty reduction is influenced indirectly by intra-organisational collaboration through organisational learning. However, task and market uncertainty reduction are not influenced indirectly by intra-organisational collaboration via organisational learning.

Innovation project performance as the ultimate dependent variable is influenced directly by intra-organisational collaboration, market, and technological uncertainty reduction. In addition, it is influenced indirectly by intra-organisational collaboration through market and technological uncertainty reduction. Moreover, organisation size, age, industry and experience in innovation project do not confound the relationships specified in this model. In summary, the following direct and interrelated path relationships in the proposed model that were found to be significant are presented in Figure 8.1 and the same model from AMOS is presented in Appendix 8.1.

The significant findings of the model can be represented in the following equations:

Task uncertainty reduction = * Intra-organisational collaboration + e

Market uncertainty reduction = * Intra-organisational collaboration + e

Technological uncertainty reduction = * Intra-organisational collaboration + *organisational learning + e

Innovation project performance = *Intra-organisational collaboration+*market uncertainty reduction +*technological uncertainty reduction + e

The total effect of intra-organisational collaboration on innovation project performance = total direct effect + total indirect effects = 0.437+ 0.432* 0.250+ 0.365*0.271 = 0.63855

In summary, the research provided empirical evidence of the effectiveness of intra-organisational collaboration in enhancing organisational learning, reducing innovation uncertainty (task, market and technological), and improving the performance of innovation projects. Baron & Kenny (1986) defined the mediation as a variable and multiple variables that explain the relation between a predictor and an outcome. Building on this definition, this research determined that market and technological uncertainty reduction were able to explain the effect of intra-organisational collaboration on enhancing innovation project performance, but task uncertainty reduction could not. Additionally, organisational learning was able to explain the relationship between intra-organisational collaboration and technological uncertainty reduction, however, it could not explain the same relationship with task and market uncertainty reduction. Above and beyond the mediation effects of organisational learning and market and technological uncertainty reduction, there are still direct effects between intra-organisational collaboration and uncertainty reduction (task, market and technological), and organisational learning and innovation project performance. The research also showed that investing in market and technological uncertainty reduction is more important than task uncertainty reduction as it results in a greater positive impact on innovation project performance. Finally, the research showed that 66.4% of the variability of innovation project performance is explained through the direct and indirect effects of intra-organisational collaboration with the total effects of intra-organisational collaboration on innovation project performance being 0.639. This research provides empirical evidence of the positive impact of intra-organisational collaboration on innovation project uncertainty reduction and innovation project performance, whilst accounting for the role of organisational learning in the context of innovation projects. The next chapter will summarise the findings of this research and address the theoretical and practical implications along with the contributions.

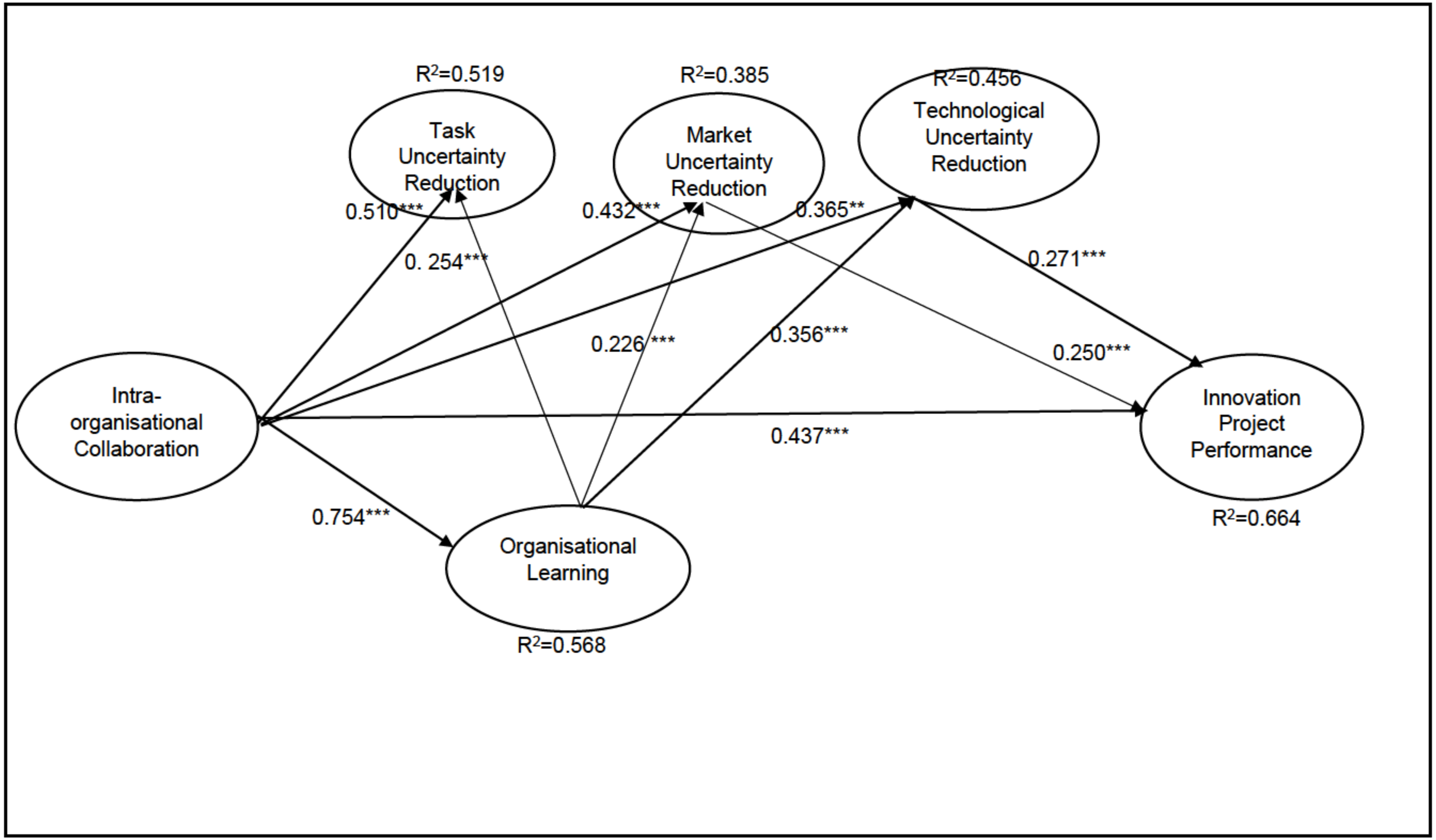


Figure 8.1 Structural Model with Only Significant Paths

# Chapter 9: Conclusion

## 9.1 Overview

This thesis has provided an empirical investigation of the impact of intra-organisational collaboration on innovation project uncertainty reduction and innovation project performance. This thesis has incorporated theoretical reasoning from two organisational theories: organisational information processing theory and organisational learning theory in a new research setting. The main research questions underpinning this research were: (i) what is the impact of intra-organisational collaboration on reducing innovation project uncertainty and enhancing performance and (ii) what is the role of organisational learning in this relationship? The fundamental objective of this research was to develop a conceptual framework, based on the antecedents of enhanced innovation project performance and their interrelationships, for empirical testing.

To address the main research question and to fulfil the research objectives, a thorough review of potentially useful theories and the relevant literature was conducted. Chapters 2 and 3 identified the three dominant sources of innovation project uncertainty, the five main dimensions of intra-organisational collaboration and that organisational learning is a major outcome of intra-organisational collaboration. The review streams were merged in Chapter 4, and in Chapter 5 a quantitative research model was developed for empirical testing. The quantitative model was tested in Chapter 6 using the collected primary data, and the results reported and discussed in Chapters 7 and 8. The findings of this research are summarised in this chapter to address the theoretical and practical implications along with the contributions of this research. This chapter concludes with a discussion of the limitations of the research and future research directions.

## 9.2 Thesis Summary

Innovation enables an organisation to be competitive and grow in an evolving global environment. However, failure rates in innovation projects are high, with devastating consequences, costing many millions of dollars (Marwa & Zairi 2008). Both academics and practitioners agree that uncertainty in innovation projects is one of the reasons for the failure of innovation projects (Lee & Veloso 2008; Yang et al. 2014).

Uncertainty has long been an area of concern in organisation theory literature (Thanasopon et al. 2016), commonly defined as inherent knowledge gaps within innovation projects (Galbraith 1974; Lee & Veloso 2008; Rosenberg 1988). The need to close such gaps to reduce uncertainty is thus recognised as fundamental to the innovation process, and crucial for improving performance and success (Alam 2006; Moenaert et al. 1995; Van Riel et al. 2004; Verworn 2009; Verworn et al. 2008).

There have been significant efforts in previous research to theorise ways of reducing uncertainty, however, there remains a limited empirical understanding of specific organisational practices that may reduce innovation project uncertainty and boost project performance. This research responds to this paucity of knowledge by empirically examining the impact of intra-organisational collaboration on innovation project uncertainty reduction and innovation project performance, whilst considering the mediating role of organisational learning. To achieve this, two theories were utilised, namely, organisational information processing theory and organisational learning theory. Further, a thorough review of the literature was conducted to identify the dominant sources of innovation project uncertainty and the main dimensions of intra-organisational collaboration in the context of innovation project.

The literature review revealed three dominant sources of innovation project uncertainty, these are task, market, and technological uncertainty. Additionally, five dimensions of intra-organisational collaboration were identified: collaborative relationship, collaborative leadership, communication and sharing information, trust formation, and commitment. Further, the review revealed organisational learning as a major outcome of intra-organisational collaboration. A research model was developed to empirically validate the proposed effects of intra-organisational collaboration on both innovation project uncertainty reduction and innovation project performance, and at the same time taking into account the mediating role of organisational learning in this relationship.

To achieve the research objectives, data were collected from innovation project professionals around the globe through an anonymous survey shared via LinkedIn. The number of usable responses considered in the data analysis was 249 responses. The conceptual model was tested using SEM by AMOS 26.0.0 and showed a very good model fit (CMIN=1.672, IFI=921, TLI=915, CFI=921, and RMSEA=.052). Chapter 7 and 8 details the findings of the model testing. Among the hypothesised paths in the conceptual model, ten paths were found to be significant and theoretically justified. In brief, the SEM results revealed that intra-organisational collaboration reduces task, market, and technological uncertainties (supporting ***H1a**, **H1b, H1c,*** respectively). The results confirmed that intra-organisational collaboration is a positive predictor of organisational learning and innovation project performance (supporting ***H2** and **H3,*** respectively). Moreover, organisational learning was found to mediate the impact of intra-organisational collaboration on technological uncertainty reduction in innovation projects (supporting ***H4c***). However, the mediation effect of organisational learning on the relationships between intra-organisational collaboration and task and market uncertainty reduction were not supported by the results. Moreover, as predicted, market and technological uncertainty reduction are positively associated with innovation project performance (supporting ***H5b** and **H5c***). Nevertheless, the research did not find any support for the positive impact of task uncertainty reduction on innovation project performance. Furthermore, the results supported the mediation impact of market and technological uncertainty reduction in the relationship between intra-organisational collaboration and innovation project performance (supporting ***H6b** and **H6c***). However, the research found no evidence of the mediation role of task uncertainty reduction in the relationship between intra-organisational collaboration and innovation project performance. This result was expected as the direct impact of task uncertainty reduction on innovation project performance is statistically not significant. Finally, the results demonstrated that the control variables: organisation age, size, industry and experience in innovation projects do not confound the relationships between intra-organisational collaboration, organisational learning and both innovation project uncertainty reduction and performance.

## 9.3 Theoretical and Practical Implications

The findings of the empirical testing reported and discussed in Chapters 7 and 8 which are summarised in the previous section have several theoretical and practical implications.

**Theoretical Implications:** Theoretical developments describing the negative consequences of innovation project failure have provided the impetus for investigating ways to enhance the performance of innovation projects. By integrating previous studies from extant literature, a new conceptual model has been proposed and empirically verified in this thesis. The results suggest that intra-organisational collaboration with its five dimensions play a vital role in directly enhancing innovation project performance, and indirectly through reducing market and technological uncertainty. The results also showed that intra-organisational collaboration is crucial in reducing market, technological, and task uncertainty in innovation projects. Additionally, the results reveal that organisational learning, resulting from intra-organisational collaboration, serves as a catalyst for reducing technological uncertainty. Within the innovation project context, this research makes an absolute contribution to the literature.

In developing this model, the findings of the research reinforced the value of using two theories, organisational information processing theory and organisational learning theory, in a new research setting. This research empirically verified the theoretical position that intra-organisational collaboration impacts innovation project performance through the integration and transfer of knowledge within the organisation (Lu et al. 2017; Mu et al. 2009). Further, the research empirically verified that intra-organisational collaboration reinforces internal learning and a double-loop learning process within the organisation which reduces technological uncertainty in innovation projects (Fliaster & Sperber 2019; Gupta & Maltz 2015; Rodríguez et al. 2008; Spieth & Joachim 2017). Most of the conceptual arguments for organisational information processing theory and organisational learning theory achieved empirical validation through this research, ensuring it is of interest to academic practitioners interested in examining innovation projects.

The thorough literature review revealed three dominant uncertainties in the existing research including: market, technological, and task. The review also revealed five dimensions of intra-organisational collaboration: collaborative leadership, collaborative relationship, trust formation, communicating and sharing information, and commitment. Most importantly, the review determined, for the first time, that the benefits and outcomes of the five key dimensions of intra-organisational collaboration operate dialectically and overlap in developing organisational learning. These findings advance research in innovation project management, by first, identifying the most important innovation project uncertainties that lead to innovation failures. Second, emphasising the imperative effect of intra-organisational collaboration in reducing the three dominant uncertainties. Third, confirming the consistent significance of organisational learning as a key outcome and enabler in the relationship between intra-organisational collaboration and technological uncertainty reduction.

This study confirms valid and reliable measurement items for intra-organisational collaboration, task uncertainty reduction, market uncertainty reduction, technological uncertainty reduction, organisational learning, and innovation project performance. Intra-organisational collaboration was treated as second-order construct, and the other constructs were treated as first-order constructs. All the measurement items used in this research, taken from previous studies were rigorously assessed through several statistical procedures, including CFA, reliability, and the validity of comparison for the first-order constructs and the second-order construct. Consistent with previous work (Cao & Zhang 2011; Edmondson 1999; Kale et al. 2000; Lin et al. 2015b, Lievens & Moenaert 2000; Rai & Al-Hindi 2000; Revilla & Villena 2012; Pinto et al. 2009; Yan & Dooley 2013), the findings of this study broaden our understanding of intra-organisational collaboration, task uncertainty reduction, market uncertainty reduction, technological uncertainty reduction, organisational learning, and innovation project performance through the use of measurement items, whose reliability and validity are tested and then proved.

This study provides empirical evidence that intra-organisational collaboration heightens innovation project uncertainty reduction. Firstly, the study reveals that intra-organisational collaboration can contribute to organisational learning through assimilating and exploiting information and knowledge, which results in knowledge development and greater processing/absorption capabilities. The study also demonstrates that organisational learning facilitates the reduction of technological uncertainty through knowledge creation and absorption. In doing so, the study demystified both the causes of uncertainty, as well as the mediating role of organisational learning. The direct empirical examination of the mediation role of organisational learning in this study serves as a starting point for future studies interested in intra-organisational collaboration and innovation uncertainty reduction.

While previous studies have asserted that intra-organisational collaboration is pivotal to enhance the performance of innovation projects (see for example, Cao & Zhang 2011; De Luca & Atuahene-Gima 2007; Ernst et al. 2010; Hise et al. 1990; Olson et al. 2001; Troy et al. 2008; Zeller 2002), this study is the first to consider the multi-dimensional nature of intra-organisational collaboration when testing its effect on innovation project performance. The importance of intra-organisational collaboration with its five dimensions is emphasised in innovation projects. The collaboration practices examined in this thesis have been proven to heighten innovation project performance through increasing information sharing and processing within the organisation. These findings thus enhance our understanding of how the five dimensions of intra-organisational collaboration work to reduce innovation project uncertainty.

The importance of intra-organisational collaboration is emphasised especially in innovation projects that involve uncertainty. The findings of this study have demonstrated that intra-organisational collaboration enables organisations to manage and overcome the difficulties inherent in innovation projects and achieve their desired goals. The higher level of task uncertainty stemming from product complexity, technological novelty, and task interdependencies, increased the necessity for such intra-organisation collaboration.

Through intra-organisational collaboration, task understanding increases through knowledge and information sharing. Task interdependencies can also be managed more effectively whereby any task change can be coordinated and reflected promptly through joint decision-making. A high level of technological and market uncertainty can also prevent project teams from predicting the marketability and feasibility of innovation project outcome and exert a negative influence during innovation projects. Intra-organisational collaboration, through intensive internal knowledge exploitation and transfer, enables project members to adapt and respond efficiently to such external precarities.

Additionally, this thesis represents the first body of work to directly examine the mediation role of innovation project uncertainty reduction in the relationship between intra-organisational collaboration and innovation project performance. This study has revealed that market and technological uncertainty reduction explain the relationship between intra-organisational collaboration and innovation project performance, while task uncertainty reduction does not.

**Practical Implications:** The benefits obtained by linking intra-organisational collaboration and reducing innovation project uncertainty have been acknowledged and appreciated by high-technological and NPD industries (Peng et al. 2014; Tatikonda & Montoya-Weiss 2001). This study enhances previous studies on uncertainty in innovation projects by providing empirical evidence of the link between intra-organisational collaboration, innovation project uncertainty reduction, and innovation project performance. Additionally, it emphasises the important role of organisational learning in this link.

For practitioners charged with managing intra-organisational collaboration for innovation projects, this study provides empirical support for the importance of intra-organisational collaboration.  It also highlights the imperative role that organisational learning, gained through intra-organisational collaboration, is an effective mechanism in reducing innovation project uncertainty and enhancing the performance. Based on these critical insights, the study offers a range of practical suggestions for best-practice in innovation project management.

Firstly, in identifying the most dominant sources of uncertainty in the literature: task, market, and technological, this research enhances understanding and awareness among project managers and practitioners, enabling the planning and implementation of mechanisms for reducing such uncertainties and thus improving the project performance.

The review also determined five dimensions of intra-organisational collaboration: collaborative leadership, collaborative relationship, trust formation, communicating and sharing information, and commitment. In revealing the multi-dimensional nature of the intra-organisational collaboration, these findings help project practitioners to understand the complexity of intra-organisational collaboration, including vital dimensions to be considered when establishing intra-organisational collaboration mechanisms. In providing such critical information, these findings encourage practitioners to forge intra-organisational collaborative practices when managing innovation projects.

Most importantly, the review revealed, for the first time, that the benefits and outcomes of the five vital dimensions of intra-organisational collaboration overlap and operate dialectically in developing organisational learning. These findings have practical implications on innovation project management practices, encouraging practitioners to share knowledge and experiences in order to build and strengthen organisational knowledge as well as incorporating lessons learned within project teams and organisations, and embed them in organisational memory, routines, and activities.  The findings confirm that organisational exploitation of team knowledge, when integrated into project management practices, enables project practitioners to manage future project challenges by avoiding potential mistakes, repeating the positive aspects, and identifying new ways to deal with them. The findings also foster an appreciation among project practitioners of creating a learning environment especially when executing a product innovation project to effectively deal with the project uncertainties.

Secondly, the empirical findings of this research inform organisations involved in innovation projects about how to significantly reduce innovation project uncertainty by establishing a wide range of collaboration activities among their departments. The five collaboration practices that reflected intra-organisational collaboration serve as knowledge creation mechanisms that enhance organisational learning within the organisation. For example, collaboration practices between marketing and the research and development team members will help to combine, refine, and redefine the market, science and technology knowledge (Lin et al. 2015b). In doing so, knowledge is generated, perfectly interpreted, and grown within the organisation, working to fill task, market, and technological knowledge gaps. This also potentially facilitates the identification of new ways to look at the market, effectively utilise the technology or perform the tasks, and ultimately could assist teams in reducing innovation project uncertainty.

Thirdly, the findings suggest that organisations prioritise intra-organisational collaboration practices within the evaluation criteria in the performance evaluation of the employees. This would help with measuring the impact of intra-organisational collaboration practices while also embedding such practices within the broader organisational culture and innovation project environment. While implementing this approach, it is suggested that organisations utilise advanced collaborative information and communication technology software that provide their teams with the necessary tools to realise these intra-organisational collaborative goals and boost such practices across the organisation. These practices should be incentivised and rewarded to achieve improved innovation performance.

Further, the evidence from this study suggests reducing market and technological uncertainty is more important than reducing task uncertainty to enhance the performance of innovation projects. This finding enhances the understanding and awareness of project managers and practitioners allowing for an appropriate focus in the planning and implementation of those mechanisms that can reduce market and technological uncertainty and thus improve the project performance.

Finally, in the early stages of forging intra-organisational collaboration team for innovation projects, team leaders may focus on developing collaborative leadership and trust formation (Lin et al. 2015b, Park & Lee 2014). Organisational learning in innovation projects accumulates through mutual trust and open communication between the members. Collaborative leadership streamlines the team's communication, encouraging individual team members to share knowledge and information openly. This may facilitate the collaborative interpretation and exploitation of knowledge, ultimately equipping project members with the tools to manage a project's difficulties in practical matters, deal with challenges arising in the project, and reduce potential errors (Peng et al. 2014; Um & Kim 2018). Overall, this leads to organisational learning, reduced innovation project uncertainty, and enhanced performance.

## 9.4 Research Contributions

The findings from this research advance seven contributions to the current literature. First, this research provides a conceptual framework, derived from extant literature and empirically verified to meet all conditions of a desired model fit to the data. Introducing such a novel model that explains the relationship between intra-organisational collaboration, innovation project uncertainty reduction, organisational learning and innovation project performance is a significant contribution to the innovation management literature. This empirically verified model can be used to inform best practice among innovation project professionals when running innovation projects in collaborative environments.

Secondly, this research builds on two organisational theories as fundamental frameworks to gain a better understanding of the impact of intra-organisational collaboration on reducing innovation project uncertainty and enhancing their performance, whilst considering the role of organisational learning in the relationship. This research accordingly extends the use of these two theories into the innovation management context and contributes to an understanding of the generalisability of the theories.

Thirdly, the systematic review of the literature revealed that despite the ubiquity of the theme of uncertainty in the organisational literature, there is no consensus on the concept itself (Gales & Mansour-Cole 1995). This is because the dynamic nature of uncertainty itself makes conceptualising it difficult (Galbraith 1974; Rickaby et al. 2018; Winch & Maytorena 2012). This research contributes to the literature by revealing the dominant sources of innovation project uncertainty are market, technological, and task uncertainty (Fanousse et al. 2021b). Identifying and understanding the sources of uncertainty is the first step to accurately conceptualising and measuring uncertainty (Yan & Dooley 2013).

Further, the review revealed inconsistencies in the literature in conceptualising intra-organisational collaboration. Intra-organisational collaboration is conceptualised as a one-dimensional construct in most previous studies (Gupta et al. 1986; Li & Calantone 1998; Moenaert & Souder 1990). This one-dimensional construct incorporates measures of collaborative relationship and communicating and sharing information. However, it fails to address other vital dimensions of intra-organisational collaboration including leadership, trust and commitment (Lin et al. 2015b, Morgan & Hunt 1994). In this research, the intra-organisational collaboration construct is conceptualised using five dimensions: collaborative leadership, collaborative relationship, trust formation, communicating and sharing information, and commitment. Therefore, this research contributes to the literature by providing a comprehensive and overarching measure of intra-organisational collaboration by combining its dimensions as identified in previous studies (Fanousse et al. 2021b).

Most importantly, this research, for the first time, through the synthesis of the literature revealed that organisational learning is a common outcome of the five dimensions of intra-organisational collaboration and a key enabler in the relationship between intra-organisational collaboration and technological uncertainty reduction. This is an original contribution to our knowledge on innovation project management. Moreover, the study has also contributed to methodology by confirming the validity and reliability of the measurement items for intra-organisational collaboration, task uncertainty reduction, market uncertainty reduction, technological uncertainty reduction, organisational learning, and innovation project performance. Through model specification and the measurement model in the Structural Equation Modelling (SEM), these constructs are confirmed to be valid and reliable, and explained the theoretical reasoning in the tested conceptual model.

This research strived to fill the contextual gap in the literature. Most of the theoretical development and empirical testing of the theories in this field have been based on certain types of innovation projects or relate to a specific industry and/or country. However, understanding organisational practices that could reduce innovation project uncertainty and enhance innovation performance in all types of innovation projects across industries and countries provides clarity of the phenomena for both academics and innovation project professionals. From an analytical perspective, this research contributes to the literature by incorporating data about all types of innovation projects from different industries around the globe, and this is seen in the wider empirical generalisations of the findings.

## 9.5 Limitations

This research exhibits an effective comprehension of the relationship between intra-organisational collaboration, organisational learning, innovation project uncertainty reduction and innovation project performance. There are however, several issues concerning the generalisability of the findings, which to some extent constrain the theoretical and practical utility of this study including:

- The conceptual model did not include factors such as organisational culture and structure that could have moderating effects on the studied relationships. Examining these factors could provide a more thorough insight into the best environment in which the impact of intra-organisational collaboration might be more pronounced. This was not included in the scope of this study since no data was collected about the organisational culture and structure.

- The data have been collected from different countries, but the highest percentage of the responses were from Australia and UAE. This limited the global generalisability of the findings.
- The data have been collected from different industries, but the highest percentage of the responses were from IT, engineering, and construction. This limited the generalisability of the findings across industries.
- The data have been collected about different innovation types, but the highest percentage of the responses were about product and process innovation and less responses were about business model and marketing innovation. This limited the generalisability of the findings across innovation types.

## 9.6 Future Research Directions

This research sheds light on the lack of studies about organisational practices that reduce innovation project uncertainty and enhance performance, it therefore provides some insights and implies some future directions for innovation management and organisational academic research. Moreover, this research strived to respond to this paucity of knowledge using extant literature and quantitative approach, thus setting the groundwork for a range of subsequent research avenues and accordingly several suggestions are made for future research.

First, while the findings of the empirical analysis of the research conceptual model of this study present challenging new evidence, they remain tentative without verification by follow-up research. Accordingly, further validation of the research conceptual model using data with equal proportion of the different innovation types, industries, and countries is open. Replicating the study using a different and larger sample would provide a more comprehensive research setting that would support generalising the present research.

Second, future work should comprehensively study the impact of intra-organisational collaboration on reducing innovation project uncertainty and enhancing project performance, whilst considering the role of organisational learning by also examining the factors of organisational culture and structure. Such research should compare and contrast the findings in the different organisational culture and structures.

Third, in managing and reducing innovation projects uncertainties, the conceptual framework included the most dominant sources of innovation project uncertainty. However, the review of the extant literature revealed that a major trend is the emergence of innovation project uncertainties over time, for example, ontological uncertainty (Fox 2012; Fox 2011), perceived collaboration uncertainty (Wu & Wu 2014), social uncertainty (Hall et al. 2014), and decision uncertainty (Ilevbare et al. 2014). Future research should explicitly consider these emerging uncertainties when empirically testing the model or determining other effective ways to address and reduce them.

Fourth, this research, for the first time, conceptualised intra-organisational collaboration as a second-order construct with five first-order constructs. This provides the groundwork for future studies interested in intra-organisational collaboration by proposing this reliable and validated construct. Further research could examine the impact of intra-organisational collaboration in other industries or contexts.

Fifth, given that this study failed to provide evidence of the relationship between task uncertainty and innovation project performance, future research is encouraged to investigate how this relationship happens in organisations, specifically within innovation projects. This could include investigating the indirect relationships between task uncertainty reduction and innovation project performance through market and technological uncertainty reduction, to further understand the impact of task uncertainty reduction on innovation project performance.

Finally, the success factors of innovation projects are a promising area of future research. This is a particularly critical area of research, as innovation is a key driver of business growth and prosperity. This research confirmed that intra-organisational collaboration is one of the success factors of innovation projects; this was verified through the study's empirical findings. Future researchers should therefore provide empirical evidence of other innovation project success factors and practices since the keys to successful innovation projects remain vague (Cooper 2019). Such research can benefit from specifying the success factors in various innovation contexts including product, service, process, etc.

## 9.7 Conclusion

Even with evidence attributing high rates of innovation project failures to project uncertainties, there remains a dearth of empirical studies on the organisational practices needed to manage this critical issue. This research responds to this paucity of knowledge by empirically investigating the impact of intra-organisational collaboration in reducing such uncertainties to enhance project performance, while considering and exploring the role of organisational learning.

To achieve the research objective, a conceptual model was developed and assessed thoroughly through a measurement model and structural model testing in SEM using AMOS. Drawing on rich survey data collected from innovation project professionals via LinkedIn, this research generated significant insight into how innovation project management is understood.

First, the findings demonstrate that intra-organisational collaboration directly reduces innovation project uncertainty. Second, the findings determined that intra-organisational collaboration leads to organisational learning. Third, the findings established that organisational learning serves as a mediator in the relationship between intra-organisational collaboration and technological uncertainty reduction. Fourth, the research has also shown that intra-organisational collaboration directly enhances innovation project performance. The mediating role of innovation project uncertainty reduction (market and technological) that explains the relationship between intra-organisational collaboration and innovation project performance was established. Drawing on these findings, this research argues that intra-organisational collaboration directly reduces innovation project uncertainty and achieves this indirectly through organisational learning. Additionally, intra-organisational collaboration directly enhances innovation project performance and indirectly through innovation project uncertainty reduction (market and technological).

These findings offer several insights into the context of innovation projects. First these findings highlight the need for organisations to develop a framework that is effective in forging collaborative practices. This research found that collaborative practices operated dialectically in enhancing organisational learning and enabled project members to foresee future demand and market changes by providing accurate and updated information between members, the transfer of knowledge for the success of an ongoing project, as well as enabling effective joint decision-making in a timely manner. Combined, these practices, ensure project members are able to successfully reduce innovation project uncertainty and enhance project performance.

The overall findings of this research extended the use of two theories: organisational information processing theory and organisational learning theory into a new context by using them as conceptual bases for the tested variables. Further this research confirms the usefulness of these theories in understanding the relationship between intra-organisational collaboration, organisational learning, innovation project uncertainty reduction and innovation project performance, and positions this understanding as a valuable endeavour in organisational theory.

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# Appendix 5.1: Survey Questions Items with the Sources

| Construct | Questions | items | source |
|---|---|---|---|
| Trust | To what extent do you agree that each of your project team members was | 1. Honest about problems when they arose | Park & Lee 2014 |
| | | 2. Supportive when making decision | |
| | | 3. Willing to provide assistance | |
| | | 4. Sincere | |
| | | 5. Completely trustworthy | |
| | | 6. Confident in the abilities of other cross functional team members | |
| Commitment | To what extent do you agree that while working on the project you were committed to | 1. The work relationship with other project members | (Rodríguez et al. 2008) |
| | | 2. Considering other project members as a part of the same team | |
| | | 3. Caring for the working relationship with other team members | |
| | | 4. Spending time working other team members | |
| | | 5. Jointly resolving projects issues | |
| Collaborative relationships | To what extent do you agree that the following occurred while you were working on the project | 1. There were positive work relationships between cross functional team members | Fawcett et al. 2019 |
| | | 2. The team resolved conflicts collaboratively | |
| | | 3. The team members trust each other because day-to-day promises are entirely met | |
| | | 4. The team worked toward a mutual goal and knew that they needed each other | |
| | | 5. The team worked collaboratively while dealing with any power differences | |
| Collaborative leadership | To what extent do you agree that your project leader/manager was successful in | 1. Reconciling different views and building a consensus. | (Lin et al. 2015) |
| | | 2. Articulating and promoting a shared vision. | |
| | | 3. Balancing the strategic and the operational delivery | |
| | | 4. Encouraging and inspiring others | |
| | | 5. Dealing comfortably with ambiguity and complexity | |
| Communicating and sharing information | To what extent do you agree that your project team members were | 1. Maintaining open and collaborative communication and exchanging opinions | (Lin et al. 2015) |
| | | 2. Taking the path of least resistance to communicate wherever possible | |

| Construct | Questions | items | source |
|---|---|---|---|
| | | 3. Investing sufficient time and attention in communication and information-sharing processes | |
| | | 4. Ensuring that information reach its targeted stakeholders in a timely manner | |
| Organisational learning | To what extent do you believe that over the last three years | 1. Your organisation has acquired and shared new and relevant knowledge that provided competitive advantage | Kale et al. 2000 |
| | | 2. Your organisation members have acquired some critical capacities and skills that have provided competitive advantage | |
| | | 3. Your organisational improvements have been influenced fundamentally by new knowledge entering the organisation | Edmondson 1999 |
| | | 4. Your organisation is a learning organisation (a company that facilitates the learning of its members and continuously transforms itself) | |
| Task Uncertainty reduction | To what extent do you agree that you and other innovation project team members were able to cope with/manage the | 1. Fluctuation in users' requirements | Rai & Al-Hindi 2000 |
| | | 2. Availability of information to perform the task | |
| | | 3. Uncertain events during the development of the project | |
| | | 4. The dependence level of one task on other to obtain resources such as materials, people, or information needed | Yan & Dooley 2013 |
| | | 5. The dependence level of one subtask on another subtask to complete the overall task | |
| | | 6. The need to check one member's job with other team member's job for the successful completion of major tasks | |
| Market uncertainty reduction | To what extent do you agree that you and your other innovation project team members were informed about | 1. The customer's needs (user requirements). | Lievens & Moenaert 2000 |
| | | 2. The potential customer/client or market | |
| | | 3. The behaviour of the user or potential customer/client | |
| | | 4. The Technological strategy of the competitors | |
| | | 5. The marketing strategy of the competitors | |
| Technological uncertainty reduction | To what extent do you agree that you and other innovation project team members were informed about | 1. The quality of the applied technologies (e.g., information technologies) | Lievens & Moenaert 2000 |
| | | 2. The user-friendliness of the adopted technologies in the project | |
| | | 3. The cost-efficiency of the technologies used in the project | |

| Construct | Questions | items | source |
|---|---|---|---|
| | | 4. The required Research & Development strategy for the project | |
| | | 5. The required technological support for the project | |
| | | 6. The required technical personnel for the project | |
| Innovation Project Performance | Based on your experience, please indicate how successful your project was in meeting the requirements below | 1. The project results, or deliverables, were in line with client objectives | Pinto et al. 2009 |
| | | 2. The project operated within the pre-estimated budget | |
| | | 3. The project operated within the pre-defined schedule | |
| | | 4. Stakeholders were satisfied with the project outcomes | |
| | | 5. The quality of the project output accorded with the standards | |

# Appendix 5.2: Human Research Ethics Committee Approval Letter

**WESTERN SYDNEY**
UNIVERSITY

**HUMAN RESEARCH ETHICS COMMITTEE**

5 February 2020

Professor Yi-Chen Lan

School of Business

Dear Yi-Chen,

Project Title: "Reducing Uncertainties in Innovation Projects Through Intra-organisational collaboration"

HREC Approval Number: H13599

Risk Rating: Low 1 - LNR

I am pleased to advise the above research project meets the requirements of the National Statement on Ethical Conduct in Human Research 2007 (Updated 2018).

Ethical approval for this project has been granted by the Western Sydney University Human Research Ethics Committee. This HREC is constituted and operates in accordance with the National Statement on Ethical Conduct in Human Research 2007 (Updated 2018).

Approval of this project is valid from 5 February 2020 until 5 February 2022.

This protocol covers the following researchers:

Yi-Chen Lan, Rola Fanousse, Dilupa Nakandala

Summary of Conditions of Approval

1. A progress report will be due annually on the anniversary of the approval date.

2. A final report will be due at the expiration of the approval period.

3. Any amendments to the project must be approved by the Human Research Ethics Committee prior to being implemented. Amendments must be requested using the HREC Amendment Request Form.

4. Any serious or unexpected adverse events on participants must be reported to the Human Research Ethics Committee via the Human Ethics Officer as a matter of priority.

5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the Committee as a matter of priority.

6. Consent forms are to be retained within the archives of the School or Research Institute and made available to the Committee upon request.

7. Approval is only valid while you hold a position or are enrolled at Western Sydney University. You will need to transfer your project or seek fresh ethics approval from your new institution if you leave Western Sydney University.

8. Project specific conditions:

There are no specific conditions applicable.

Please quote the registration number and title as indicated above in the subject line on all future correspondence related to this project. All correspondence should be sent to humanethics@westernsydney.edu.au as this email address is closely monitored.

Yours sincerely

Professor Brett Bowden

Presiding Member,

Western Sydney University Human Research Ethics Committee

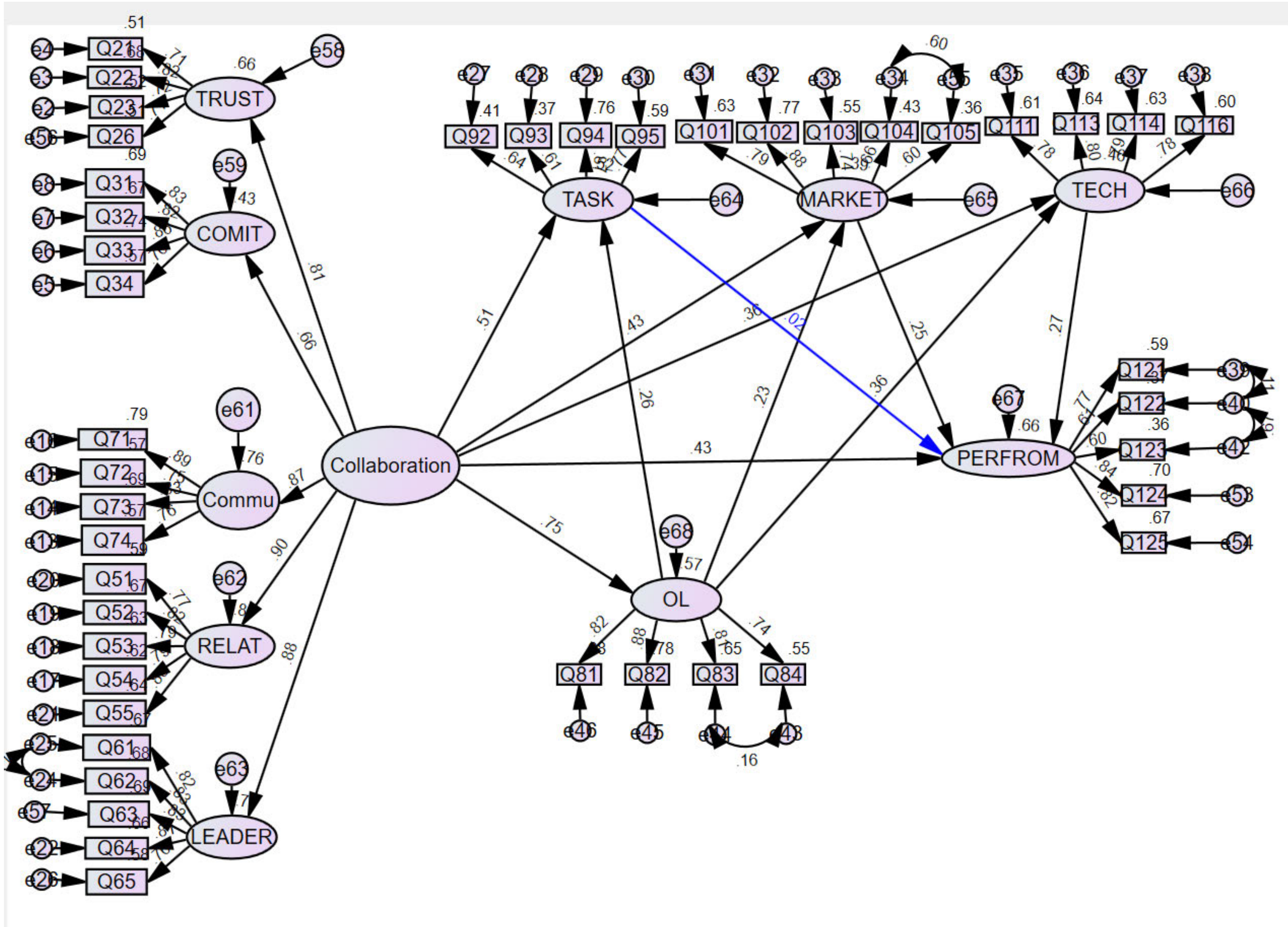
# Appendix 6.1: Common Bias Method Testing Results

**Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 17.938 | 40.768 | 40.768 | 17.938 | 40.768 | 40.768 |
| 2 | 3.495 | 7.942 | 48.710 | | | |
| 3 | 1.816 | 4.128 | 52.838 | | | |
| 4 | 1.583 | 3.599 | 56.437 | | | |
| 5 | 1.465 | 3.329 | 59.766 | | | |
| 6 | 1.364 | 3.099 | 62.865 | | | |
| 7 | 1.196 | 2.718 | 65.583 | | | |
| 8 | 1.108 | 2.518 | 68.101 | | | |
| 9 | .954 | 2.169 | 70.269 | | | |
| 10 | .944 | 2.146 | 72.415 | | | |
| 11 | .868 | 1.973 | 74.389 | | | |
| 12 | .753 | 1.711 | 76.100 | | | |
| 13 | .669 | 1.521 | 77.621 | | | |
| 14 | .647 | 1.471 | 79.092 | | | |
| 15 | .610 | 1.387 | 80.479 | | | |
| 16 | .571 | 1.297 | 81.776 | | | |
| 17 | .535 | 1.217 | 82.993 | | | |
| 18 | .491 | 1.116 | 84.109 | | | |
| 19 | .476 | 1.083 | 85.191 | | | |
| 20 | .445 | 1.012 | 86.203 | | | |
| 21 | .421 | .957 | 87.160 | | | |
| 22 | .404 | .917 | 88.078 | | | |
| 23 | .380 | .863 | 88.940 | | | |
| 24 | .375 | .853 | 89.794 | | | |
| 25 | .359 | .816 | 90.609 | | | |
| 26 | .343 | .780 | 91.389 | | | |
| 27 | .327 | .743 | 92.132 | | | |
| 28 | .308 | .700 | 92.832 | | | |
| 29 | .291 | .662 | 93.495 | | | |
| 30 | .279 | .634 | 94.129 | | | |
| 31 | .265 | .603 | 94.732 | | | |
| 32 | .250 | .569 | 95.300 | | | |
| 33 | .247 | .561 | 95.861 | | | |
| 34 | .228 | .519 | 96.380 | | | |
| 35 | .208 | .474 | 96.854 | | | |
| 36 | .194 | .442 | 97.295 | | | |
| 37 | .182 | .414 | 97.710 | | | |
| 38 | .175 | .397 | 98.107 | | | |
| 39 | .166 | .378 | 98.485 | | | |
| 40 | .151 | .344 | 98.829 | | | |
| 41 | .143 | .326 | 99.155 | | | |
| 42 | .132 | .300 | 99.455 | | | |
| 43 | .124 | .283 | 99.737 | | | |
| 44 | .116 | .263 | 100.000 | | | |

Extraction Method: Principal Component Analysis.

# Appendix 7.1: AMOS Structural Model

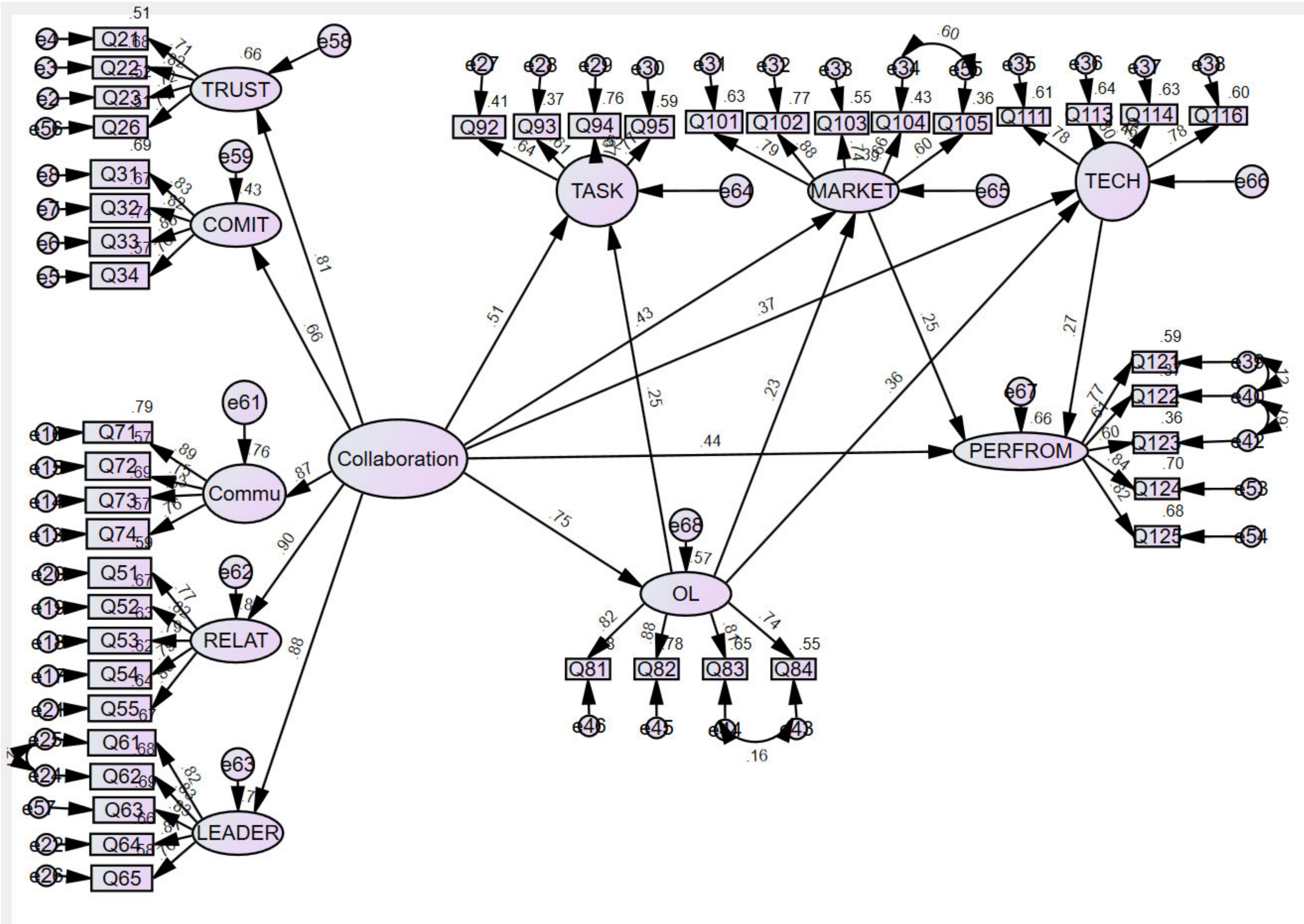


# Appendix 7.2: Indirect Effects Results

| Indirect Path | Unstandardized Estimate | Lower | Upper | P-Value | Standardized Estimate |
|---|---|---|---|---|---|
| Collaboration --> OL --> TASK | 0.175 | -0.036 | 0.483 | 0.148 | 0.193 |
| Collaboration --> OL --> TASK --> PERFROM | 0.006 | -0.036 | 0.121 | 0.751 | 0.193 |
| Collaboration --> OL --> MARKET | 0.229 | -0.094 | 0.666 | 0.219 | 0.171 |
| Collaboration --> OL --> MARKET --> PERFROM | 0.055 | -0.007 | 0.260 | 0.158 | 0.171 |
| Collaboration --> OL --> TECH | 0.379 | 0.057 | 0.840 | 0.071 | 0.269† |
| Collaboration --> OL --> TECH --> PERFROM | 0.094 | 0.008 | 0.354 | 0.060 | 0.269† |
| Collaboration --> TASK --> PERFROM | 0.014 | -0.134 | 0.171 | 0.622 | 0.011 |
| Collaboration --> MARKET --> PERFROM | 0.139 | 0.034 | 0.362 | 0.046 | 0.106* |
| Collaboration --> TECH --> PERFROM | 0.128 | 0.030 | 0.315 | 0.048 | 0.097* |

Significance of Estimates: *** $p < 0.001$,** $p < 0.010$,* $p < 0.050$,† $p < 0.100$

# Appendix 8.1: AMOS Structural Model with Significant Paths



# Appendix 8.2: AMOS Structural Model with Additional Paths between Uncertainty Reduction Variables