Formalising, Integrating and Assessing Portfolio Management Processes in Technology-Intensive Firms

This thesis is submitted for the Degree of Doctor of Philosophy

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Aug 2019

DECLARATION

This dissertation is the result of my own work and includes nothing which is the outcome of work done in collaboration except as declared in the Preface and specified in the text. It is not substantially the same as any that I have submitted, or, is being concurrently submitted for a degree or diploma or other qualification at the University of Cambridge or any other University or similar institution except as declared in the Preface and specified in the text. I further state that no substantial part of my dissertation has already been submitted, or, is being concurrently submitted for any such degree, diploma or other qualification at the University of Cambridge or any other University or similar institution except as declared in the Preface and specified in the text. It does not exceed the prescribed word limit for the relevant Degree Committee.

Nitish Gupta

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ABSTRACT

Technology-intensive firms strive to introduce new products and services effectively and efficiently, having to tackle challenging issues of technology and market uncertainties in their dynamic business environments. This implies that organizing for portfolio management (i.e. taking appropriate decisions regarding projects for new product & service development) is a critical capability for a firm's survival and growth. However, both academic and practical studies reveal that firms often report a challenge of low levels of portfolio management effectiveness, which increases the likelihood of poor portfolio management performance.

After a comprehensive literature review of multi-domain scholarly contributions central to portfolio management, a process design framework for portfolio management provides a basis to tackle this challenge, by addressing three main knowledge gaps:

I. Lack of guidance on how and what to formalise in portfolio management processes
II. Limited understanding of inter-relationships between portfolio management processes
III. Lack of a comprehensive assessment approach for portfolio management processes

With the objective to fill these knowledge gaps, this research analysed portfolio management in more than 40 multinational firms operating in different industries including industrial automation, medical devices, manufacturing and semiconductors. This involved use of multiple rounds of various empirical methods such as case studies, focus groups, workshops and participatory observations.

As a result, this research bridges these respective knowledge gaps by developing:

- <u>Portfolio Management Formalisation Framework</u> reveals five key portfolio management processes that could be formalised and that have implications for portfolio

management performance: a) Ecosystem Surveillance, b) Portfolio Strategy Development, c) Business Case Management, d) Portfolio Decision-Making, and e) New Product Management. The three portfolio management stakeholder functions driving these processes are: a) Corporate Functions, b) Top Management Functions, and c) Project Management Functions.

- Portfolio Management Integration Framework: develops the inter-relationships between these portfolio management processes as well as stakeholder functions in the form of exploratory relationships. Better integration of these processes and functions could enable better portfolio management performance.

- Portfolio Management Diagnostic Tool: a template-based tool for assessing the management practices underpinning the portfolio management processes and stakeholder functions. It involves scoring of these practices against the criteria of relevance, importance, consistency and execution quality. The scores can reveal areas of strengths and weakness in overall portfolio management and can be used for process improvement purposes.

This research contributes to theory by conceptualising five key portfolio management processes and three portfolio management stakeholder functions as components of portfolio management formalisation. It also conceptualises the inter-relationships between these processes and function as components of portfolio management integration. The practical utility of the proposed diagnostic tool lies in using it to diagnose and benchmark portfolio management processes and stakeholder functions.

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ACKNOWLEDGEMENT

I would first like to express my sincere and utmost gratitude to my supervisors Robert Phaal and David Probert, who have patiently guided and encouraged me throughout this doctoral journey. Without their critical and constructive feedback and advice, I would not have been able to complete this PhD research. Rob has always encouraged me to do research that has an impact on practice, and David always helped me in understanding theoretical constructs underpinning this research. I would like to thank Anna Gannon, my tutor at St. Edmund's College, Mukesh Kumar and my colleagues at Institute for Manufacturing, Cambridge who have always supported me and has been pillars of my strength.

My sincere gratitude goes to all the academic and industrial informants (who can't be named for the sake of confidentiality) of my PhD research, who gave their valuable inputs at different stages of this PhD research. This research was made possible due to generous financial support from R&D Management Association, (UK), Department of Engineering, St. Edmund's College, and Centre for Technology Management, Institute for Manufacturing, School of Technology, Strategic Technology and Innovation Management (STIM) Consortium, and my supervisors at University of Cambridge.

Finally, I would like to thank my family and friends in India who left no stone unturned to encourage me to conduct this research.

This thesis is dedicated to my parents:

Suresh Kumar Gupta & Madhu Gupta

ABBREVIATIONS

ACAP	Absorptive Capacity
ADL	Arthur D. Little
AHP	Analytical Hierarchy Process
APM	Association for Project Management
BCG	Boston Consulting Group
BU	Business Unit
CEO	Chief Executive Officer
CPM	Corporate Portfolio Management
DCV	Dynamic Capabilities View
ECV	Expected Commercial Value
E&Y	Ernst & Young
EUPHA	A Pharmaceutical Case Company in Europe
IRR	Internal Rate of Return
ISO	International Organisation for Standards
IT	Information Technology
MC	McKinsey & Company
MPT	Modern Portfolio Theory
NDA	Non-Disclosure Agreement
NPD	New Product Development
NPV	Net Present Value
OECD	Organisation for Economic Co-operation and Development
OGC	Office of Government Commerce
PACAP	Potential Absorptive Capacity
PITS	Product Innovation and Technology Strategy
PMI	Project Management Institute
PoTS	Probability of Technical Success
PwC	PricewaterhouseCoopers
RACAP	Realised Absorptive Capacity
RBV	Resource-Based View
R&D	Research and Development

RO	Research Objective
RQ	Research Question
ROI	Return on Investment
STIM	Strategic Technology and Innovation Management
TRL	Technology Readiness Level
UK	United Kingdom

GLOSSARY

Bounded Rationality: refers to the limitation of decision-making capability due to lack of complete and accurate information, the human cognitive limitations in interpreting the information, and the finite amount of time available to make decisions

Components: refers to either activity or artefact (e.g. document) as constituents of management processes and functions

Dynamic Capabilities View: refers to the theoretical concept which states that in order to cope with uncertainty or environmental dynamism, organisational capabilities need to be evolved or continuously improved

Portfolio Management: refers to dynamic decision-making process on new product or service development projects to achieve goals such as portfolio strategic alignment, value maximisation, and balance

Portfolio Management Effectiveness: refers to degree to which portfolio management goals can be achieved

Portfolio Management Evolution: refers to continuous improvement of portfolio management processes by assessing their strengths and weaknesses

Portfolio Management Formalisation: refers to systematic organisation and governance of portfolio management processes; with description of activities to be carried out in processes and by whom

Portfolio Management Integration: refers to inter-relationships or degree of inter-connectedness between portfolio management processes and relevant stakeholders

Stakeholder Functions: refers to set of activities carried out by a group of portfolio management stakeholders

Technology-Intensive Firms: refers to the firms which invest substantially in R&D such as technological innovation and operate in highly uncertain market and technical environments. Due to this uncertainty, the need for effective portfolio management becomes critical for these firms.

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CHAPTER 1 INTRODUCTION

This chapter provides a brief summary of the research background, focus, research questions and approach, and structure of the thesis. The aim of this research is to develop aids which can be deployed by technology-intensive firms to formalise, integrate and assess their portfolio management processes, and potentially leading to improved portfolio management performance.

Contents

1.1 Research background

Understanding the sources of performance heterogeneity of the firms operating in technology-intensive environment is a key focus of management research. Among various theoretical frameworks used by management scholars to understand how and why some firms perform better or worse than others, the Resource-Base View (RBV) is one of the most popular (e.g. Penrose, 1959; Barney, 1991; Verona, 1999). The RBV states that the core competency (Prahalad and Hamel, 1990) of a firm lies in the configuration and management of its unique tangible and intangible resources. Since tangible resources such as manufacturing tools, equipment, money and raw materials are increasingly commoditised for such firms, it is important to shift focus to understanding intangible resources, such as organisational routines and capabilities (Amit and Schoemaker, 1993; Teece, 2007) which could be a source of distinctive organisation success. Stemming from the innovation management domain, two such capabilities critical to firm performance are:

- New product development (NPD) capability, which focuses on successfully managing single NPD projects (i.e. '*doing things right'*) (cf. Langerak et al. 2004; Cooper et al. 2001)
- Portfolio management capability, which focuses on effectively managing various NPD projects collectively (i.e. '*doing right things'*) (e.g. Cooper et al., 2001; Urhahn & Spieth, 2014; Kester et al. 2014)

As technology-intensive environments can be characterised by high levels of market and technical uncertainties, rapidly changing customer needs, and shrinking product-lifecycles (Hauser et al. 2006; Eisenhardt, 1989), firms operating in such environment must continuously innovate in order to survive in the short and long term. The NPD capability, i.e. ability to successfully develop and introduce new products or services into new and existing markets, can enable firms to generate cash flows to continue funding existing operations while investing part of its revenue in future innovation efforts (e.g. Chao & Kavadias, 2013). Despite the positive association between the NPD capability and firm performance, there are research studies which also indicate the high rate of failure of new products, eventually leading to low firm performance (Cooper et al. 2001; Repenning, 2001; Barczak et al. 2009). The various reasons investigated for poor firm performance in the context of NPD include inadequate resource allocation, unmet customer needs, lack of clear strategy, poor NPD selection and termination quality. Formalising and adapting NPD capabilities is one way to avoid such scenarios (Cooper et al. 2001; Griffin, 1997), but the risk of such failures can also be reduced when NPD projects are collectively managed to ensure organisational success, i.e. focusing on the portfolio management capability (Urhahn & Spieth, 2014; Kester et al. 2014).

Portfolio Management is understood as a complex, dynamic decision-making process for selecting new NPD projects, terminating irrelevant NPD projects, (re)prioritising and (re)allocating resources to such projects in order to achieve strategic alignment, balance and value maximisation (Cooper et al. 2001). However, the context in which portfolio decisions are taken amplifies the complexity of portfolio management tasks (i.e. limited resource availability, highly uncertain environment (Petit, 2012; Floricel et al. 2008), ambiguous and poor information quality (Kopmann et al. 2015; Jonas et al. 2013), and unclear strategy (Beringer et al. 2013), high interdependencies among NPD projects (Teller et al. 2012). Such complexities and uncertainties can render portfolio management ineffective. Among various portfolio management contextual factors (such as process design, managerial dispositions, portfolio characteristics, organisation strategy, culture and structures), process design is chosen as the relevant factor (in this thesis) to further explore and address this challenge of portfolio management ineffectiveness (See Section 2.4). The primary reason for choosing this factor is that it is under the control of a firm or can be influenced by a firm and implementing associated changes in practice could take relatively less time or effort (as compared to other factors). Furthermore, this factor is most likely to have direct impact on portfolio management performance (e.g. Kock et al., 2014). There is at least one primary knowledge gap (regarding portfolio management formalisation) and two secondary gaps (regarding portfolio management integration and evolution) from a process design perspective to which ineffectiveness in portfolio management from both theoretical and practical aspects can be attributed (e.g. Martinsuo, 2013; Kester et al. 2014; Jonas et al. 2013; Meifort, 2015; Chao & Kavadias, 2013; Cooper et al., 2001, 2004; Petit, 2012):

I. <u>Portfolio Management Formalisation:</u> lack of guidance on how and what to formalise in portfolio management processes

Portfolio management formalisation refers to systematic organisation and governance of portfolio management processes; with description of activities to be carried out in processes and by whom. A number of research studies argue that there is a lack of understanding portfolio management in practice or real-world settings (Martinsuo, 2013; Kester et al., 2014; Jonas et al. 2013). The literature suggests that knowledge about portfolio management processes, and the associated dynamics, is quite limited (Martinsuo, 2013; Teller & Kock, 2013; Jonas et al. 2013). One of the underpinning reasons behind this limited knowledge is that the existing portfolio management process models have limitations in terms of their scope, completeness, and description with respect to portfolio management formalisation. E.g. the 'PITS' model by Copper et al. (2001) does not provide description or guidance on how to formalise portfolio management processes and what their underlying practices are (see Section 2.5 for further information). Despite regular calls for opening the 'black box' of portfolio decision-making (Kester et al. 2009, 2011, 2014; Criscuolo et al. 2017), only few studies have revealed portfolio decision-making genres and decision-making styles (Kester et al. 2009; 2011). On one hand, normative portfolio decision-making tools such as two-dimensional portfolio maps, mathematical linear programming, multi-criteria decision-making techniques used for research allocation have been critiqued due to non-availability of reliable, unbiased, and quality information (Nippa et al., 2011; Jonas et al. 2013) as input to portfolio decisions.

On the other hand, limited guidance exists for configuring such tools according to the context of particular firms. Martinsuo (2013) and Christiansen & Varnes (2008) have called for an understanding of portfolio decision-making as negotiating or bargaining events. Urhahn & Spieth (2014) and Spieth & Lerch (2014) have provided empirical evidence linking portfolio management formalisation to its performance. However, the existing portfolio management literature does not reveal the various aspects of formalisation i.e. clear rules, processes, tools and structures, that need to be operationalised for organising portfolio management. This lack of formalised portfolio management can result in non-transparent and politically motivated portfolio decisions (Kester et al., 2011, 2014), reduced ideation quality (Heising, 2012; Kock et al. 2014), and strategic dilution (Cooper et al. 2001).

II. <u>Portfolio Management Integration:</u> limited understanding of inter-relationships between portfolio management processes

Portfolio management integration refers to inter-relationships or degree of inter-connectedness between portfolio management processes and relevant stakeholders. Recently, the concept of portfolio management has gained interest in a variety of management disciplines, such as strategy, innovation and operations (Kwak & Anbari, 2009; Meifort 2015). For example, strategic management scholars have studied portfolio management as a strategic decision-making process, suggesting the use of different decision-making styles concurrently in portfolio management meetings (Kester et al. 2011, 2014), and have indicated potential impacts of business strategy on portfolio management design (Klingebiel & Joseph, 2015). Innovation management scholars have investigated portfolio decisions from the viewpoint of decision types and tools, i.e. selection, hold or termination decisions for NPD projects, and have used qualitative and quantitative approaches such as multi-criteria scoring, Analytical Hierarchy Process (AHP), and linear programming techniques (Cooper et al. 2001). Operations management scholars have focused primarily on project management functions and associated structures. For example, various roles for the project management office have been suggested by Unger et al. (2012), and a variety of techniques for resource allocation to NPD projects have been suggested (Chao & Kavadias, 2013; Chandrasekaran et al., 2016). As portfolio management has been studied in various disciplines, the relationships between portfolio management processes and stakeholders have been largely ignored particularly in existing portfolio management process models. E.g. the portfolio management process model by Archer and Ghasemzadeh (1999) clearly neglected the information on such relationships (see Section 2.5 for further details).

These different management disciplines use different units and levels of analysis, which is useful for expanding portfolio management knowledge, but poses a serious challenge for developing an integrated and holistic view of portfolio management capability in terms of relationship between its processes and stakeholders (Kester et. 2011, 2014; Archer & Ghasemzadeh, 1999; Meskendahl, 2010).

III. Portfolio Management Evolution: lack of comprehensive assessment approach for portfolio management processes

Portfolio management evolution refers to continuous improvement of portfolio management processes by assessing their strengths and weaknesses. A low maturity level of portfolio management capability is a common finding from both global academic surveys and industrial reports over time (e.g. Cooper et al. 1998; Menke, 2013; Martinsuo, 2013; PwC Survey on Current State of Project Management, 2014). These studies not only suggest that there is an apparent lack of guidance or aids which can be used by the firms to identify strengths and weaknesses of their portfolio management processes, but also indicates that the way portfolio management is carried out needs to be adapted due to high levels of complexity and uncertainty manifested in the internal and environments of firms. There are very few portfolio management maturity process models (e.g. Kahn et al., 2006; Killen et al., 2013) which could be used as the diagnostic aids for portfolio management. However, these models offer limited guidance in terms of their implementation and lacks completeness such as not covering different aspects of portfolio management (e.g. project assessment, resource allocation, stakeholder functions) all together. Furthermore, only a limited number of scholars have invoked the Dynamic Capabilities view (Teece, 2007; Killen et al. 2008, 2010; Petit, 2012; Newey & Zahra, 2009, Biedenbach & Muller, 2012) to further investigate this underexplored but important knowledge gap relating to the adaptation and improvement of portfolio management processes using a diagnostic approach.

Overall, despite acknowledging the important role of the portfolio management for firm performance, the above three knowledge gaps have important implications for setting the direction and focus of portfolio management research. Therefore, portfolio management research described in this thesis focuses on providing theoretically relevant and practical interventions or aids which can be used by technology-intensive firms to formalise, integrate and assess portfolio management processes and associated stakeholder functions.

1.2 Research Focus

A key assumption underlying this research study is stated below, before outlining the research focus and theoretical positioning, with the assumption helping to narrow down the scope of the research, in order to ensure research relevance and contribution.

Effectiveness of portfolio management can be achieved by formalisation, integration, and evolution of portfolio management processes, which in turn would potentially improve portfolio management quality and eventually, portfolio management performance.

Figure 1.1 depicts the premise underpinning this research in the form of the linkages between three knowledge gaps (as identified in Section 1.1), portfolio management processes, quality and performance. The concept of *portfolio management quality* is proposed by Jonas and colleagues (2013), comprising three parts: information, allocation and cooperation quality. Information quality is concerned with the accuracy, timeliness and reliability of data about the status of projects of a portfolio available for decision-makers. Allocation quality is defined as the efficient and effective distribution of resources to projects within a portfolio. Cooperation quality can be understood as cross-functional collaboration in terms of cross-project assistance and problem-solving efforts.

Portfolio management performance consist of a set of constructs that are conceptually proposed and empirically validated in a number of studies (c.f. Meskendahl, 2010; Jonas et al. 2013; Spieth and Lerch, 2014; Cooper et al., 2001; Padovani and Carvalho, 2016; Teller and Kock, 2013). Strategic alignment means aligning NPD projects with overall the strategy of a firm and ensuring such strategic fit is maintained throughout new product development efforts. Value maximisation ensures that both financial and non-financial values inherent in NPD projects are maximised. Portfolio balance denotes an appropriate and dynamic trade-off between various portfolio dimensions such as risk vs reward, and incremental vs radical innovation. Average project success indicates whether single NPD projects are completed on time, remains within allocated budget and deliver predetermined quality or not. Average product success comprises market and financial success of each new product developed as part of a portfolio. The concept of Synergies indicates the use of market and technical commonalities and dependencies between projects in a portfolio. Preparedness for future covers the development of technical competences needed for long-term survival of a firm.

Jonas and colleagues provided empirical support by positively linking portfolio management quality and portfolio management performance. This type of relationship is further confirmed by Unger et al. (2012) and Rank et al. (2015). Portfolio management formalisation can enable decision-transparency and improve portfolio management quality. For example, clearly defined rules or processes for collecting and managing project data can increase the quality of information needed for portfolio decision-making. By defining clear responsibilities and roles of stakeholders as a step-in formalising portfolio management can increase cooperation quality between cross-functional teams. Portfolio management integration can be linked with cooperation and allocation quality in a way that fosters cross-functional dialogue for doing due-diligence in deriving appropriate value profiles of NPD projects, which has implications for portfolio selection and termination decisions, and eventually portfolio management performance. Portfolio management evolution is imperative for improving portfolio management quality. For example, a dynamic business environment may render infrequent portfolio reviews inadequate, and therefore more frequent portfolio reviews may be needed, which can in turn improve allocation quality by enforcing proactively termination of irrelevant projects.

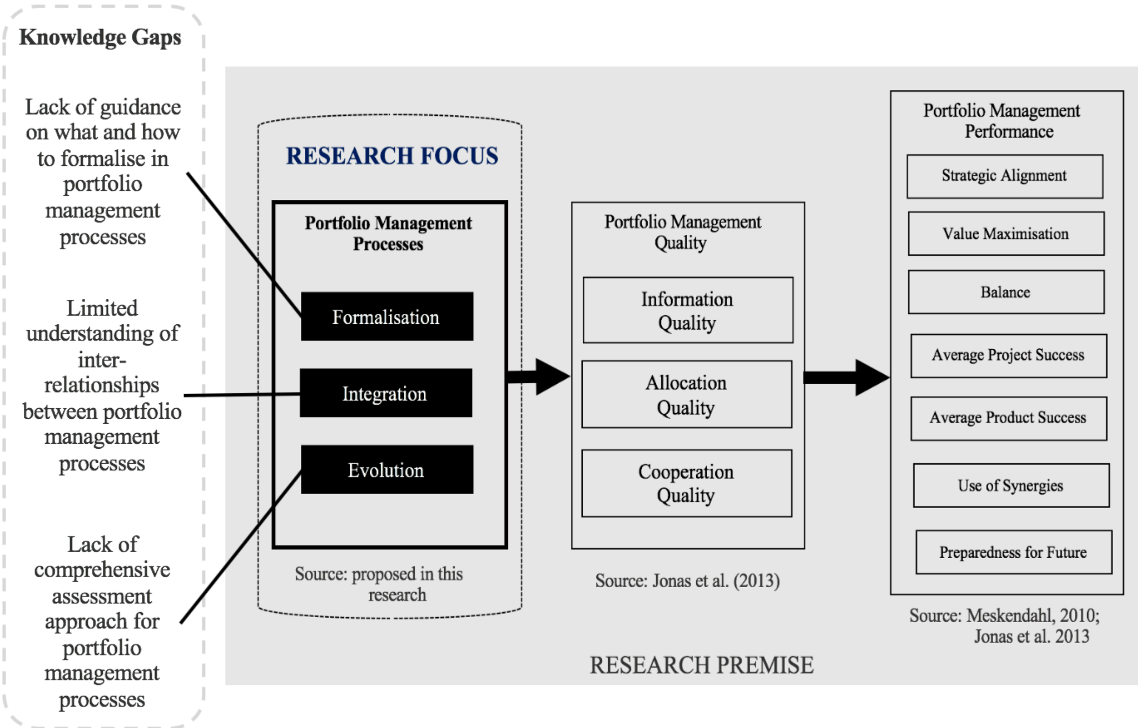


Figure 1.1: Linking Knowledge Gaps, Portfolio Management Processes, and Performance

This PhD adopts the RBV of a firm and considers innovation management as one of the unique and critical resources of a technology-intensive firm (i.e. innovation management is an intangible resource in the form of knowledge codified in processes, tools, structures deployed for successfully managing new product development investments to achieve organisational success). Portfolio management capability is one constituent of innovation management, which is used to deliver strategy by undertaking appropriate projects, enabling selection, termination and hold decisions for NPD projects as and when warranted, and optimising the allocation of resources among NPD projects. Portfolio management capability consists of processes and stakeholder functions and formalisation, integration and evolution of these processes and functions forms a core focus of this research.

1.3 Research Questions

As mentioned in the Sections 1.1 and 1.2, theoretical insights and practical guidance concerning how to make portfolio management more effective are limited in the literature. The three research gaps identified in the literature, and the research focus defined to fill these gaps, lead to definition of overall research aim of this study:

To develop theoretically relevant and practical aids which can be deployed by technology-intensive firms to improve portfolio management performance

This overall aim is further decomposed into following four research objectives (RO):

- **RO-1**: Identification of key portfolio management processes, to enable portfolio decision-making.

- **RO-2:** Formalisation of portfolio management processes, to define underlying sub-processes, components and practices

- **RO-3:** Integration of portfolio management processes, to synergise these processes by understanding their inter-relationships

- **RO-4:** Assessment of portfolio management processes, to provide diagnostic aid which can be deployed to enhance maturity levels of portfolio management processes

Therefore, the overall research question can now be defined as:

How may key portfolio management processes be formalised, integrated and assessed in order to improve portfolio management performance in technology-intensive firms?

1.4 Research Approach

In answering the overall research question for this study, the four research objectives as defined in Section 1.3 need to be addressed. This research adopts the multi-phase, qualitative research approach because: a) the existing portfolio management body of knowledge is limited in addressing the above mentioned three knowledge gaps; and b) there is a need to develop practical guidance for firms in overcoming the issues of ineffectiveness in portfolio management.

To address these research objectives, a total of 45 interviews, 3 focus groups and 4 workshops have been conducted with 116 relevant portfolio management stakeholders, based in the UK, Denmark, Germany, India, Japan, and Sweden, representing more than 40 multinational firms operating in more than 14 industrial sectors. The data collected was analysed using grounded analysis, case and cross-case analysis techniques. Further details about case selection criteria for firms, informants and other aspects of research methods adopted are provided in Chapter 3.

The overall data collection was divided into three phases (Phase I, II and III), which each phase linked to one or more of the four research objectives. Table 1.1 links these objectives, data collection and analysis of three phases and corresponding results. Key implications of each of these phases are highlighted below.

Implications from Phase I (leading to Result I: Identification of Portfolio Management Processes):

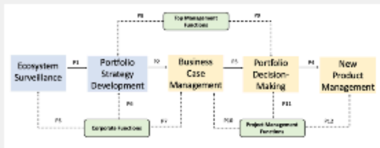
- Ascertains the practice relevance and utility of the research objectives and overall research question defined in this study
- Identifies 5 key portfolio management processes that could be formalised: Ecosystem Surveillance, Portfolio Strategy Development, Business Case Management, Portfolio Decision-Making, and New Product Management
- Identifies two portfolio management stakeholder functions: Corporate Functions and Top Management Functions, which needs to be further explored and expanded along with the five identified processes

Table 1.1: Linking Research Objectives, Data Collection and Results

*Stage I and II of Phase II results into the development of Portfolio Management Process Framework V.2 and V.3 respectively

<table>
<tr><th>Research Objectives</th><th colspan="4">Data Collection & Analysis</th><th>Results</th></tr>
<tr><td rowspan="2">RO-1: Identification of portfolio management processes</td><td colspan="4">Phase I</td><td rowspan="2">Result I (Chapter -4)


(See Figure 4.1)</td></tr>
<tr><td>Ist Focus Group</td><td colspan="2">9 Exploratory Interviews</td><td>2nd Focus Group</td></tr>
<tr><td colspan="6">Portfolio Management Process Framework V.1</td></tr>
<tr><td rowspan="3">RO-2: Formalisation of portfolio management processes</td><td colspan="4">Phase II</td><td rowspan="3">Result II (Chapter -5)

(See Figure 5.3)</td></tr>
<tr><td>Stage I</td><td colspan="2">Stage II</td><td>Stage III</td></tr>
<tr><td>9 Case Studies</td><td>17 Exploratory Interviews</td><td>10th Case Study</td><td>3rd Focus Group</td></tr>
<tr><td colspan="6">*Portfolio Management Process Framework V.4</td></tr>
<tr><td>RO-3: Integration of portfolio management processes</td><td colspan="2">Insights from Literature Review</td><td colspan="2">Insights from Stage I-III</td><td>Result III (Chapter -6)


(See Figure 6.1)</td></tr>
<tr><td colspan="6">Portfolio Management Process Framework V.5</td></tr>
<tr><td rowspan="2">RO-4: Assessment of portfolio management processes</td><td colspan="4">Phase III</td><td rowspan="2">Result IV (Chapter -7)

(See Figure 7.1)</td></tr>
<tr><td colspan="2">4 Workshop-based Pilot Studies</td><td colspan="2">3 Non-Workshop-based Pilot Studies</td></tr>
</table>

Implications from Phase II (leading to Result II: Formalisation of Portfolio Management Processes and Result III: Integration of Portfolio Management Processes):

- Identifies a comprehensive set of sub-processes, components and practices underpinning the five key processes (Result II)
- Identifies the three portfolio management stakeholder functions (and their components): Corporate Functions, Top Management Functions and Project Management Functions (Result II)
- Supports development of relationships exploring causal logic or narratives for understanding the interrelationships between these processes and functions (Result III).

Implications from Phase III (leading to Result IV: Assessment of Portfolio Management Processes):

- Validates the comprehensive set of management practices underpinning portfolio management processes and functions (Result II)
- Suggests practical utility of the piloted assessment tool for diagnosing portfolio management processes and provided a set of scores of portfolio management practices for benchmarking purposes.

1.5 Structure of Thesis

The content of this thesis is organised into total of 8 chapters, as shown in Figure 1.2. A brief summary of each chapter is provided below. ***Instead of discussing research results all at once as a standalone chapter, Results I to IV are discussed in their respective chapters in this thesis.***

Chapter 1 Introduction: discusses the research background, identifies research focus, objectives and questions, the qualitative research approach adopted, and structure of the thesis.

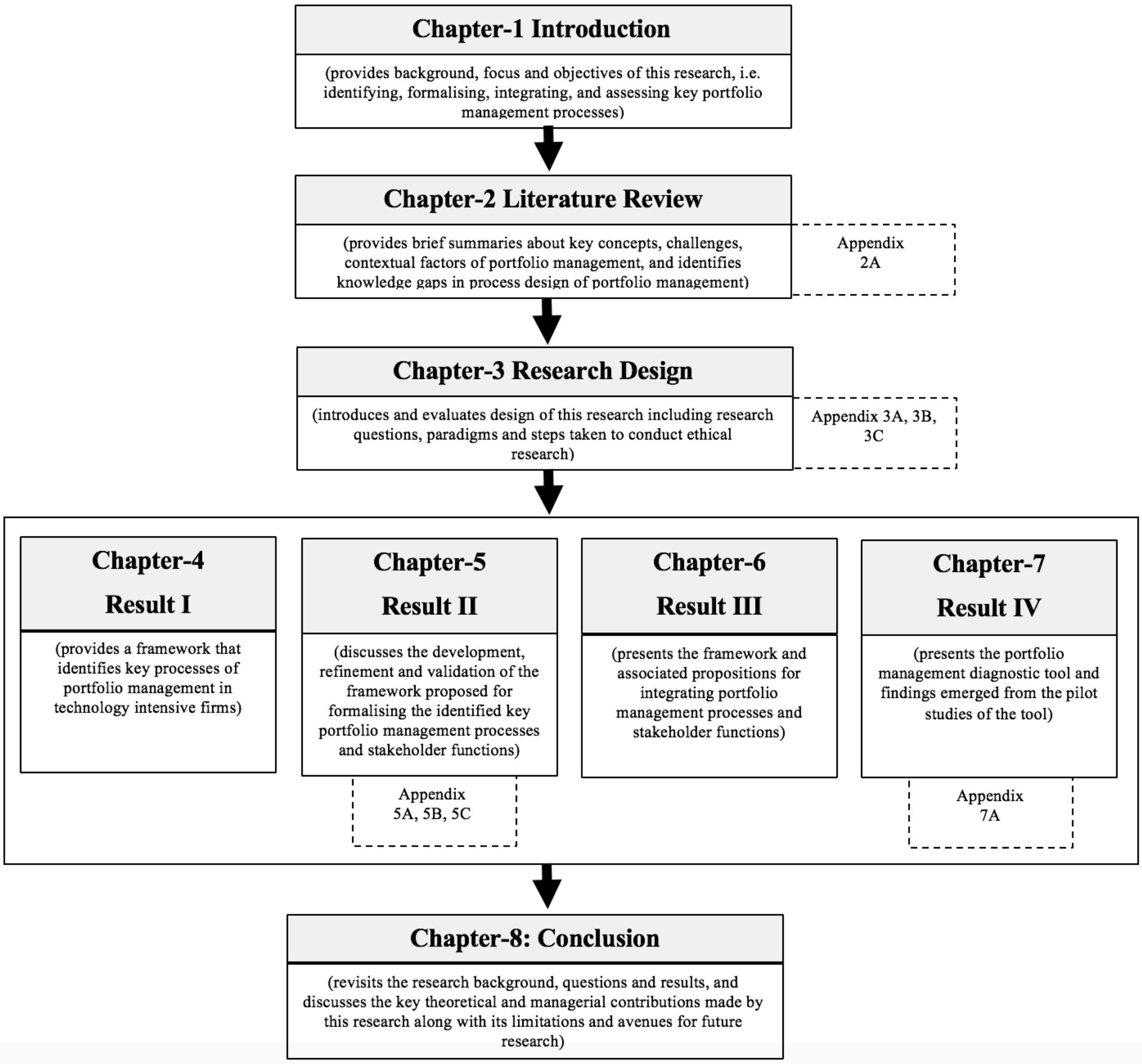


Figure 1.2: Structure of the PhD Thesis

Chapter 2 Literature Review: builds upon a comprehensive literature review about portfolio management concepts, challenges and contextual factors and identifies knowledge gaps in process design of portfolio management.

Chapter 3 Research Design: discusses research paradigms, philosophy, qualitative data collection and analysis techniques used to achieve the four research objectives (as identified in Chapter 1). The links between research objectives, data collection phases and results are shown in Table. 1.1.

Chapter 4 Results I: develops the Portfolio Management Process Framework (V.1) that identifies key portfolio management processes in technology-intensive firms.

Chapter 5 Results II: develops the framework (V.4) for formalising portfolio management processes and associated stakeholder functions. It discusses sub-processes, their components and management practices underlying these processes and functions.

Chapter 6 Results III: develops the framework (V.5) for integrating portfolio management processes and stakeholder functions by exploring their inter-relationships.

Chapter 7 Results IV: develops the portfolio management diagnostic tool, which involves assessment of portfolio management practices. It also outlines findings from the 7 studies conducted to pilot this tool in practice.

Chapter 8 Conclusion: revisits research background and results, with outline of theoretical and managerial contributions made by this research along with its limitations and directions for future research.

Following these chapters, key references used in this research are listed, and appendences included describing additional information about different aspects such as meta-data about interviews.

1.6 Summary of Introduction

Key knowledge gaps with respect to process design of portfolio management identified in the literature are discussed in this Chapter, which then informs the focus of this research, leading to a definition of the overall research question. Using qualitative approaches, this research results in: 1) Portfolio Management Formalisation Framework (Result I and II); 2) Portfolio Management Integration Framework (Result III); and finally, 3) Portfolio Management Diagnostic Tool (Result IV). The following chapter provides an extensive review of portfolio management literature and relevant industrial reports.

CHAPTER 2 LITERATURE REVIEW

This chapter begins with the introduction to key concepts in portfolio management, such as its origin, definitions, types, goals, tools and process models. It then explores key portfolio management challenges that are frequently surfaced in both theory and practice. Following which it outlines different contextual factors of portfolio management such as its process design, strategy, organisational structures which can be relevant in addressing these challenges. With process design chosen as the relevant factor, three knowledge gaps are identified regarding formalisation, integration and assessment of portfolio management processes. The chapter closes with the conceptual framework of overall portfolio management process which will serve as the basis for further research, and a summary of the literature.

Contents

2.1 Introduction to Literature

As mentioned in Section 1.1, portfolio management is an interdisciplinary concept and there is a proliferation of research articles, industrial surveys and reports regarding its different aspects, such as concepts, challenges and contextual factors. This literature review aims to form a strong conceptual understanding of portfolio management and its challenges and to identify relevant knowledge gaps in theory and practice which can be filled to address these challenges. Overall, the literature review is split into four sections:

2.2 Portfolio Management Concepts: outlines the key concepts in portfolio management, such as its origins, definitions, types, goals, tools and process models. These topics are chosen to gain a fair level of understanding about depth and breadth of portfolio management knowledge, and to clarify associated terminology to be used in this research.

2.3 Portfolio Management Challenges: discusses the challenges of making strategic decisions such as portfolio decisions (e.g. project selection or termination) under uncertainty. It then explores key portfolio management challenges that are frequently encountered in both theory and practice. The purpose of this section is to identify practical challenges which can be addressed to improve overall portfolio management performance (See Appendix 2A for further information on portfolio management performance).

2.4 Portfolio Management Contextual Factors: presents different contextual factors such as its process design, organisational structures, strategy, which could influence portfolio management performance, and eventually firm performance. These topics are chosen to explore different facets of portfolio management context and identify the relevant one(s) to address the practical challenges as identified in previous Section 2.3.

2.5 Portfolio Management Process Design and Knowledge Gaps: explores three aspects of portfolio management process design: its formalisation, integration and evolution (or assessment). It then appraises the significance of the various process models (as discussed in Section 2.2) in light of these three design aspects. The purpose of this section is to identify the relevant knowledge gaps in the context of process design which can be filled to address the portfolio management challenges as identified in Section 2.3.

Based on the synthesis of the extant literature, a conceptual framework called as Portfolio Management Process Framework V.0 is developed (Section 2.6) which will be further explored and developed in this research, and then a summary of the literature is provided (Section 2.7).

2.2 Portfolio Management Concepts

This section introduces the literature on portfolio management and associated key concepts such as its origins, definitions, types, goals, tools and process models. The purpose of this section is to gain a fair level of understanding about depth and breadth of portfolio management knowledge, and to clarify associated terminology to be used in this research.

2.2.1 Origins

The origin of the portfolio[1] management approach can be traced back to 1738, and a quote by Daniel Bernoulli (as cited in 'Exposition of a New Theory on the Measurement of Risk', pp. 32, published in *Econometrica* in 1954) indicates the need for diversification of assets to mitigate risk:

"...it is advisable to divide goods which are exposed to some small danger into several positions rather than to risk them all together"

However, it was in the 20th century that the portfolio management approach was formally acknowledged and recognised as the *Modern Portfolio Theory (MPT)*, rooted in the Economics and Finance disciplines (Markowitz, 1952). The seminal paper by Henry Markowitz in 1952 argued that the MPT seeks to reduce the overall risk of a financial portfolio by diversifying the investments in assets having non-correlated returns, therefore providing mathematical support for the philosophical assertion of Aristotle (350 B.C.):

"The whole is greater than sum of its parts"

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[1] The Oxford University dictionary defines a 'portfolio' as: 'a range of investments held by a person or organisation'. Traditionally, the investments have been understood as a form of market instruments, and therefore mainly studied under the domain of Finance and Economics until subsequent concepts and approaches of portfolio management were developed in other management disciplines in the late 20th century.

However, the MPT is not fully valid or applicable in the context of other non-financial management disciplines, particularly Innovation Management (which is the domain of this research). There are subtle differences in the underlying assumptions underpinning 'Portfolios' when comparing Finance & Economics and other disciplines (e.g. Cardozo et al., 1983). The major differences are:

- Investments (e.g. new product investments) are less liquid than financial options
- Short selling of the investments is not usually possible
- Investments are not indefinitely divisible
- Each firm does not have the same opportunity to invest

Following the above limitations of MPT, the need to extend the portfolio management approach to other management disciplines such as Strategy, Innovation and Operations was fuelled. In Strategy discipline, the concept of corporate portfolio was introduced by management consulting firms such as the Boston Consulting Group[2] (BCG), McKinsey & Co.[3] (MC) and Arthur D. Little[4] (ADL) in the 1970s. In Innovation discipline, the concepts of product portfolio (Cardozo et al. 1983) and technology portfolio (Pappas 1984) attracted significant attention from management scholars. Notably, the New Product Development (NPD) portfolio concept was introduced during the 1990's by Cooper and his colleagues, who suggested that the three goals of managing a portfolio of new product development projects are: strategic alignment, balance and value maximisation[5]. Around the same point in time, in Operations discipline, project management scholars started studying the processes of managing a set of projects (which could be an innovation or any type of project) or a project portfolio (Platje et al. 1994; Archer & Ghasemzadeh, 1999).

The portfolio management literature also suggests that other portfolio types such as business model, alliance, supplier and capability portfolios are gaining interest among management scholars. However, discussing these other types of portfolios is beyond the scope of this

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[2] www.bcg.com
[3] www.mckinsey.com
[4] www.adlittle.com
All these websites were accessed between 2015 and 2018

[5] There has been increasing evidence that portfolio management of new products and services are not significantly different from each other (e.g. Killen et al., 2010). For example, Killen et al. (2010) conducted a large survey among 60 organisations in Australia to understand portfolio management practices and found that both types of portfolio management share many characteristics and have the similar portfolio management maturity levels. The main argument for non-significant differences is that underlying routines and aspects such as goals, tools of portfolio decision-making remain mostly the same. Therefore, from now on in this research, the term portfolio management refers to the portfolio management of products and services together.

research. Before exploring other portfolio management concepts such as its types, it would be useful to understand different definitional notions of portfolio management.

2.2.2 Definitions

Since the origin of concept of portfolio management[6] in the management disciplines, a number of definitions have emerged in both academia and industry. The purpose here is to review relevant definitions of portfolio management and to synthesise these into key components.

Portfolio Management definitions in Academia

One of the most widely used definitions of portfolio management was given by Cooper et al. (2001): "*Portfolio management is a dynamic decision process, whereby a business's list of active new product (and R&D) projects is constantly updated and revised. In this process, new projects are evaluated, selected and prioritised; existing projects may be accelerated, killed or de-prioritised; and resources are allocated and re-allocated to the active projects. The portfolio decision process is characterised by uncertain and changing information, dynamic opportunities, multiple goals and strategic considerations, inter-dependence among projects, and multiple decision makers and locations.*" (Cooper et al., 2001).

The above notion of portfolio management as a decision-making process can be extended by definition provided by Archer & Ghasemzadeh (1999), which adds the context and constraints under which portfolio decisions are taken. Archer & Ghasemzadeh (1999) defines portfolio management: "*… as the periodic activity involved in selecting a portfolio, from available project proposals and projects currently underway, that meets the organization's stated objectives in a desirable manner without exceeding available resources or violating other constraints*" (Archer & Ghasemzadeh, 1999). Furthermore, Dye and Pennypacker (1999) added the notion of supporting tool and techniques to the above definitions and defined it as "*the art and science of applying set of knowledge, skill, tools and techniques to a collection of*

[6] Some studies referring to portfolio management use terms such as 'programme management', 'multi-project management' or 'pipeline management' (e.g. Wheelwright & Clark, 1992). However, there exist some differences between these terminologies. For example, pipeline and multi-project management refers to better utilisation of internal resources and resource allocation to simultaneous projects respectively. Programme management refers to delivering more value or benefits from inter-related projects by managing them all together.

projects in order to meet or exceed the needs and expectations of an organization's investment strategy" (Dye and Pennypacker, 1999).

Challenging the strategic nature of portfolio management, McDonough and Spital (2003) indicated that portfolio management is more than just project selection, and defines it as "*the day-to-day management of the portfolio including the policies, practices, procedures, tools and actions that managers take to manage resources, make allocation decisions, and ensure that the portfolio is balanced in such a way as to ensure successful portfolio-wise new product performance*" (McDonough and Spital, 2003).

Portfolio Management definitions in Industry

The Project Management Institute[7], a leading professional body in area of project management, defines portfolio management as: "*the coordinated management of one or more portfolio to achieve organizational strategies and objectives. It includes interrelated organizational processes by which organization evaluates, selects, prioritizes, and allocates its limited internal resources to best accomplish organizational strategies consistent with its vision, mission, and values. Portfolio management produces valuable information to support or alter organizational strategies and investment decisions*" (Project Management Institute, 2013)

In line with the Cooper's definition, the International Organisation for Standardisation[8] or ISO (2015) argued that portfolio management is "*a continuous decision-making process, whereby an organization's list of portfolio components is subject to periodic review for alignment with the organization's strategy. In this approach, new opportunities or threats are evaluated, selected, prioritized and authorized. Portfolio components may be modified, accelerated, postponed or terminated.*" It further states that portfolio management includes "a *set of interrelated organizational processes and methods by which an organization allocates resources to implement its strategic objectives*" (ISO, 2015).

The Association of Project Management[9] or APM, another leading professional body in project

[7] www.pmi.org
[8] www.iso.org
[9] www.apm.org.uk
All these websites were accessed between 2015 and 2018

management defines portfolio management as "*the selection and management of all of an organisation's projects, programmes and related operational activities taking into account resource constraints. A portfolio is a group of projects and programmes carried out under the sponsorship of an organisation*" (APM, 2006). This definition resonates with the one provided by Archer & Ghasemzadeh (1999) in terms of portfolio management context and structures. Adding a change management perspective to portfolio management, the Office of Government Commerce[10] or OGC defines portfolio management as "*a co-ordinated collection of strategic processes and decisions that together enable the most effective balance of organizational Change and Business as Usual.*" (OGC, 2009). Two leading research and advisory (consulting) firms, Ernst & Young[11] or E&Y and PricewatehouseCoopers[12] or PwC, view portfolio management as a prime mechanism to deliver benefits to an organisation.

E&Y defines portfolio management as "*a group of programs and/or projects managed in a coordinated way to support business strategy and to deliver benefits in line with strategic objectives*". It is argued that portfolio management "*provide organizations with a mechanism to make sure the organization is doing the right things*" (E&Y, 2012). PwC defines portfolio management as "*a function dedicated to supporting delivery of a portfolio's overall benefits through insightful reporting and controls, appropriate resource allocation, and continued refinement*" (PwC, 2017)

Another research and advisory firm, Gartner[13], views portfolio management as "*the continuous cultivation of a product set and the set of capabilities to prioritize and manage product development programs. (…) includes dashboards with executive views of decision variables, such as risk, opportunity, resource allocation, investments, product-revenue performance and customer acceptance.*" (Gartner, 2018). This emphasises the role of communication in portfolio management by noting the importance of portfolio visuals tools or dashboards across different organisational stakeholders.

Both academic and industry-based definitions have an overlap of notions to some extent as they view portfolio management as vehicle to achieve strategic goals or deliver benefits to

[10] www.gov.uk
[11] www.ey.com
[12] www.pwc.com
[13] www.gartner.com
All these websites were accessed between 2015 and 2018

organisation. Whereas differences exist in labelling portfolio management either as a decision-making process or an operational process carried out with support of management tools, synthesis of the above definitions reveals four key aspects of portfolio management described below (see Table 2.1):

Table 2.1: Synthesis of Portfolio Management Definitions in Academia and Industry (Source: Author)

	Planning	Decision-Making	Structures	Performance
Cooper et al. (2001)	X	X	X	X
Archer & Ghasemzadeh (1999)		X	X	X
Dye and Pennypacker (1999)	X		X	X
McDonough and Spital (2003)		X	X	X
Project Management Institute (2013)	X	X		X
International Organisations for the Standards (2015)	X	X	X	X
Association for Project Management (2006)		X	X	
Office of Government Commerce (2005)		X	X	
Ernst & Young (2012)	X		X	X
PricewaterhouseCoopers (2017)			X	X
Gartner (2018)		X	X	X

Academia Industry

- **Planning**: developing strategy or setting strategic directions in which an organisation should invest or put its resources, identifying and analysing the potential portfolio components (such as Business Unit, NPD Project, Technology)
- **Decision-making**: overall processes of selecting/killing/holding the portfolio components (new and existing), and associated operational activities carried out to enable these portfolio decisions
- **Structures**: management tools and structures such as relevant portfolio stakeholders supporting portfolio planning and decision-making
- **Performance**: managing performance of portfolio components to deliver key strategic goals or benefits which an organisation aims to achieve

This research follows the definition provided by Cooper et al. (2001) as it the most comprehensive definition which covers all the four aspects of portfolio management.

2.2.3 Types

The portfolio types and associated management approaches vary according to the functional context and organisational levels. For example, at a corporate level, one could consider the portfolio of business units and how firms develop corporate strategies; at a business unit level, one could explore how to manage a set of technologies or products in development or in use. From a functional point of view, one could study human resources, market and customer portfolios. The three portfolio types relevant to this research are:

- Corporate Portfolio Management: portfolio of business units
- Product Portfolio Management: portfolio of new and existing products
- Technology Portfolio Management: portfolio of new and existing technologies

Corporate Portfolio Management

Corporate Portfolio Management (CPM) has been a central focus of Strategy research and literature. Before discussing the CPM, it is necessary to briefly review the concept of Strategy. The origin of term *Strategy* is considered to be rooted in the military, and is derived from the

Greek word *Startegos,* which is translated to '*general of the army'*. Early contributions in Strategy research were made by Chandler (1962) and Ansoff (1965). Chandler conceptualised Strategy as '*the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses from action and allocation of resources necessary for carrying out the goals*' (1962, pp. 15-16); whereas Ansoff stated that the strategy '*is designed to transform the firm from present position to the position described by the objectives, subject to constraints of the capabilities and the potential*' (1965, p.205).

Both conceptualisations indicate that the role of Strategy is to allocate or invest organisational resources to achieve firm's objectives, in order to maximise economic returns on investment. These definitions were further extended by Mintzberg (1994), who argued that Strategy is a pattern or stream of minor or major decisions that influence the future of a firm. It entails a variety of decisions by senior management, such as in which direction(s) (e.g. for markets, products, technology, capabilities or respective goals) a firm should invest its financial and non-financial resources (Ansoff et al., 1970) and how much resources should be allocated to different goals. Following the above context, CPM can be considered as one such important step in strategy planning for firms.

CPM is concerned with strategic decision-making in multi-business firms, aimed at allocation of scarce, limited and unique resources to business units, disinvestment of value-destroying units, and whether to enter into new businesses or not (Nippa et al. 2011). Pearce et al. (1987) define formal strategic planning as "*the process of determining the mission, major objectives, strategies and policies that govern the acquisition and allocation of resources to achieve organizational aims*". One of the key interests of the scholars in this area has been to explore the relationship between strategic planning and firm performance. For example, Thune and House (1970) and Ansoff et al. (1970) argue that firms perform better when they have formal strategy planning system in place, while other studies found the reverse (e.g. Fulmer & Rue, 1974; Whitehead and Gup, 1985) or non-significant effects (Karger and Malik, 1975).

The key message from these studies is that in general formal strategic planning tends to have positive impact on firm performance, but the relationship is contingent on other factors such as environmental uncertainty and cultural context. An important limitation in quantifying such a relationship is that it lacks consideration of the product perspective. This is important because firm performance is based on how much revenue a firm generates from its products, by satisfying needs of both existing and new customers.

Product Portfolio Management

The concept of product portfolio encompasses the successful management of new products in development and existing products in market. In order to understand how product portfolios are managed, it is important to first understand how a single new product development is managed, and then consider a portfolio perspective on such developments.

Early models of NPD process can be traced back to mid 20^{th} century, with firms alternatively following the pattern of 'technology push' or 'market pull' (Rothwell 1994; Mowery and Rosenberg, 1979) while handling both internal and external uncertainties. A study by Cooper in 1998 indicated that an effective and formalised NPD process is a potential source of core competence and influences firm performance. For managing a single NPD project, the Stage-Gate™ process (Cooper, 2002) is quite popular in both theory and practice, illustrated in Fig. 2.1.

Following the introduction of this process, there has been numerous research studies aiming to reveal best practices in managing new products (Cooper et al., 2004). The idea behind the process is to define each gate as a 'Go' or No Go' decision for NPD projects. Each gate decision refers to specific criteria which an NPD project has to clear in order to proceed further. The benefit of the deploying an NPD process is that it ensures that quality issues and risks are addressed at each stage of the process.

Studies in product innovation suggest that an effective NPD process (along with other factors such as resource availability and top management support) can be considered as antecedents for overall success of new product, which in turn is the critical component of firm performance (e.g. Cooper et al., 2001). However, the question to be asked here is: *Whether an effective NPD process is sufficient condition for superior firm performance?* The question can be partially answered from the synthesis of benchmarking studies conducted by the PDMA over time (Griffin & Page, 1993; Griffin, 1997; Barczak et al. 2009) and the work by Cooper and his colleagues (2004).

The key message that can be extracted from these studies is that even though the percentage of firms deploying formal NPD processes increases, the self-reported NPD performance tends to be constant (Barczak et al. 2009). Furthermore, these studies also indicated that firms are increasingly facing challenges when it comes to managing a set of NPD projects as a whole, i.e. portfolio management (Barczak et al. 2009). See Section 2.2.2 for the definition of product portfolio management as proposed by Cooper et al. (2001).

For taking a portfolio perspective on NPD projects, links between Stage-Gate and product portfolio management (see Figure 2.2) could be explored such as how portfolio decisions are taken, what the contextual factors that influences these decisions are, how firms organise for

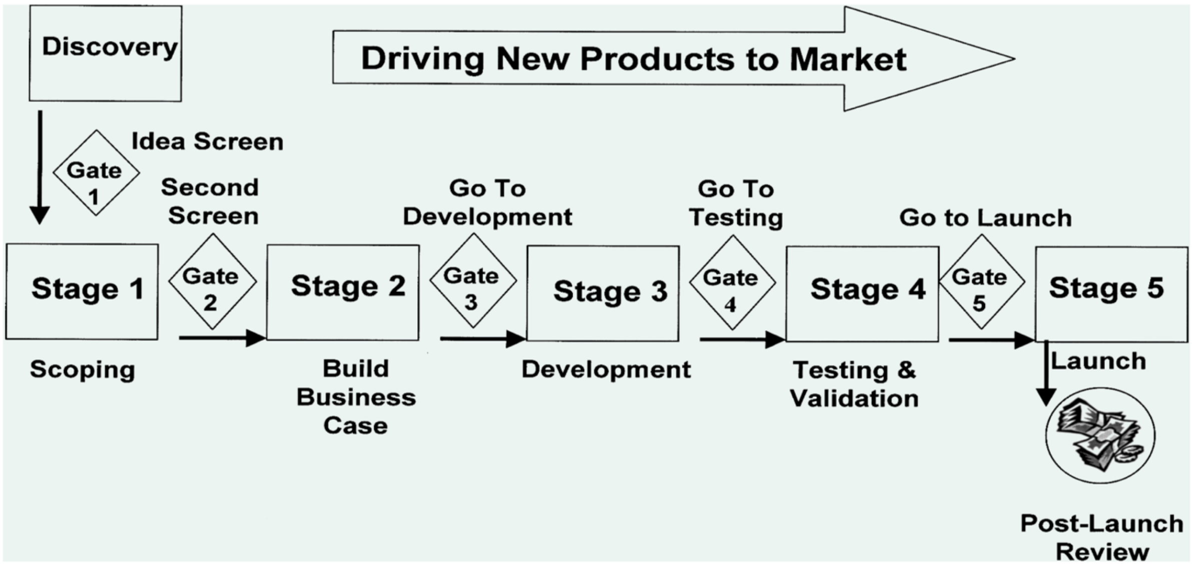


Figure 2.1: Stage-Gate™ Process (Cooper, 2002)

portfolio management, and what the key success factors of portfolio management are. As shown in Figure 2.2, as different NPD projects hit the milestones set by respective gates (depending on their progress) in the process, they are put forward into portfolio decision-making events, where decisions whether to continue or kill or hold NPD projects are taken. Periodically, the top or senior management of the firm, reviews NPD portfolios in order to develop and adapt the firm's overall strategic objectives or monitor their status of progress.

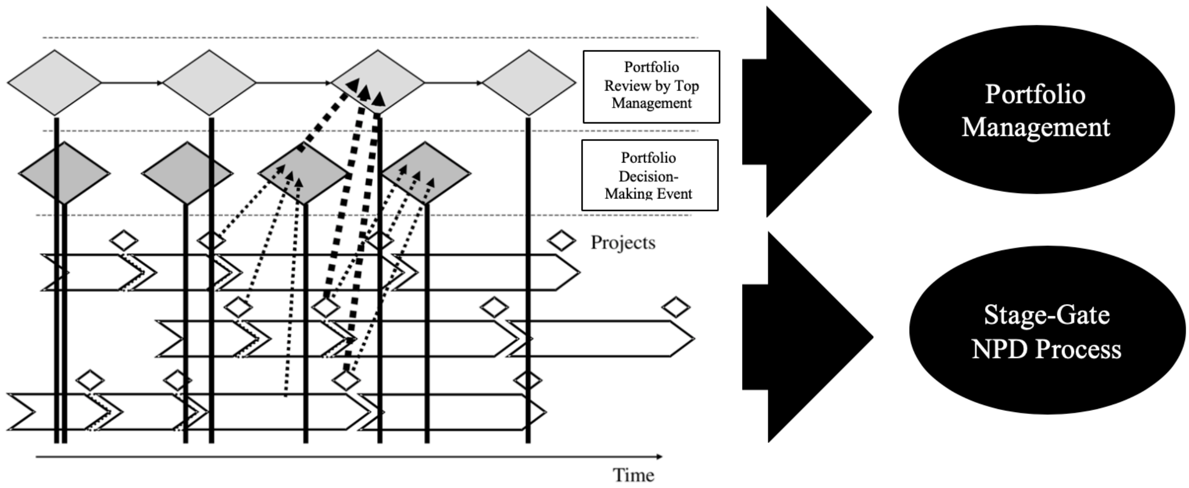


Figure 2.2: Linking Stage-Gate and Portfolio Management (adapted from Artto et al. 2007)

There have been several efforts to consolidate the literature on portfolio management (c.f. Meifort, 2015; Kwak & Anbari, 2008; Martinsuo, 2013), and these studies particularly call for investigating the processes underlying portfolio management (i.e. portfolio decision-making) and exploring those processes is the core focus of this PhD thesis.

Technology Portfolio Management

Similar to new product development processes, there exist a number of processes to manage technology[14] development. Among them, Technology Readiness Levels (TRLs) and Technology Stage-Gate models are prominent (Cooper, 2006). The common aspect of these models is that they are used to assess the development maturity or progress of technology development, following which decisions to continue or terminate can be taken. For example, a three-staged technology development model (and associated activities and deliverables) has been proposed by Cooper (2006) is presented in Figure 2.3. The idea is similar to product portfolio management in that at each stage-gate all technology development projects are reviewed, and decisions as to whether to continue or not are taken. However, the challenge of managing a set of technology investments, i.e. technology portfolio management, continue to exist. 'Technology portfolio' has been defined as "*a model for technological resource allocation and as an aid in choosing an optimal set of technologies from a set of feasible alternatives*" (Capon & Glazer, 1987).

[14] Capon & Glazer (1987) defines technology as "*know-how, more specifically (with respect to a firm), as the information required to produce and/or sell a product or service*".

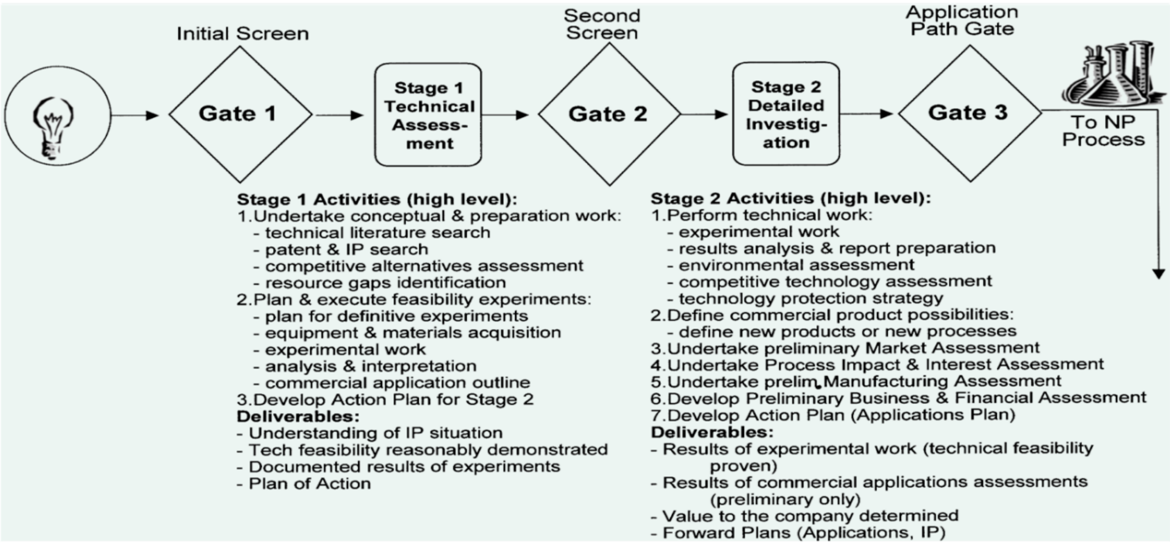


Figure 2.3: A Model for Technology Development (Cooper, 2006)

To conclude, corporate, product and technology portfolio management have been discussed based on relevant literature. The early contributions remain in the area of determining or fixing the appropriate composition of these portfolios but there has been an increasing interest in revealing the underlying processes which are used to enable decision-making of these portfolios. The focus of this research is primarily on product portfolio management or simply referred as portfolio management.

2.2.4 Goals

According to Cooper et al. (2001) and Dye and Pennypacker (2002), the three primary goals of portfolio management are:

1. Value Maximisation
2. Balance
3. Strategic Alignment

Value Maximisation

Cooper et al. (1998) stated that "*the first goal of portfolio management is to maximise the value of portfolio against one or more business objectives (such as profitability; strategic, acceptable risk*". This means that the value of an overall portfolio should be maximised. A variety of methods and tools can be applied to identify, assess and maximise a portfolio value, such as

Expected Commercial Value, Productivity Index, Dynamic Rank-Ordered List and Scoring Models (Cooper, 1998). This goal has been accepted by both academicians and practitioners.

Balance

A portfolio can be 'balanced' in terms of a number of key dimensions such as fit with business strategy, strategic importance to business, risk vs reward, probabilities of success, cost, time to completion, project types (e.g. new products, product improvements, extensions, cost reductions, technology or platform types) (Cooper 1998). Multi-dimensional matrices (also known as *bubble charts*) comprising two (and sometimes three or more) dimensions are used to aid portfolio balancing. However, these matrices have been criticised due to their static nature as they only provide a snapshot of portfolio (Phaal & Muller, 2009).

Strategic Alignment

Another important goal of portfolio management to focus the organisational resources on a set of projects that reflects organisational strategy. To view strategic alignment, a portfolio breakdown by spending across project types, markets, technologies can be understood (and often visualised) as to whether the portfolio reflects the strategic objectives or not. Among various techniques, top-down approaches are quite popular (e.g. s*trategic buckets*). Other techniques such as bottom-up approaches (e.g. *strategic criteria)* and hybrid methods are also discussed in the literature.

Additionally, a fourth goal has been increasingly suggested by leading portfolio management scholars, which is *Continuous Improvement or Evolution* of portfolio management (Arlt, 2010; Killen & Hunt, 2010; Petit, 2012). This goal is rooted in quality management and Dynamic Capabilities View (DCV) (Teece, 2007), using which portfolio management can be considered as a capability of a firm, which needs to be constantly revised due to uncertainties and changes in internal and external environments. This indicates that there exist levels of maturity of portfolio management that might have implications for firm performance.

2.2.5 Tools

The portfolio management literature is more inclined towards the development of numerous quantitative and qualitative tools, rather than focusing on portfolio management processes. As a result, there is a plethora of tools or methods for portfolio management such as scoring, optimisation, multi-criteria decision-making and visualisation. Before discussing various classifications of portfolio management tools, it is important to note here that this thesis is not focused on developing the new classification or methodology of tool selection. But since tools are an integral part of portfolio management processes, it is useful to discuss the important tools. A well-developed portfolio management system should explicitly mention and clarify which types of management tools should be used for which type of portfolio processes and goals. As mentioned before various scholars have developed the classifications of portfolio management tools. For example:

- Linton et al. (2002) classified the tools based on degree of objectivity in portfolio decision-making into two types: multi-criteria decision-making methods and subjective decision-support systems. The multicriteria method is focused on assessing individual projects and subjective methods are for assessing portfolio compositions as whole.

- Archer & Ghasemzadeh (1999), defining three types based on the argued that different tools are needed for different types of processes and their activities. For example, as shown in Table 2.2, NPV is used for analysing the value of a single project, and matrices are used for adjusting overall portfolio composition.

- Dawidson (2006) proposed the types according to the goals of portfolio management which they support, as shown in Figure 2.4. For example, for achieving a goal of portfolio balance, bubble charts and pie charts could be used. Further description of tools in this classification is provided below.

Tools for maximising portfolio value

The tools for this goal of portfolio management include Net Present Value (NPV), Expected Commercial Value (ECV), real-options and scoring models. For example, ECV is of a project depends on various aspects such as its cost of development, and likelihood of its technical and commercial success. Previous studies have revealed that a firm's performance is likely to be lowered if they rely merely on financial models (Cooper et al., 2001). This indicates that there is a need for more complementary aspects of financial valuation. The common challenge of these tools are cognitive biases and uncertain data, leading to poor estimates or information quality.

Tools for achieving portfolio balance

The tools for this goal include visual tools such as bubble charts, matrices, histograms and pie-charts. For example, Figure 2.5 shows a 2*2 matrix or bubble chart with two dimensions: reward (NPV) and probability of technical success, with the size of 'bubbles' normally indicating the amount of resources deployed (with colour representing a further dimension, such as market sector). In this case the projects named 'Solvent 800' and 'Top Seal' clearly skews the portfolio balance. However, even though these bubble charts are popular, the associated challenges include complexities in interpreting data when more than two dimensions are used, a static view (no time dimension), and a lack of reliable data.

Table 2.2: Classification of Portfolio Management Tools by Processes
(Archer &Ghasemzadeh, 1999)

Process stage	Selection stage	Activity	Potential methodologies
Pre-process	Strategy development, methodology selection, development of strategic focus, resource constraints, choice of model technique	Strategic mapping, portfolio matrices, cluster analysis, etc.	
Portfolio selection process	Pre-screening	Rejection of common parameters for each project	Manually applied criteria; strategic focus, champion, feasibility study avail.
	Individual project analysis	Calculation of common parameters for each project	Decision trees, uncertainty est., NPV, ROI, resource requirements, etc.
	Screening	Rejecting non-viable projects	Ad-hoc techniques (e.g. profiles)
	Portfolio selection	Integrated consideration of project attributes, resource constraints, interactions	AHP, constrained options, scoring models, sensitivity analysis
Post-process	Portfolio adjustment	User-directed adjustments	Matrix displays, sensitivity analysis
	Final portfolio	project development	Project management techniques, data collection

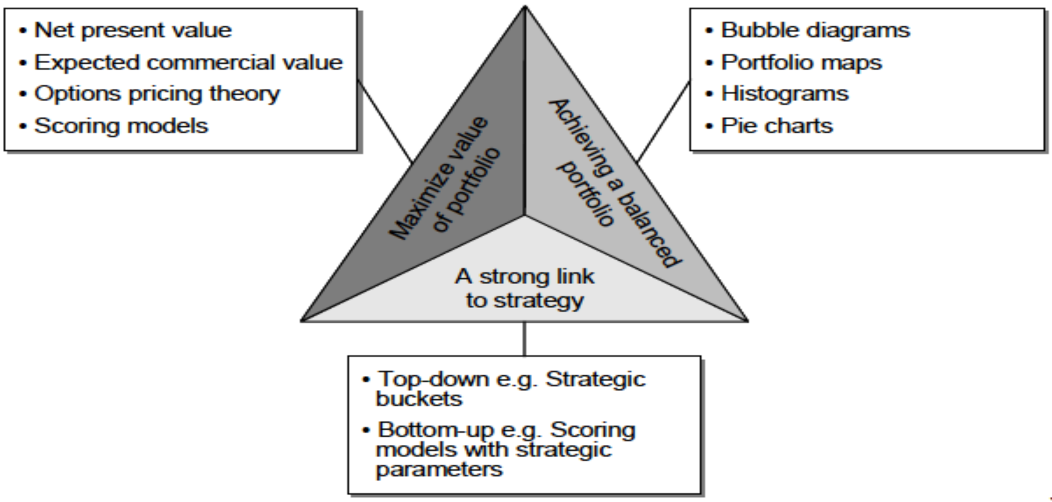


Figure 2.4: Classification of Portfolio Management Tools by Goals (Dawidson, 2006)

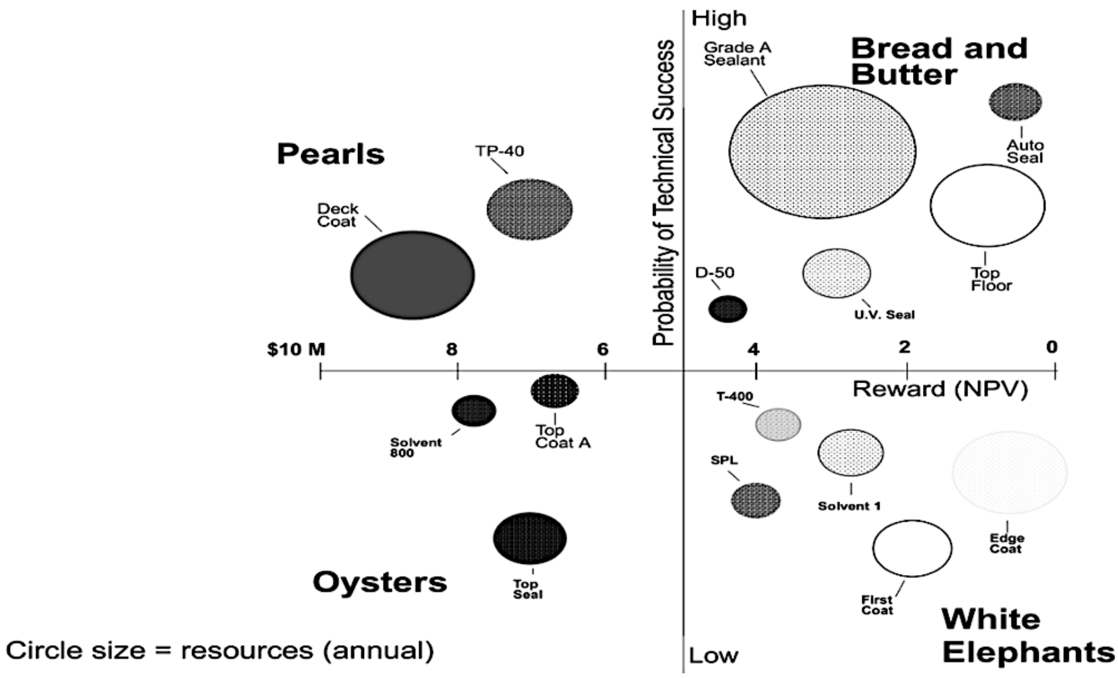


Figure 2.5: Bubble Chart for Visualising Portfolio Balance (Cooper et al., 2001)

Tools for achieving strategic alignment

The tools for achieving this goal include the use of strategic buckets and strategic criteria methods. Portfolio management is considered as a vehicle to plan and deliver strategic benefits to a firm. Strategic alignment (i.e. ensuring portfolio reflects business strategy) is one of the core goals of portfolio management. Within strategic management, two schools of thought have gained the majority of attention: "*planning*" or rational school and the "*learning*" or adaptive school (Mintzberg, 1987). The planning school takes the rational approach (i.e. structured and controlled) and the learning school argues that planning emerges and adapts over time rather than being deliberately controlled. The model of rational planning emphasises a top-down approach that resonates with *strategic buckets,* the top-down strategic alignment technique, proposed by Cooper et al. (1998). On the other hand, the learning school seeks to develop strategy from a bottom-up perspective, resonating with Cooper's bottom-up strategic alignment technique, in which the *strategic criteria* are built into decision-making criteria for projects in a portfolio, with strategy emergent.

Scholars have called for the integration of both the schools, known as 'rational adaption' (Segars et al., 1998), similar to the hybrid approach of strategic alignment. The question of *what the dimensions of strategic alignment are* has not been addressed to a significant extent, with the notable exception of Say et al. (2003), who have proposed such dimensions for strategic alignment of a portfolio, for example:

- Size and nature of future business goals (by markets)
- Meeting time requirements
- Return on existing assets (e.g. technology)
- Investment in new assets
- Balance between business objectives (e.g. line extension vs new products)
- New Sales Ratio goal

The Strategic buckets method operates on the principle that "*implementing strategy equates to spending money on specific projects*" (Cooper et al., 1998). This begins with senior management developing business strategy for a firm and making choices along different dimensions such as market segment, project type, type of product lines and technology types, resulting in 'envelopes of money' or 'buckets' with their budgets. Then each of the new and existing projects are evaluated and distributed into one of these buckets. Following which, the gap (if any) between planned budget and actual spending for each bucket is identified and closed. For example, Figure 2.6 shows four strategic buckets (and associated program and their ranking scores) of a business unit of a firm, which include investments in advanced technologies, cost reductions, new products, and improvement and modifications.

However, developing strategic buckets is often perceived as a complex and heuristic task by senior management. Overall, there are some challenges in operationalising this method: (a) it can be argued that strategy should not always be developed using a top-down approach, and there should be space or structures to allow strategy to emerge itself; (b) sub-optimisation of each bucket; and (c) lack of guidance on how to close gaps in strategic buckets.

The Strategic criteria approach indicates that strategy is implemented or delivered when a firm evaluates new and existing projects against a number of strategic criteria, making resource allocation decisions accordingly. Cooper et al. (1998) stated that "*Strategy begins when you start spending money! Until you begin allocating resources to specific activities – for example, to specific development projects – strategy is just words in a strategy document*". This suggests that even when a firm has decided where to invest or allocate its resources, the strategy is not

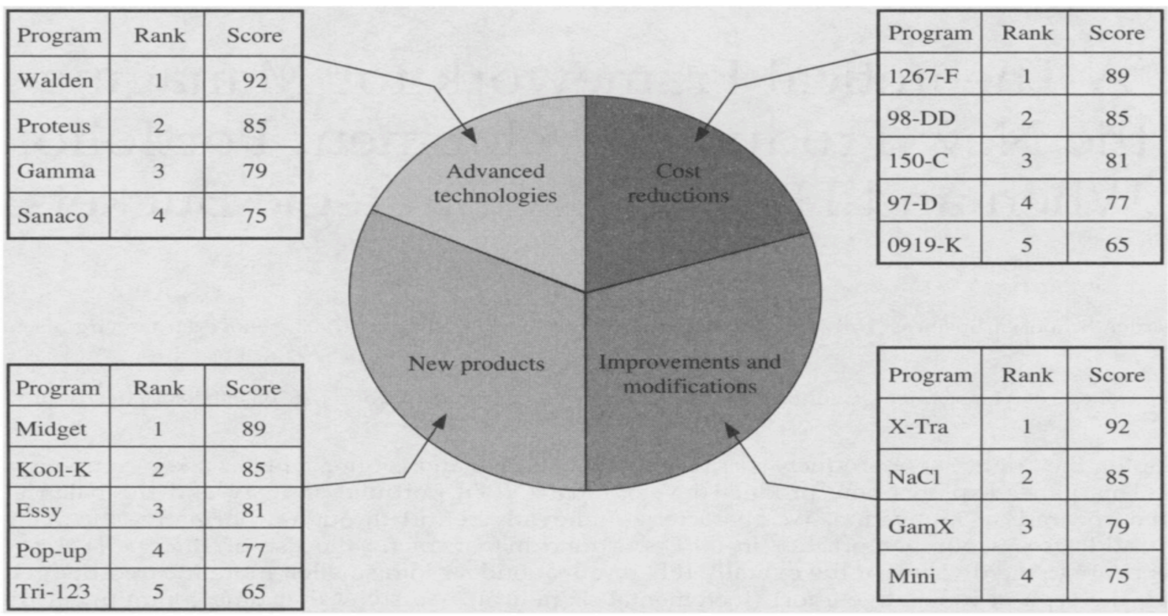


Figure 2.6: Example of Strategic Buckets Method (Chao & Kavadias, 2008)

implemented until and unless the projects reflecting those priorities are resourced and carried out. This is because projects are considered as a vehicle to implement strategy, and result in tangible benefits such as profit or sales (for example in the case of product innovation or new product development).

Adding the argument that strategic alignment should be achieved over time, Sanchez and Robert (2010) provided a framework to ensure strategic benefits from overall portfolio are delivered on time (see Figure 2.7).

The benefit of strategic alignment of portfolio or portfolio strategy is that it gives a sense of direction (e.g. product & technology development) for resource allocation, or defines the key strategic objectives to be achieved, which forms the basis of resource allocation. Another benefit is that it helps in determining the portfolio characteristics such as budget, composition, type of product development strategy.

Overall, management tools are an integral part of portfolio management in the way they help in assessing the value of individual projects and ensure that portfolio composition is balanced or appropriate, and strategically aligned. However, the extent to which portfolio management goals are achieved depends on how well the processes are carried out to enable portfolio decisions such as project selection and project termination to achieve these goals.

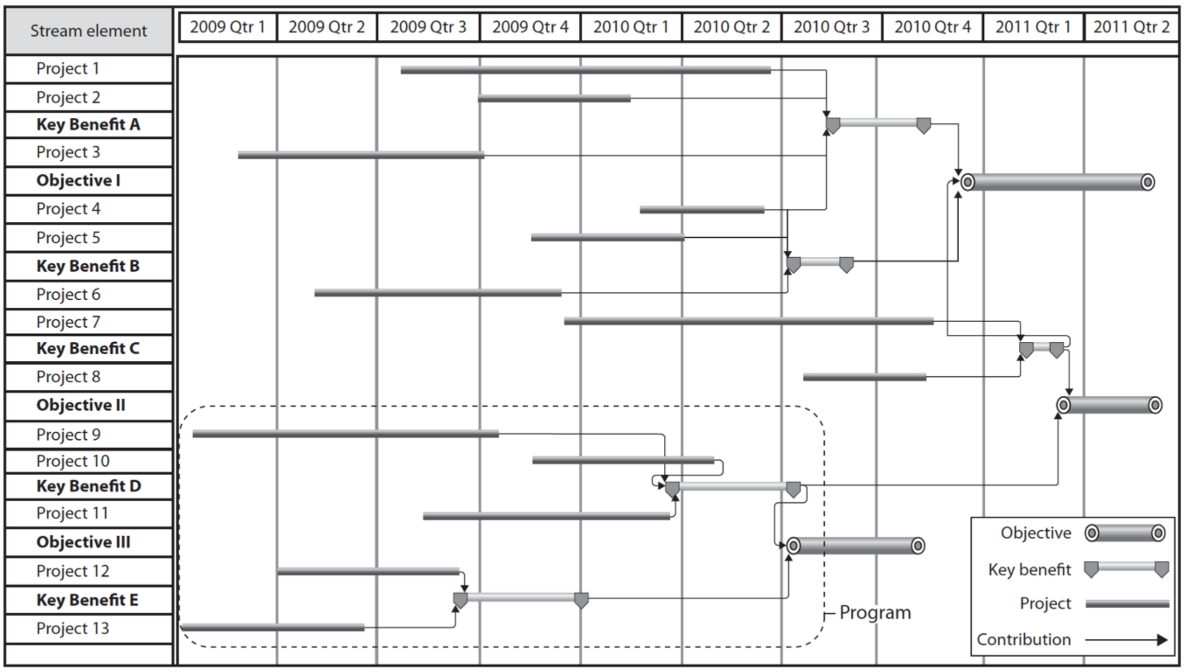


Figure 2.7: Strategic Benefits Roadmap (Sanchez and Robert, 2010)

2.2.6 Process Models

Before discussing different portfolio management process models, it would be useful to first understand key portfolio decision types (e.g. project selection, termination) for which these processes are carried out.

Project Selection

Project selection includes the process of allocating resources after evaluating or screening new project proposals against pre-determined criteria. It is a complex task as the information quality about technology, market, scope and revenue is often considered as quite poor and uncertain at the earlier stages and gates of the NPD process, often called the 'fuzzy front end' (Kock et al., 2014; Kahn et al., 2006). With more novel NPD projects, project selection becomes more difficult and could result in lower level allocation of resources than requested (Criscuolo et al., 2017). Since NPD is critical for firm performance (Cooper et al. 2001), firms have to set up the process of selecting the 'best' new product projects from a pool of potential projects. The core of project selection is the criteria used for assessing the proposals. The criteria used for screening projects has been an important aspect of portfolio management process design, with implications for portfolio management performance (Cooper et al., 2001; Jugend et al., 2013; Lerch & Spieth, 2013). For example, in a benchmarking study in 1998 by Cooper et al. found that higher performing firms tend to use a mix of financial and non-financial criteria.

The type of project selection criteria to be used depends on the type of decision-making processes used for portfolio decisions. For example, Kester et al. (2011) revealed that 'synoptic formalist' decision-makers used financial and quantitative criteria for assessment, 'incremental' decision-makers used their experience and intuition with qualitative criteria for project selection, and 'integrative' decision-makers used a mix of the above two. Different criteria can be used at different stages and gates of NPD process, therefore implying different criteria classifications types. For example, one classification of criteria was proposed by Cooper and colleagues (1998), describing four dimensions against which proposals can be assessed: (a) product strategy (or alignment of new product ideas with new product strategy); (b) market opportunity (available portion of market share which can be captured with the idea); (c) product opportunity (financial potential and product life); (d) synergy with existing resources (e.g. production and supply chain). The later contributions suggested that multi-functional criteria are more useful for assessing proposals. For example, Mitchell et al. (2018) provided orthogonal criteria for opportunity (or impact) and feasibility (or ease / appropriability) as shown in Table 2.3 below, with the relative merit determined by the product of opportunity (O) and feasibility (F), a proxy for return on investment (ROI).

Project Termination

Project termination is one the most challenging tasks for portfolio decision-makers due to sunk costs, escalation of commitment and other organisational contextual factors such as politics. Project termination involves the process of assessing on-going projects as to whether they are expected to deliver benefits to an organisation or not; if not these 'bad' projects may be terminated or put on hold until more certain information about the project is derived.

The benefits of project termination include increases in strategic fit as the resources can be freed up by terminating the 'bad' projects, which can then be allocated to more relevant projects (Unger et al., 2012; Lechler & Thomas., 2015). Few studies have explored the sources of escalation of commitment in portfolio decisions which include personal responsibility for projects and independent sources of information (e.g. Schmidt and Calantone, 2002).

A study by Lechler & Thomas (2015) proposed the concept of project termination decision quality, and empirically argued about its antecedents, and Unger et al. (2012) provided evidence that the better the termination quality, the better would be the strategic alignment of a portfolio. Various contextual factors that influence project termination include top management involvement, managerial dispositions to terminate a project, and portfolio attributes.

A key message here is that importance of project termination is widely acknowledged but the extant literature remains silent on how to be more rational, transparent or analytical in the process of a project termination.

Table 2.3: Project Selection Criteria (Mitchell et al., 2018)

Dimension	Factor	Explanation
Volume	Market size	Size of potential market, or number of potential adoptions, reasonably available to us
	Our sales potential in a given time	Sales volume or number of adoptions anticipated in a defined time (say, 5 years)
	Synergy opportunities	Possible additional benefits to other projects or activities; or the possibility of new opportunities in combination
	Customer benefit	Identifiable benefit to customers (internal or external) or potential adopters
	Competitive intensity in market	Number or significance of the competition
Margin	Increased margin, or benefit per unit	Improvement in product margin (e.g. by cost reduction or price premium) compared to existing products; or benefit to us per adoptions
	Business cost reduction or simplification	Contributes towards cost reduction or simplification of business process
	Industry / market readiness	How easy will it be for customers or adopters to take up the product; do they have to change their behaviour or processes?
Platform for future growth	Market growth	Anticipated growth rate of market
	Future potential	Product is a platform for future products or could open new markets beyond the project timeframe
Intangibles	Learning potential	Will improve the knowledge or competence of the business
	Brand image	Will improve the image of the company with investors, customers or other stakeholders
	Customer relations	Project is important for retaining key customers

Dimension	Factor	Explanation
Characteristics of the product	Product differentiation	How well the product is differentiated from those of major competitors
	Sustainability of competitive advantage	Our ability to sustain our competitive position (e.g. IPR, brand strength)
	Technical challenge	How confident are we that the proposed product is technically feasible at all?
Skills and knowledge	Market knowledge	Our understanding of size and requirements of the market
	Technical capability	Do we have the required technical competences to complete the project?
Business processes	Fit to sales and/or distribution	Fit to our sales competences and/or distribution chain
	Fit to manufacturing and/or supply chain	Ability to manufacture or supply the product
	Finance	Availability of finance for the project
Organisational backing	Strategic fit	How well does the project fit our company strategy?
	Organisational backing	Level of staff or management backing at an appropriate level

Overall, the literature on project selection and termination is compartmentalised and associated with separate streams of research. However, the basis of selection and termination is closely aligned with the business cases for projects, which is explored only a few studies in the literature. For example, Kopmann et al. (2015) provided empirical evidence that business case control has the potential to influence the extent to which portfolio management goals can be achieved. However, what the components and practices of business case management are rarely revealed.

As previously discussed, there exists a variety of portfolio management definitions; similarly, the extant literature proposes a number of portfolio management process models. There is no commonly accepted model, but it is argued that the models have to be configured or adapted according to the context of the focal portfolios and organisations. The purpose here is to review and discuss key process models (see Table 2.4) underlying portfolio decisions:

- **Portfolio Management Process Model by Cooper et al. (1998)**

Cooper et al. (1998) suggested a model called ‘Product Innovation and Technology Strategy’ (PITS) in which they argued for close and cyclical linkages between new product development processes (such as the Stage-Gate process) and portfolio review processes. The main idea is that projects at each gate or review point in the process are considered in portfolio review meetings in which the decisions are taken considering the overall portfolio composition and goals.

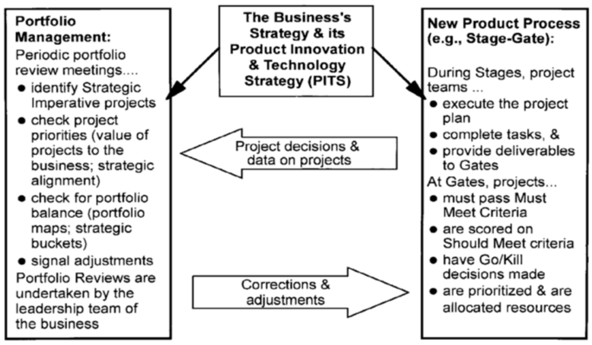
- **Portfolio Management Process Model by Archer & Ghasemzadeh (1999)**

Expanding on a particular aspect of a portfolio review or decision-making event, a model for portfolio selection was introduced by Archer and Ghasemzadeh (1999), in which there is an iterative loop between individual project analysis and project development until it reaches successful completion. They divided the whole process into three stages: Pre-process, Portfolio Selection Process and Post-Process. However, there is not much guidance or description on the constructs of strategy development and method selection in this framework. To address this gap, Arlt (2010) extended this framework and proposed a number of steps involving clarification about the availability of good quality data, determining the level of organisational acceptance and maturity level of portfolio methods.

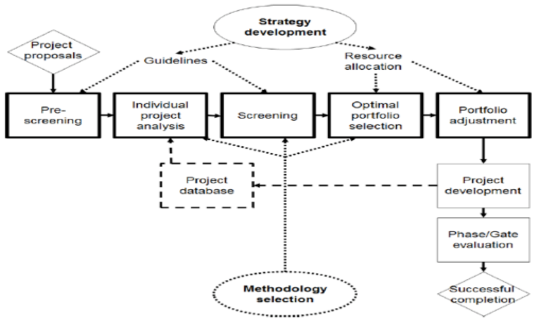
- **Portfolio Management Process Model by Patterson (2005)**

In an attempt to provide a more comprehensive picture of portfolio management, a model was proposed by Patterson (2005). This model shares similarities with the one provided by Archer and Ghasemzadeh (1999). For example, portfolio planning in this model is similar to strategy analysis and portfolio to portfolio adjustment stages. In this model, the strategic direction of the portfolio is defined by product and technology roadmaps after scanning for opportunities or threats from technology and market perspectives. Following this, the portfolio is assessed, which means individual projects are reviewed, and it is decided whether to pursue the project (or not) and then resources are allocated. Common to other models, there is a loop between the portfolio management and new product development projects.

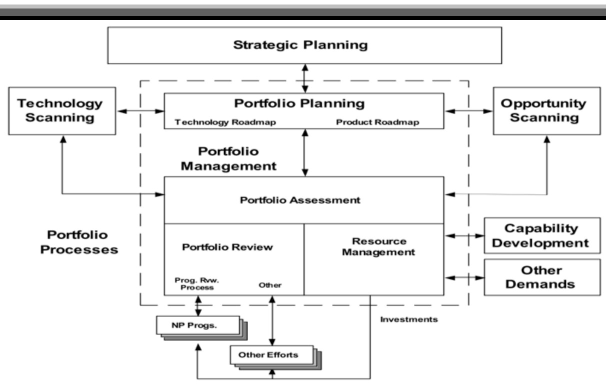
Table 2.4 Portfolio Management Process Models



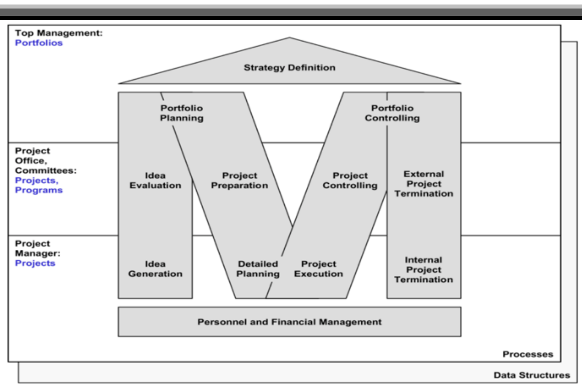
Cooper et al. (2001)



Archer & Ghasemzadeh (1999)



Patterson (2005)



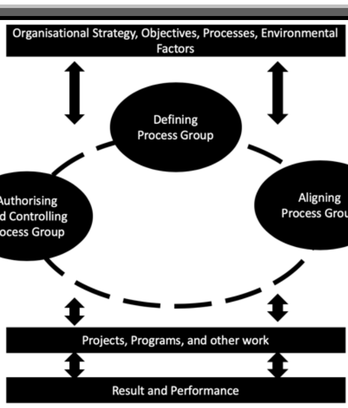
Ahlemann (2009)

Formal managerial tasks derived from a process-based definition.

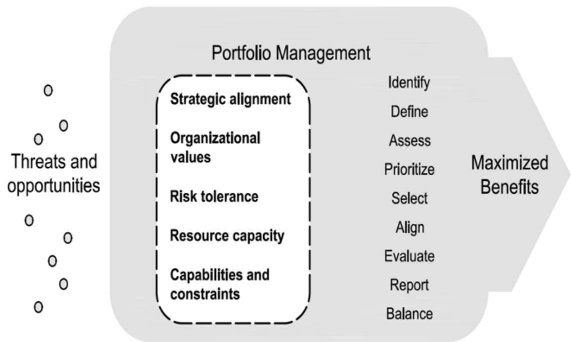
Phase
Portfolio structuring (cyclic)
Strategic (portfolio-) planning
Definition of the long-term target portfolio
Evaluation of project proposals
Deliberate selection of projects
Resource management
Cross-project resource planning
Formal resource approval
Conflict management in case of resource conflicts
Resource re-allocation in reaction to short-term change requests
Portfolio steering (continuously)
Monitoring of the strategic alignment of the portfolio
Development of corrective measures in case of deviations from the target portfolio
Identifying synergies between projects
Coordination of projects across business lines (e.g., divisions or departments)
Organizational learning and portfolio exploitation
Evaluation of project results
Post project reviews (e.g., benefits tracking) at a later date
Store and maintain relevant knowledge after project closure
Utilization of lessons learned from earlier projects

Jonas (2010)

OGC (2009)



Adapted from PMI (2013)



ISO (2016)

- **Portfolio Management Process Model by Ahlemann (2009)**

The models discussed so far do not clarify what the underlying practices or components of these activities are, nor what organisational levels they are carried out at. To address this, a process model called the 'M-Model' by Ahlemann (2009) could be useful. This model defines three levels of hierarchy and indicates the respective portfolio management related activities. For example, at the project management or team member level, the focus is on generating ideas, project planning and execution. At the next level, ideas are evaluated, and project related reports are developed, and at the top level, strategy is defined, and portfolio is planned and controlled. Overall portfolio management is based on strategy defined by top management of a firm. Another distinct feature of this model is that it explicitly indicates the need of supporting structures such as project office, committees, personnel and financial management functions in the overall portfolio management process, which are missing in the previously discussed models.

- **Portfolio Management Process Model by Jonas (2010)**

In an attempt to develop a process model based on managerial tasks, Jonas (2010) proposed four key inter-dependent and chronologically sequenced stages: portfolio structuring, resource management, portfolio steering, and organisational learning and portfolio exploitation. Portfolio structuring is a cyclical phase in which portfolio strategy is defined, and components to achieve the strategy are identified and selected. Then, resources are allocated to the components, and associated conflicts are resolved. Following this, the portfolio is steered in a such a way that it remains aligned with strategy, and if not, corrective actions are taken. Finally, when projects are completed, post-implementation reviews are conducted, and the knowledge generated is gathered and applied in the overall portfolio management system. This model describes the phases and their activities quite well, but it does not identify the components of each activity and does not indicate the importance of supporting structures as given in the M-Model.

- **Portfolio Management Process Models by OGC, PMI and ISO**

The models described so far are primarily from the academic literature, but the models such as the OGC (2009), PMI (2013) and ISO (2015) process models are also gaining attention by both academic and practice-oriented scholars. For example, the OGC model includes two key processes: portfolio definition and delivery. The portfolio definition process covers strategic aspects of portfolios, such as planning and balancing, while the delivery process relates more to the operational side of portfolio management, such as governance, risk management, benefits management and resource management. Similarly, The PMI's three process groups: defining process, aligning process group and authorising controlling process groups, overlaps with portfolio definition and portfolio delivery processes, respectively (PMI, 2013). Another model has been introduced by the ISO, in which threats and opportunities are assessed, following which various actions such as identification, assessment and selection of portfolio components are carried out to maximise benefits, with all these activities performed in the context of organisational values, risk tolerance capacity and constraints.

Overall, a concern with the above process models in both academic and industry is that they tend to more prescriptive than descriptive, i.e. very limited or no guidance exists on how to operationalise these models, or as to what the associated or underlying management practices are. Another underexplored aspect of these models is how the different processes in these models are related or inter-connected, and what the relationship between them is. These models vary in terms of scope (organisational levels involved), empirical derivation (evidence of deployment and consistency in practice), and completeness (the extent to which key portfolio processes and supporting activities or structures are included).

Overall, Section 2.2 discusses key portfolio management concepts such as its origins, types, goals, tools and process models. Among various other types of portfolio management, product portfolio management (or simply portfolio management) is relevant to this research. There exists a variety of portfolio management tools (such as scoring models, ECV, matrices and strategic buckets) to achieve three goals of portfolio management: value maximisation, balance and strategic alignment. The variety of portfolio management process models are discussed in the extant literature, but guidance on operationalising them (such as key portfolio management processes, structures and underlying practices) and understanding of their inter-relationships are limited. This suggests that portfolio management body of knowledge warrants further investigation as to further explore and develop its processes and structures. After gaining the overview of portfolio management concepts, the next section discusses portfolio management challenges.

2.3 Portfolio Management Challenges

As mentioned in Section 1.1, technology-intensive environments can be characterised by high levels of market and technical uncertainties, rapidly changing customer needs, and shrinking product-lifecycles (Hauser et al. 2006; Eisenhardt, 1989), firms operating in such environment often face challenges in undertaking portfolio decisions under these uncertainties. Before outlining such challenges, it would be useful to review the concept of strategic decisions.

This is because portfolio decisions are often labelled as strategic decision (Eisenhardt and Zbaracki, 1992; Atuahene-Gima and Li, 2004; Mulebeke and Zheng, 2006) because they involve resource allocation of critical and unique resources of a firm done by top management under uncertain conditions. The purpose here is to identify key practical challenges which can be addressed to improve overall portfolio management performance (See Appendix 2A for further information).

2.3.1 Strategic Decisions under Uncertainty

Strategic decisions can be broadly understood as decisions involving significant resource commitments by the top management of a firm under uncertain conditions (Elbanna, 2006) and this is the reason why portfolio decisions are an instance of strategic decisions. The central tenet of the research on strategic decisions is that strategic choices (or content view) and strategic decision-making (or process view) have an influence on firm performance (see Figure 2.8). Numerous studies have investigated the link between strategic choices (e.g. Child, 1972; Hambrick, 1980; Snow & Hambrick, 1980) and decision-making processes (Elbanna, 2006), on firm performance[15].

[15] The construct of *Firm Performance* has been operationalised and measured using various items across number of studies. Firm performance can be broadly divided into two: economic and non-economic performance. As the purpose here is neither to investigate different measures of firm performance or to actually assess firm performance empirically, it would be useful to discuss relevant measure(s) used in portfolio management studies. One of the most common constructs of firm performance includes customer satisfaction, market effectiveness and profitability). For example, see Vorhies and Morgan (2005), Kester et al. (2014) for further details.

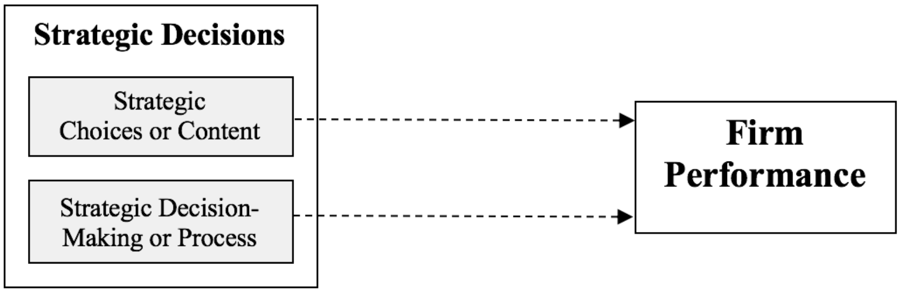


Figure 2.8: Strategic Decisions and Firm Performance (Source: Author)

Strategic Choices include choices as to how a firm plan to compete in its environment or strategy archetypes of its components such as products, technology, manufacturing and operations and marketing. For example, it could exist in a form of the new product development strategy – whether a firm plan to become a leader or follower in a new or mature market segment for its products. Another classic example is the Ansoff or Product-Market Matrix (Ansoff, 1965), which aids in deciding what the strategic orientation of a firm should be, depending on the position of its products in one of the four quadrants as shown in Figure 2.9.

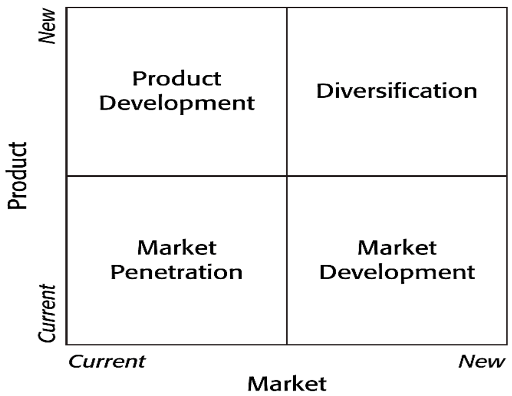


Figure 2.9: Ansoff Matrix (Ansoff, 1965)

Along similar lines, Porter's general strategies of cost leadership, differentiation and focus can be considered as strategic structures or choices which a firm might pursue to achieve competitive advantage (Porter, 1980; Prahalad & Hamel, 1990). Other examples of strategic choices include innovation vs reliability (Miles and Snow, 1978) and innovation timing vs focus. The concept of strategic choice has been linked with firm performance as well (Voss &Voss, 2000; Kohli & Jaworski, 1990).

Numerous studies have also investigated the role of strategic decision-making processes on firm performance (e.g. Dean and Sharfman, 1996; Thune & House, 1970). Different characteristics of decision-making, such as rationality, politicisation, rule formalisation, centralisation and speed (or pace) have been linked with firm performance (Papadakis et al., 1998; Baum & Wally, 2003; Eisenhardt & Zbaracki, 1992). For example, Baum & Wally (2003) collected data on determinants of decision-speed and firm performance from 318 CEOs and found that the decision speed is positively associated with firm performance. Another example is a study by Eisenhardt & Bourgeois II (1988) in which they explored decision-making in the microcomputer industry, finding that politically centred decision-making is linked with poor firm performance. Thune and House (1970) and Ansoff et al. (1970) argue that firm perform better when a formal strategy decision-making system is in place, while other studies found contrary (Fulmer & Rue, 1974; Whitehead and Gup, 1985) or non-significant effects (Karger and Malik, 1975).

Overall, it can be concluded that both strategic choices and decision-making processes have implications for firm performance. However, the essence of strategic decisions is that firms proactively or reactively try to align their objectives and capabilities with opportunities, threats and constraints in external environment (Papadakis et al., 1998). This external environment is often labelled as uncertain. Uncertainty[16] in the external environment exists in multiple forms such as market uncertainty, technical uncertainty and strategic uncertainty.

As a result, different studies use different constructs or measures to characterise uncertainty. For example, Eisenhardt & Bourgeois II (1988) use the term 'high-velocity' environment to indicate "*rapid and discontinuous change in demand, competitors, technology or regulation, so that information is often inaccurate, unavailable or obsolete*". Other examples of uncertainty constructs include turbulence, growth and instability (Floricel et al., 2008). Uncertainty is understood to be a considerable influencing factor on both strategic choices and decision-making, and as well their relationships with firm performance (c.f. Child, 1972); see conceptual representation in Figure 2.10.

[16] Some authors argued that *Uncertainty* is a broader concept than Risk. Risk management is more focused on opportunities and threats, whereas uncertainty management focuses on exploring and understanding origins or sources of uncertainty in addition to managing opportunities or threats emerging from those sources (as described in Petit, 2012).

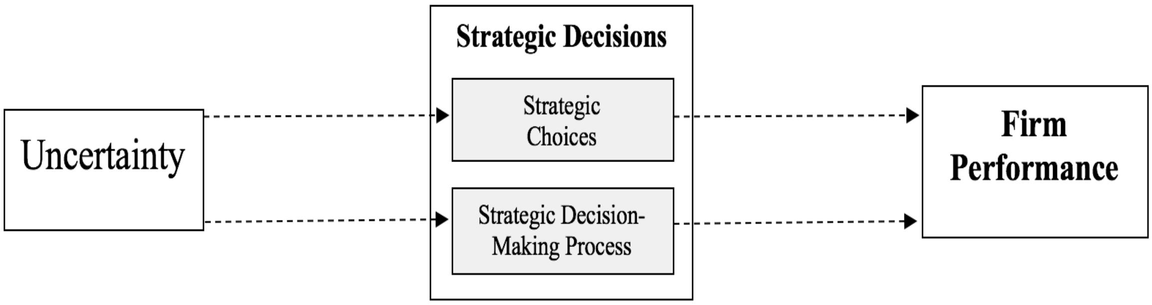


Figure 2.10: Conceptual Representation of Strategic Decisions under Uncertainty (Source: Author)

For example, Khandwalla (1977) argued that a manufacturing firm undertakes strategic choice of cost reduction in response to stresses experienced from the external environment. Another example is provided by study of the Miles and Snow (1978), in which they proposed three strategic postures or orientations depending upon uncertainty perspectives: prospectors, defenders and analysers. Similarly, the impact of uncertainty on the decision-making process has also been investigated (e.g. Dean and Sharfman, 1996), with uncertainty in the environment also making decision-making uncertain. For example, Dean & Sharfman (1996) showed that environmental instability moderates the relationship between procedural rationality of decision-making and strategic decision effectiveness. Supporting this argument, Goll & Rasheed (1997) found that in high environmental dynamism, the relationships between rationality and firm performance are stronger.

To conclude, strategic choices and decision-making process are both influenced by environmental uncertainty and have implications for firm performance. Portfolio decisions can be considered as a type of strategic decisions because they involve a considerable amount of resource allocation among different projects by top management teams under uncertain conditions (Elbanna, 2006).

2.3.2 Portfolio Decisions under Uncertainty

Firms operating in technology-intensive environment take portfolio decisions such as project selection and termination (discussed in the Section 2.2) under uncertain conditions as the criteria used often relate to future anticipated conditions and outcomes. Similar to strategic decisions in general, portfolio decisions can be explored from two views: portfolio strategic choices (content) and portfolio decision-making (process), which have implications for portfolio management performance and eventually firm performance (see Appendix 2A). Moreover, these decisions and their relationships with the two performances are also influenced by the environmental uncertainty (as conceptually depicted in Figure 2.11). Also portfolio choices and portfolio decision-making could be linked to two aspects of portfolio management (as mentioned in Section 2.2.2) planning and decision-making respectively. Considering the link between portfolio choices and firm performance, a study by Kang & Montoya (2014) first conceptualised portfolio strategy as: (a) introduction intensity (from product development strategy) – i.e. rate of introduction of new products in a portfolio; (b) pioneering intensity (from market entry strategy) – i.e. rate of first-to-market launches in a

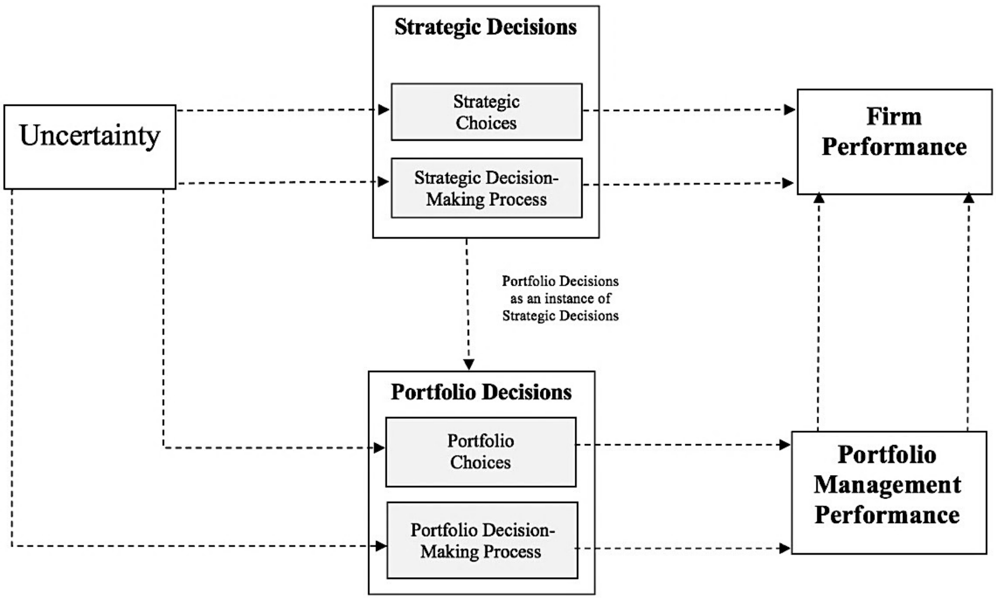


Figure 2.11: Portfolio Decisions under Uncertainty (Source: Author)

portfolio; (c) Composition of portfolio components based on integration of new product development strategy (mature vs new) and market entry strategy (leading vs following), revealing four types of strategic archetype for portfolio components, and provided empirical evidence of its influence on firm performance.

As shown in Figure 2.12, a framework proposed by Meskendahl (2010) particularly explicated the links between portfolio choices (as strategic orientation) and portfolio decision-making process (as portfolio structuring) with portfolio management performance (as project portfolio and business success). Strategic orientation deals with the characteristics of a business strategy, which in turn describes how a firm intends to compete in an industry in comparison to its competitors. Strategic orientation consists of analytical, risk taking and aggressive postures, and these postures have an impact on portfolio management process design and eventually performance. For example, a more analytical posture will help with due-diligence on investment proposals, resulting into better resource allocation (Meskendahl, 2010).

Similar to strategic decisions under uncertainty, quite a few studies investigated portfolio decisions under uncertainty. For example, the impact of environmental dynamics or uncertainty on portfolio strategy or choices has been studied by Chao & Kavadias (2008). They argue that

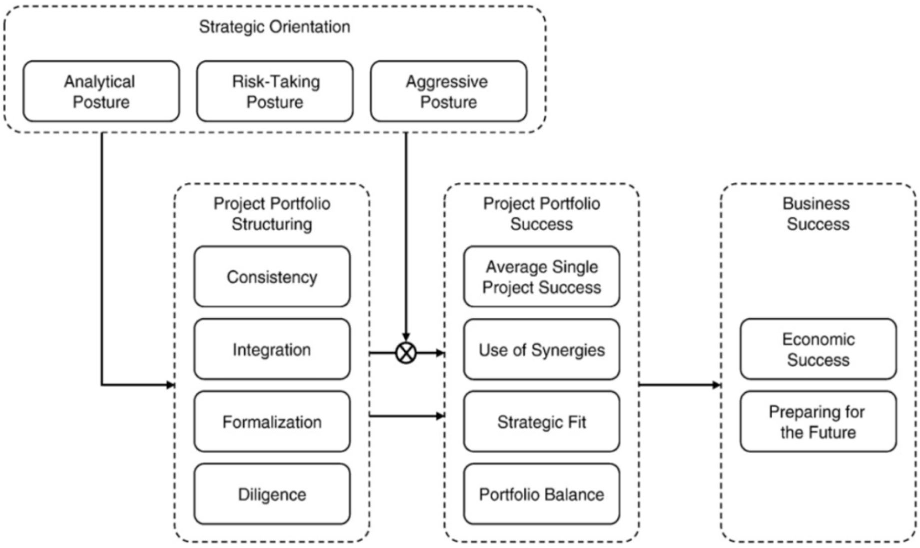


Figure 2.12: Influence of Strategic Orientation and Portfolio Structuring on Portfolio Management Performance (Meskendahl, 2010)

portfolio strategy needs to be adapted to changes in the external environment of a firm. They provided guidance on managing strategic buckets depending on environmental complexity and instability. For example, if the environment is highly instable, the approach to maximising portfolio value is to focus on the development of incremental products (i.e. one of the architypes of product development strategy; which eventually determines innovativeness of a portfolio).

However, the impact of uncertainty on portfolio decision-making process has not been the focus of attention for management scholars. a few notable studies have explored these aspects.

For example, Klingebiel & Joseph (2015) argued that portfolio decision-making should be more selective in highly uncertain environments if a firm's strategy is to be a follower for its product development and should be more open if a firm's strategy is to be a leader in the same environmental conditions. Along the similar lines, Floricel & Ibanescu (2008) proposed that depending on environmental dynamics, the portfolio management process should be adapted accordingly. One of their empirical findings was that in technology-intensive environments portfolio decision-making should be more structured and integrated.

Overall, it can now be said that similar to strategic decisions, portfolio decisions influence portfolio management and firm performances and are impacted by uncertainty. Having gained a broader overview of strategic portfolio decisions under uncertainty, it will be now useful to explore the variety of portfolio management challenges and particularly with aim to answer the following question, *what are the key portfolio management challenges, what are the sources of these challenges, and are these sources linked to uncertainty?*

2.3.3 Challenges in Portfolio Management

The challenges in portfolio management have been revealed by a number of benchmarking studies and surveys (e.g. Cooper et al., 2001). These studies also reveal that poor portfolio management performance (or ineffectiveness) has been a common pain point for many firms across multiple industry sectors. For example, a benchmarking study by Cooper and his colleagues (1998) indicates that two thirds of the participating firms tended to not be satisfied with their portfolio management approaches and are not in a position to recommend their approach to others with confidence. In particular, portfolio management challenges could be broadly classified into two categories:

- **Strategic Dilution**: when the link between NPD projects and organisational strategy gets fuzzy and does not reflect strategic priorities (Cooper et al. 2001; Repenning, 2001). It could also be the situation when portfolio having too many small and low impact projects (Cooper et al., 2001)

- **Portfolio Overload**: tends to happen when there too many projects in a portfolio for the available resources. As a result of this, resources may be thinly distributed over the projects, leading to gridlock or insufficient market studies in projects, and ‘firefighting’ (Repenning, 2001) Another interpretation of portfolio overload could be skewed portfolio balance between the ratio of incremental to radical products, leading to lower sales (Barczak et al., 2009; Griffin 1997; Griffin & Page, 1993). This challenge has been further attested by results from a global survey conducted by the APM and consulting firm Wellingtone[17] in 2016. The survey established the state of project management with the response of 686 practitioners in 318 organisations (UK based), revealing that attempting to do too many projects is the largest challenge in portfolio management, which is portfolio overload.

It is not surprising that two of the above two challenges portfolio overload and strategic dilution can contribute to the NPD failures, eventually lowering portfolio management and firm performance (Cooper et al. 2001; Repenning, 2001; Barczak et al. 2009). The ability to overcome these two challenges is potentially the factor that most significantly differentiates best and worst performing firms (Cooper et al. 2001); see Figure 2.13. Put another way, overcoming these two challenges has implications for portfolio management performance. For example, strategic dilution can be related to portfolio management goals: strategic alignment and value maximisation, and portfolio overload can be related to portfolio balance. As mentioned in Appendix 2A, the literature has empirically started acknowledging the positive association between portfolio management performance and firm performance.

Poor Information Quality

Information quality can be considered poor when information is inaccurate, incomplete or obsolete (Eisenhardt & Bourgeois II, 1988). The market and technical uncertainties could lead to poor market forecasting estimates and low-quality project information (Cooper et al., 2001), as a result, portfolio decisions such as project selection and termination become fragile. This potentially reduces the ability to distinguish ‘bad’ or ‘good’ projects, and as a result lead to selection of too many projects, known as portfolio overload. Similarly, unclear or poorly defined goals and objectives due to lack of information market and technology environments

[17] www.wellingtone.co.uk (accessed between 2015 and 2018)

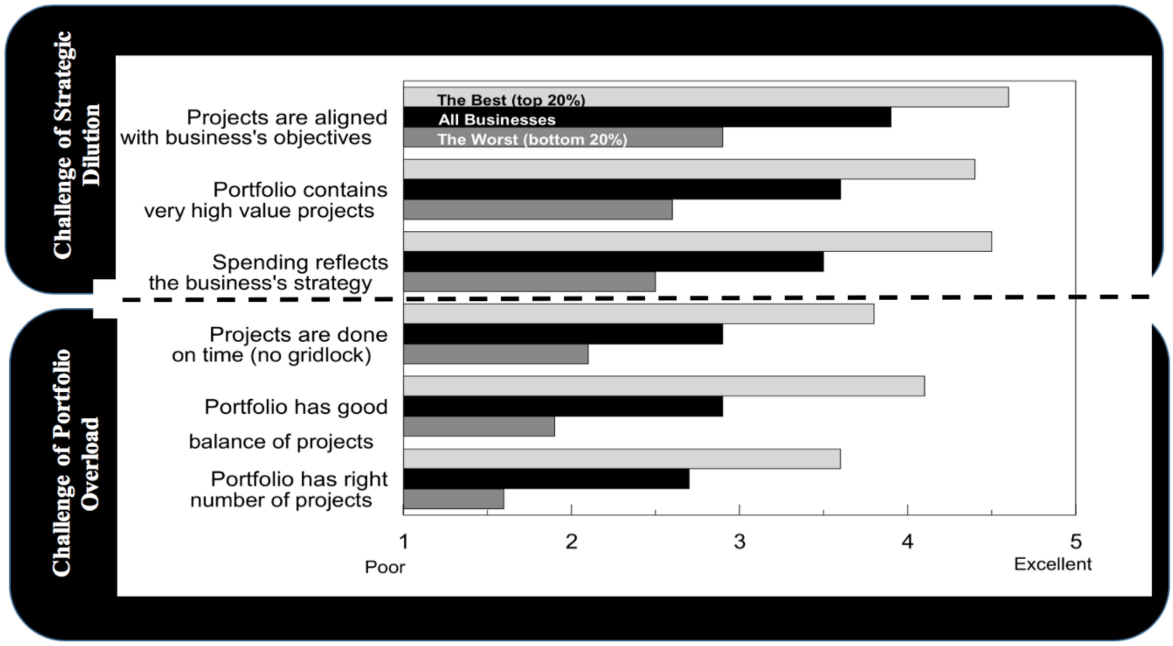


Figure 2.13: Portfolio Management Performance Benchmarking Results (Cooper et al., 2001)

could lead to the situation of strategic dilution. The sources of portfolio overload and strategic dilution can be attributed to poor information quality and low portfolio management maturity, which are likely to be induced by uncertainty.

Poor information quality could hamper portfolio management performance. For example, a number of studies have argued that information quality is a determinant of decision-making performance. Jonas et al. (2013) particularly found that information quality is positively associated with portfolio management performance. As (average) project success is one of the indicators of portfolio management performance (see Appendix 2A), it can be said that poor information quality could lead to project failures as well.

For example, the PwC's global portfolio management survey (2014) revealed the top three reasons for project failure (see Table 2.5). It is not surprising that poor information quality in terms of bad /poor estimates in the planning phase are common, in addition to poorly defined goals or objectives. Furthermore, it also indicates that changes in the environment, potentially leading to scope changes during the project lifecycle, is also a recurring reason for project failure. These findings are further supported by the PMI's 2017 (Pulse of Profession) survey of 3,234 project management professionals, which reported that inaccurate requirement gathering, changes in organisational priorities and inadequate project goals are the most common and significant reasons for project failure.

Table 2.5: Top Three Reasons for Project Failure (PwC's 4th Global Portfolio and Programme Management Survey, 2014)

2004	2007	2012	2014
Bad estimates/ missed deadlines	Bad estimates/ missed deadlines	Poor estimates in the planning phase	Poor estimates in the planning phase
Scope changes	Scope changes	Lack of executive sponsorship	Change(s) in scope mid-project
Changes in environment	Insufficient resources	Poorly defined goals and objectives	Insufficient resources

Low Portfolio Management Maturity

Newey & Zahra (2009) and Petit (2012) have established that uncertainty is likely to be the cause of low portfolio management maturity and firms must continuously improve their portfolio management practices to deal with challenges posed by uncertainty. Low portfolio management maturity could potentially lead to the challenges of strategic dilution and portfolio overload as well. For example, a survey conducted by PMI (2015, Pulse of Profession Survey) to establish the state of portfolio management, revealed that strategic dilution is the result of low portfolio management maturity levels, as 70% of high maturity firms perform better when it comes to strategy implementation as compared to only 26% of low maturity firms. Similarly, the survey

conducted by a consulting firm Planview[18] (2017) in which 54% of firms (total of 191) reported that their projects are not well aligned with the strategic business goals. The PMI survey (2015) also suggests that low portfolio management maturity hampers the management of individual projects, which is very likely to happen when portfolio is overloaded with more project than its capacity.

[18] http://www.planview.com/ (accessed between 2015 and 2018)

Moreover, number of industrial surveys have constantly revealed that firm often report low portfolio management levels. For instance, Jeffery & Leliveld (2004) clearly revealed there is significant gap between the number of firms (24% of 130 senior respondents) claiming to have a well-established portfolio management compared to those who (78% of 130 senior respondents) plan to have or establish portfolio management processes.

This finding was further corroborated by the surveys of PwC, BCG and PMI, indicating that the maturity of portfolio management is perceived to be low among participating firms. For example, the PwC's survey in 2014 showed that most of the participating firms (of a total of 3,025) have low to medium portfolio management maturity. In a similar vein, based on a survey of 446 portfolio management practitioners from more than 20 industries in 2015, BCG and PMI reported that 42% of participating firms have low levels of portfolio management maturity, and are more likely to be the candidates for low portfolio management and firm performance. Nevertheless, the survey also indicated that only 23% firms reported that they have either established portfolio management processes or are continuously improving them. However, in another round of a similar survey in 2017, PMI found that 72% of the firms reported low to medium portfolio management maturity, and only 28% of the firms reported somewhat high or very high portfolio management maturity. These surveys suggest that there is only a slight increase in portfolio management maturity of firms over time.

Uncertainty could be linked with the sources of strategic dilution and portfolio overload (i.e. poor information quality and low portfolio management maturity. For example, changes in project scope and bad market estimates are results of environmental dynamism such as frequent changes in customer demands, competitors or regulations. Similarly, uncertainty creates a need for continuously improving the ways with which portfolio decisions are taken (Floricel & Ibanescu, 2008; Petit, 2012; Newey & Zahra, 2009).

For Section 2.3, it can now be concluded that portfolio decisions are one of the types of strategic decisions that are taken under uncertainty. Among various portfolio management challenges, two key challenges impacting portfolio management and firm performance are portfolio overload and strategic dilution. Furthermore, sources of these challenges can be potentially linked to poor information quality and low portfolio management maturity levels, which are induced by uncertainty or environmental dynamism. It is now clear that in order to improve portfolio management performance, the sources of these two challenges need to be addressed. The next section explores potential contextual factors of portfolio management which could be used to for addressing these two sources in particular.

2.4 Portfolio Management Contextual Factors

After discussing two key portfolio management challenges in the Section 2.3, the objective of this section is to explore different contextual factors of portfolio management and identify the relevant factor which can be used to address low information quality and low portfolio maturity level, potentially leading to strategic dilution and portfolio overload challenges.

Recent studies have started exploring the context in which portfolio decisions are taken and how these contextual factors can influence portfolio management performance. Based on literature analysis, total of seven contextual factors of portfolio management influencing its performance are identified as shown in Figure 2.14:

- **Environmental Dynamics**: includes factors external to a firm such as market turbulence and technology turbulence (e.g. Floricel et al., 2008; Petit, 2012). Uncertainties arising from to environmental dynamics have a significant impact on portfolio decision-making. For example, firms have to be agile in terms of changing the composition of their portfolio reactively and proactively to ensure portfolio value is maximised and strategically aligned (Kester et al., 2011, 2014).

- **Organisational Culture**: includes factors such as creative encouragement (Kock et al., 2014), top management encouragement and top management autonomy (Jonas, 2010), risk management culture (Teller & Kock, 2013) and management perception & satisfaction (Spieth & Lerch, 2014). Organisational culture tends to have considerable impact on portfolio management performance. For example, Kock and his colleagues (2014) discovered that creative encouragement is associated with front-end and portfolio management performance.

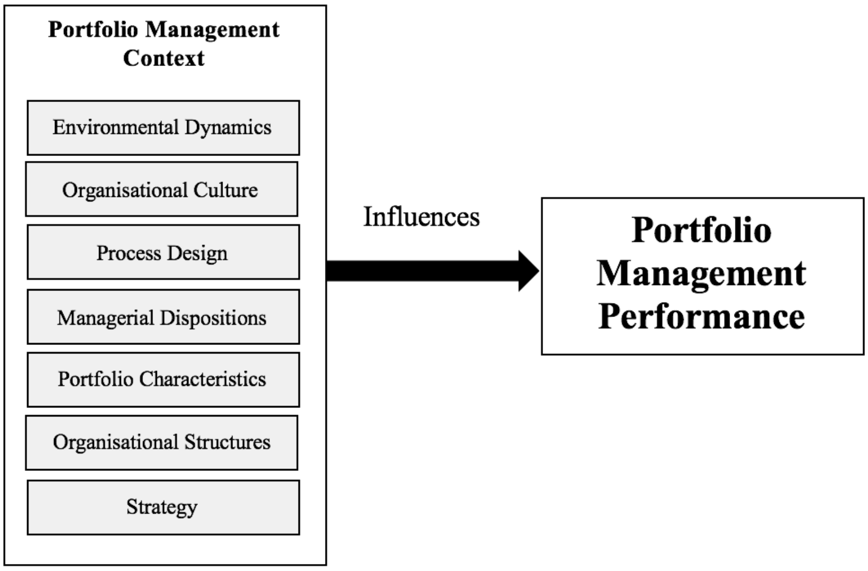


Figure 2.14: Contextual Factors of Portfolio Management Performance (Source: Author)

- **Process Design**: includes factors related to project and portfolio management processes such as ideation process formalisation (Kock et al., 2014), business case control (Kopmann et al., 2013), management quality (Jonas et al., 2013; Lerch & Spieth, 2013), Methods (Lerch & Spieth, 2013), portfolio process formalisation (Lerch & Spieth, 2013; Teller et al., 2012), project management formalisation (Teller et al., 2012), formalisation of risk management (Teller & Kock, 2013), risk transparency (Teller & Kock, 2013), commitment and emergence (Floricel et al., 2008), due-diligence and consistency (Meskendahl, 2010), integration (Teller & Kock, 2013) and evolution (Petit, 2010,2012; Killen et al., 2010, 2013; Arlt, 2010; Newey & Zahra, 2009). There tends to be consensus that in order to have better portfolio management performance, the process design has to be formalised and integrated across structures such as organisational functions and levels.

- **Managerial Disposition**: includes factors relating to cognitive aspects of individuals and group-decision making dynamics, such as directive leadership style (McNally et al., 2013; McNally et al., 2009), need for cognition (McNally et al., 2013), change resistance and ambiguity tolerance (McNally et al., 2009), analytical cognitive style (McNally et al., 2009), management perception & satisfaction (Lerch & Spieth, 2013) and decision-making styles (Kester et al., 2011). These studies showed that these factors tend have an impact on portfolio management performance.

- **Portfolio Characteristics**: includes the descriptive features of a portfolio and its components such as portfolio size (Kopmann et al., 2015), project interdependency or complexity (Kopmann et al., 2015; Voss 2012; Teller et al., 2012), innovativeness (Schultz et al., 2013; Urhahn & Spieth, 2014) and portfolio type (Voss, 2012). Portfolio characteristics could be influenced by other contextual factors such as strategy and process design.

- **Organisational Structure**: includes the structures that have been put in place to enable portfolio decision-making such as accountability for benefits realisation and incentives for portfolio success (Kopmann et al., 2015), portfolio management office orientation (Unger et al., 2012), role clarity (Jonas, 2010; Teller, & Kock, 2013), top management involvement (Unger et al., 2012), internal interactions or cross-functional Integration (Kester et al., 2011; Jugend et al. 2014, 2016) and top management team diversity (Criscuolo et al., 2017). For example, Criscuolo et al. (2017) found that the more diverse the portfolio management team would lead be more preference for radical projects in a portfolio, eventually influencing the portfolio management performance.

- **Strategy**: includes the core factors relating to strategic aspects of a firm such as ideation strategy (Kock et al., 2014), strategy risk perception (McNally et al., 2013), customer integration (Voss, 2012) and strategic orientation (Meskendahl, 2010). These factors tend to have a considerable impact on portfolio strategic alignment and balance.

As conceptually depicted in Figure 2.15, these contextual variables could be inter-related as well and process design could be identified as a central contextual factor of portfolio management. For example, environmental dynamics can influence process design. In more dynamic environments, firms have to increase their portfolio review frequency so that no major opportunities or threats are being missed with respect to portfolios. The study by Kock et al. (2014) states that creative culture (i.e. Organisational culture factor), ideation strategy (i.e. Strategy factor), and formalised ideation processes influence portfolio management performance. Similarly, the study by Lerch & Spieth (2013) states that formalisation of portfolio management is a determinant of portfolio management performance. The message that can be extracted here is that the influence of most of the contextual factors is likely to be mediated through the process design.

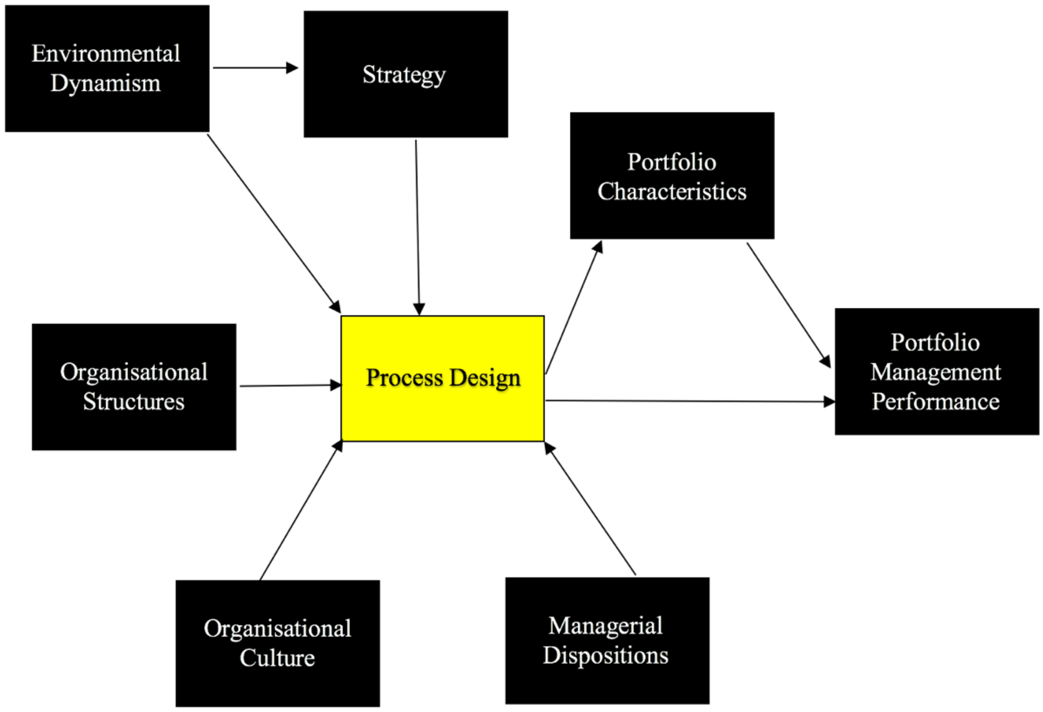


Figure 2.15: A Contextual Model for Portfolio Management (Source: Author)

Referring back to identifying relevant contextual factors to address the two sources of portfolio management challenges, it is useful to consider those factor(s):

- which are under control or can be influenced by a firm (in other words, not to focus on those factors for which organisations have no control)
- and implementing associated changes in practice takes relatively takes less time or efforts and potentially has direct impact on portfolio management performance (so limiting the scope of mediating aspects of other context or factors).

From the above seven factors, environmental dynamism can be considered external to firm, and over which firm has no control, and changes in organisational culture take a long time and require substantial resources. Similarly, managerial dispositions are implicit characteristics of individuals, groups and are related to organisational culture, and would involve huge time commitments. Moreover, these three factors do not directly relate to the two sources of the challenges. The portfolio characteristics can be controlled by portfolio decision-making or can be considered its outcomes, but here the focus is on portfolio decision-making itself. Strategy mainly include portfolio choices of portfolio decisions rather than portfolio decision-making; in fact low information quality is also a challenge for making strategic choices. Organisational structures such as cross-functional integration can address portfolio overload and strategic dilution. However, it is the process design factor on which a firm has maximum control as it is internal to a firm and can take less time or resources comparatively in implementing associated changes depending upon its maturity and have the potential to address the sources of the challenges: poor information quality and low portfolio management maturity. Another reason for choosing the process design factor is that its relationship with portfolio management and firm performance is direct as compared to other factors and could be considered as a central contextual factor of portfolio management.

To conclude Section 2,4, the process design of portfolio management is considered and selected as the most relevant contextual factor to address the two sources (poor information quality and low portfolio management maturity) of the portfolio management challenges (strategic dilution and portfolio overload). To further investigate how process design aspects could be used to manages these sources, it is important to answer the following questions: *what specific aspects of process design could be used for managing these sources, and what are the knowledge gaps in existing literature with respect to these specific design aspects?* The next section aims to answer these questions.

2.5 Portfolio Management Process Design & Knowledge Gaps

After identifying process design as the most relevant contextual factor to address the sources of the portfolio management challenges in the Section 2.3, this section further investigates the particular aspects of process design, their theoretical underpinnings and knowledge gaps which can be filled to reduce the likelihood of strategic dilution and portfolio overload and potentially improving portfolio management performance.

Among various aspects of process design (as mentioned in the previous Section 2.4), particular attention should be paid to portfolio management process design as compared to ideation or project management processes because it is the focus of this research. In particular, three important aspects of portfolio management process design related to portfolio management and firm performance are: *Formalisation, Integration*, and *Evolution*.

Portfolio Management Formalisation

Van de Ven and Ferry (1980) define formality as "*the degree to which rules, policies and procedures govern the role behavior and activities of organisations*". Formality represents how explicitly the norms of an organisation have been stated and formulated. A review study by Elbanna (2006) clearly indicates there is an abundance of literature on linking formalisation of decision-making and firm performance (c.f. Fredrickson and Mitchell, 1984; Goll and Rasheed, 1997; Eisenhardt & Bourgeois II, 1988). For example, taking a sample of four computer firms, Eisenhardt & Bourgeois II (1988) found a positive relation between rational decision-making processes and firm performance. Another example is a study by Goll and Rasheed (1997), it found that rationality is associated with firm performance, based on a sample of 62 large manufacturing firms.

In Innovation discipline, a number of studies posit that formalising the NPD process is one the best NPD management practices (e.g. Barczak et al., 2009; Kahn et al., 2012). In portfolio management context, formalisation occurs via utilisation of structured processes for portfolio management. It consists of rules, procedures for conducting periodic planning, selection and steering of portfolios. More recently, scholars have started investigating whether formalisation of portfolio management has implications for portfolio performance or not. Most of the studies tend to provide empirically supported findings that formalisation is positively associated with portfolio management performance (Spieth & Lerch, 2014; Jugend & da Silva, 2014). For instance, early contributions include benchmarking surveys by Cooper et al. (2001), which states that formalised is a differentiating factor between best and worst performing firms (see Figure. 2.16)

However, the question arises as to *whether formalisation will help in addressing poor information quality and low portfolio management maturity?* This question can be partly answered from the studies by Jonas et al. (2013) and Spieth & Lerch (2014). These studies empirically emphasised the positive association between formalisation and portfolio management performance. The logic is that formalised portfolio management enables fair comparison and assessment of different NPD projects, fosters communication of responsibilities among relevant stakeholders, provides transparent criteria and integrity of project data, and that all of these leads to improved information quality (e.g. Spieth & Lerch,

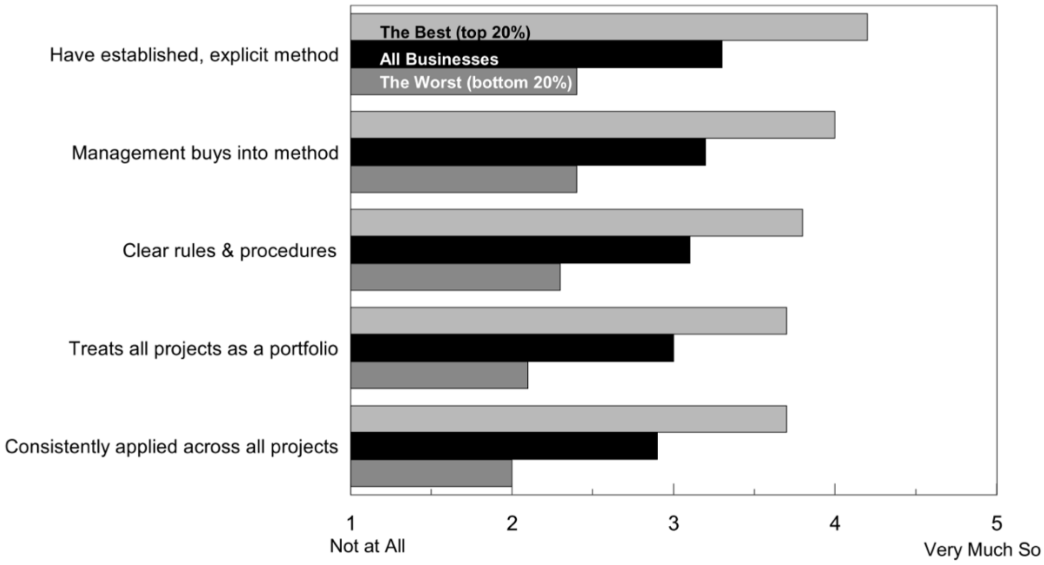


Figure 2.16: Influence of Portfolio Management Formalisation on Portfolio Management Performance (Cooper et al., 2001)

2014; Teller et al., 2012; Jonas et al., 2013). Formalisation can be considered as an initial or first level of portfolio management maturity (e.g. Kahn et al., 2006; Jeffery & Leliveld, 2004). After arguing about the relevance of formalisation for poor information quality and low portfolio management maturity, another set of questions becomes relevant: *is formalisation a challenge for firms*; *are the process models (discussed in 2.2) not sufficient enough to guide formalisation of portfolio management, and if so, what are the knowledge gaps?*

Answers to above questions can be based on the findings of the global surveys conducted by PMI (2014) and PwC (2014). These surveys clearly support the contention that portfolio management formalisation is quite challenging for firms as nearly half of the participating firms lack formal portfolio management processes. Moreover, the portfolio management process models discussed in Section 2.2 have limitations in terms of their scope, completeness and description, and can be considered as insufficient for providing guidance on what and how to formalise portfolio management. For example, even though Cooper et al. (2001) empirically support the argument for formalising portfolio management, but their 'PITS' model does not give much description or guidance as to what the sub-processes and components of portfolio management process are, and what their underlying practices are. Similarly, the model by Archer & Ghasemzadeh (1999) had a narrow scope in terms of describing portfolio selection process only and can be considered lacking other portfolio management processes such as portfolio planning and steering, and some aspects remained unanswered in their model such as what encapsulates strategy development and who should be involvement in portfolio management. However, the model by Patterson (2005), the M-Model (Ahlemann, 2009) and Jonas et al. (2013) provide a little more description of portfolio management processes and have a comparatively broader scope in terms of organisational hierarchies, but the sub-processes and components of those processes and list of associated management practices are not provided. The key message that that can be extracted here is that despite portfolio management formalisation being increasingly revealed as important determinant of portfolio management performance, **there exists a knowledge gap regarding what and how to formalise in portfolio management processes**.

Portfolio Management Integration

Integration in process design of portfolio management is based on premise that portfolio management processes and stakeholders are inter-related with each other, and synergies could be created, potentially influencing portfolio management performance. One of the theoretical roots of portfolio management integration is Information Processing Theory (Galbraith, 1973). The central tenet of this theory is that to deal with uncertainties in the environment by increasing the flow of quality information, firms should focus on their information processing needs, information processing capabilities, and the fit between the two (Galbraith, 1973). The implications of information processing for firm performance have been well noted in the literature (e.g. McNally et al., 2013).

Although the PMI's definition and process model clearly indicates that portfolio management processes are inter-related (PMI, 2013), but their relationships have been rarely explored. In a similar vein, Jonas et al (2013) call for inter-connectedness between various processes such as portfolio planning and steering but does not provide much guidance on their inter-relationships. Cross-functional integration (Kester et al., 2014), which is concerned with integrating different functional stakeholders such as marketing and finance managers in processes of portfolio management. For instance, Kester et al. (2014) revealed cross-functional integration as a determinant of the input generating process of portfolio decision-making, which is further linked to portfolio decision-making style. Another aspect is the degree of functional diversity in the portfolio decision-making team, and Criscuolo et al. (2017) showed that more functionally diverse portfolio teams prefer more innovative projects.

The question arises as to *whether integration will help in tackling the challenges of poor information quality and low portfolio management maturity?* This question can be partly answered from the study by Meskendahl (2010) and Floricel and Ibanescu (2008). Meskendahl (2010) argues that cross-functional integration helps in performing due-diligence on projects and decision-making. By fostering cross-functional collaboration, information quality can be increased as it fosters the exchange of information between different functions. Another example is cross-project facilitation and learning, which not only increases the knowledge base of a firm but also creates valuable inputs or learnings which have implications for further portfolio decisions (Jonas et al., 2013), which is an aspect of portfolio management maturity. The logic is that integration in portfolio management increases information flow and information processing capabilities, which in turn enables better decision-making capabilities.

After discussing the relevance of integration in portfolio management, another set of questions comes into the picture: *is integration a challenge for firms*; *are the process models (discussed in Section 2.2) not sufficient enough to guide integration in portfolio management, and if so, what are the knowledge gaps?*

Among the process models discussed in Section 2.2, the PITS model suggests integration of NPD project management process and portfolio management processes (Cooper, 2001), and the M-Model indicates the need for integration of portfolio management processes and stakeholders (Ahlemann, 2009). However, despite revealing that top management and portfolio management offices have performance implications, these models are limited in terms of elaborating the connections between these stakeholder and portfolio management processes. For instance, the model by Archer and Ghasemzadeh (1999) clearly neglected the integration of stakeholders with portfolio management processes. Similarly, the model by Jonas et al. (2013) does not integrate relevant stakeholders in their four processes of portfolio management. Although the sequence between the processes is indicated in the models by Archer and Ghasemzadeh (1999), Patterson (2005), PMI (2013), how these processes impact each other is rarely explored. For example, what is the impact of portfolio strategy development on project selection or termination decisions, and how is business case management related to portfolio decision-making processes?

Overall, it can be concluded that integration is an important aspect of the process design and have implications for portfolio management performance, but **there exists a knowledge gap regarding how to integrate portfolio management processes** (and associated stakeholders).

Portfolio Management Evolution

Evolution of portfolio management can have multiple forms of expression or interpretation. For example, it could mean continuous improvement of portfolio management processes – i.e. maturity (Killen et al., 2013; Petit, 2012) or adaptability of portfolios (e.g. Kester et al., 2014). The former is a process design aspect, and the later can be considered as an outcome of it. The theoretical roots of evolution or continuous improvement of portfolio management can be attributed to the DCV (Teece, 2007; Newey & Zahra, 2009). The central tenet of this theory is that in order to cope with uncertainty or environmental dynamism, capabilities needs to be evolved or continuously improved.

For example, a study by Floricel & Ibanescu (2008) and Meskendahl (2010) states that with changes in the environment, portfolio management processes need to be adapted and continuously improved. Floricel & Ibanescu (2008) argued that turbulence and instability in the environment is related to portfolio management emergence. Similarly, Meskendahl (2010) made the link between portfolio management evolution with firm performance. Another study by Petit (2012) exemplified the DCV by revealing the first and second order changes in portfolio management processes. A study by Newey & Zahra (2009) stated that the interaction between operating capabilities such as NPD process, and dynamic capabilities such as portfolio management, leads to evolution of the latter. Taking the case of a pharmaceutical company, they argued that exogenous shocks (i.e. environmental dynamism) results in evolution in NPD and portfolio management processes.

The question arises as to *whether evolution will help in tackling the challenges of poor information quality and low portfolio management maturity?* The evolution of portfolio management and its maturity can be synonymous to each other. The evolution of portfolio management can also be linked to information quality using the logic that as the portfolio management processes remain relevant and appropriate with changes in the internal and environment, information quality can be maintained or enhanced. High levels of portfolio management maturity can be characterised by good information quality (e.g. Kahn et al., 2006; Jeffery & Leliveld, 2004).

After arguing about the relevance of evolution in portfolio management for these challenges and its importance for firm performance, another set of questions comes into the picture: *is evolution a challenge for firms*; *are the process models (discussed in 2.2) not sufficient enough to guide evolution in portfolio management, and if so, what are the knowledge gaps?*

From the Section 2.3, it is clear that nearly half of the firms surveyed in number of industrial surveys report low portfolio management maturity and that pattern is consistent with time. The extant academic literature on portfolio management process design can be considered limited with respect to providing diagnostic aids to assess the state of portfolio management processes. For example, due to limited description, scope and comprehensiveness of the process models (discussed in Section 2.2), the utility of these models tends to be less for the case of their deployment in diagnostic modes. However, the literature has introduced few maturity models, such as the PDMA's portfolio management maturity model (Kahn et al., 2006) and the portfolio management OLMM model (Killen et al.,2013). However, these models are criticised on the basis of their rigidness, lack of completeness, lacking the basis of tacit knowledge about portfolio management in practice. The maturity model by the PDMA lacks many other components of portfolio management maturity such as project assessment, resource allocation and stakeholder functions. Also, these models are less intuitive, in that firms would need to rely on external support to deploy these models. Another issue is that using these models does not give a sense of strengths and weaknesses in particular aspects of portfolio management processes. This means that it would be difficult to identify and envisage where the actions originating from use of these models would be put in the processes, what their implications would be, and what could be required to implement those actions. Also, due to a lack of understanding about inter-connections between processes, it is hard to understand the implications of changes in one process on another.

Overall, it can be said that evolution (i.e. continuous improvement or maturity) is an important aspect of the process design, but **there exists a knowledge gap regarding the lack of comprehensive assessment approach for portfolio management processes.**

The key message of Section 2.5 is that there are three knowledge gaps in process design of portfolio management: lack of guidance on what and how to formalise portfolio management process, limited understanding of inter-relationships between portfolio management processes, and a lack of comprehensive assessment approach for portfolio management processes to identify areas of improvement to embark on the journey of continuous improvement. The next section outlines the conceptual framework developed to be used as a basis for following empirical studies conducted in this thesis to fill these gaps.

2.6 Portfolio Management Process Framework V.0

The aim of this section is to develop a conceptual portfolio management process framework which will be used as a basis to fill the three knowledge gaps identified in Section 2.5 with respect to the process design. The derivation of the conceptual framework follows the synthesis of portfolio management process definitions (see Table 2.1) as well as models (see Figure 2. 17) as described in Section 2.2 (to ensure a holistic approach is taken to address the challenge of portfolio management ineffectiveness). As mentioned in Section 2.2.2 and Table 2.1, the synthesis of portfolio management definitions leads to the four key aspects of portfolio management: planning, decision-making, structures and performance. The framework is built upon three of these aspects: portfolio planning (i.e. planning which includes portfolio choices), portfolio decision-making (i.e. decision-making which includes decisions such as project selection/termination/hibernation) and portfolio management stakeholders (i.e. structures). As portfolio decisions are an instance of strategic decisions (see Section 2.3), the overall portfolio management process is driven by business level strategic inputs and results into new products and service introductions. This overall process consists of portfolio planning and portfolio decision-making processes and are driven by portfolio management stakeholders. The conceptual framework here is referred as framework V.0.

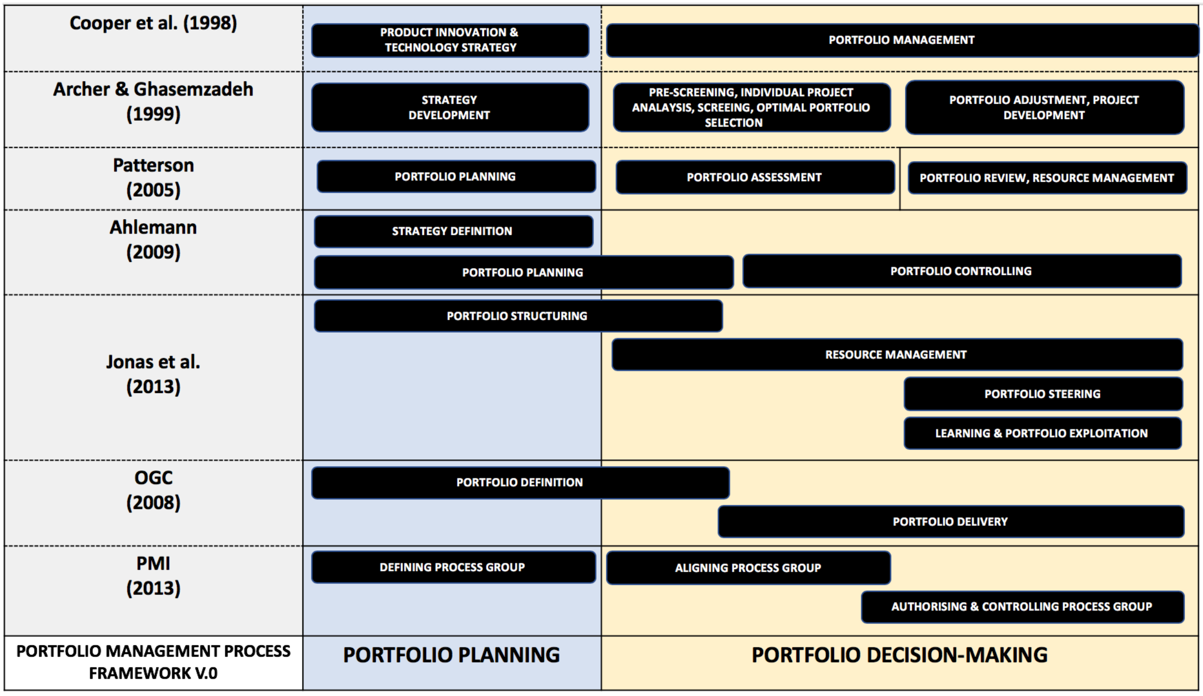


Figure 2.17: Synthesis of Portfolio Management Process Models

Portfolio Planning is the process in which portfolio strategy (Kang & Montoya, 2014) is developed. As strategic alignment of a portfolio has been considered as one of the goals of portfolio management (Cooper et al. 2001; Chao & Kavadias 2008), this process aims to take strategic choices such as what should the new product strategy be, and what the strategic goals and benefits which a firms aims to achieve by management its portfolio are. Portfolio decision-making aims to take decisions such as project selection (e.g. Archer & Ghasemzadeh, 1999) and project termination or hibernation, which usually involves assessing each NPD project in terms of financial and non-financial criteria using qualitative and quantitative methods (Lerch & Spieth 2013) and making decisions accordingly. For all these processes, a number of stakeholders representing different corporate functions such as top management and marketing should be involved (e.g. Kester et al., 2011, 2014). This framework V.0 could be as a basis to fill the three identified knowledge gaps because:

- it is based on key aspects (planning, decision-making, structures) of portfolio management which have been derived from number of academic and industrial portfolio management definitions (see Table 2.1). As a result, it reasonably ensures that the resulting framework would be theoretically and practically relevant

- the three gaps could be filled by further development of this framework as the formalisation gap could be filled by revealing sub-processes, components and underpinning management practices of portfolio planning and decision-making; the integration gap could be filled by exploring the inter-relationships between these processes and stakeholders, and the evolution gap could be filled by developing an assessment approach based on management practices underpinning these processes

- it comprehensively covers variety of portfolio management process models in both theory and practice as discussed in Section 2.2. The Figure 2.17 provides the synthesis of existing portfolio management process models.

Considering portfolio planning, portfolio decision-making and portfolio management stakeholders comprehensively and holistically covers existing portfolio management process definitions and models, as well as can be used to address the three knowledge gaps with respect to the process design, the Portfolio Management Process Framework V.0 can now be constructed (see Figure 2.18) and will be used as the basis to address these gaps.

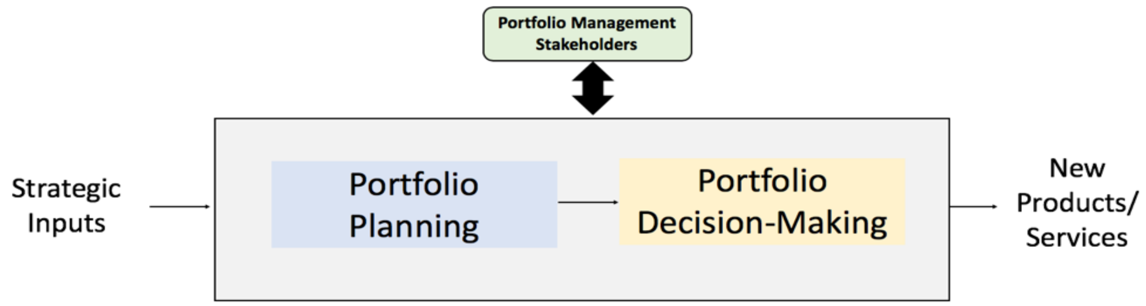


Figure 2.18: Portfolio Management Process Framework V.0

2.7 Summary of literature

This chapter outlines various key concepts in portfolio management such as its origins, definitions, types, goals, tool and process models. This research follows Cooper's definition of portfolio management, viewing it as a dynamic decision-making process for NPD projects and focuses on portfolio of new products and service development projects (i.e. product portfolio management type). A variety of tools such as scoring models and bubble diagrams can be used to achieve three core goals of portfolio management, which are strategic alignment, value maximisation and balance. These tools form integral parts of portfolio management processes, with a variety of process models introduced in both theory and practice.

Portfolio decisions are instances of strategic decisions which are impacted by uncertainty in the external environment. Similar to strategic decisions, portfolio decisions influences portfolio management and firm performance. Uncertainty leads to variety of portfolio management challenges which can be classified into two categories: strategic dilution and portfolio overload, which implications for portfolio management and firm performance. The potential sources of these challenges are poor information quality and low portfolio management maturity. To address these challenges and their sources, the process design of portfolio management is chosen as a relevant factor among other seven portfolio management contextual factors.

Within process design, there exist three relevant knowledge gaps:

- Lack of guidance on what and how to formalise in portfolio management process
- Limited understanding of inter-relationships between portfolio management processes
- Lack of a comprehensive assessment approach for portfolio management processes.

To fill these gaps, a conceptual portfolio management process framework (V.0) has been built using key aspects of portfolio management and variety of process models. This framework will be explored empirically to fill these knowledge gaps.

CHAPTER 3 RESEARCH DESIGN

This chapter discusses research aims, questions and philosophical positions taken to address these questions. It then presents the overall research design, which consists of three phases, and data collection and analysis methods for each of the phases are discussed. Finally, the research design is evaluated, and a summary is provided.

Contents

3.1 Introduction to Research Design

The purpose of this chapter is to outline various aspects of research design for the investigation described in this thesis, such as philosophical positions, data collection and analysis methods, and ethical considerations. As mentioned in the previous Chapter 2, there exists three knowledge gaps with respect to process design for portfolio management. These gaps lead to the derivation of research objectives and consequently the research questions to be addressed in this research, which are set out in the section 3.2. As philosophical positions such as ontology, epistemology and methodology influence the way in which research questions can be answered, Section 3.3 briefly outlines the positions taken in this research, collectively termed the research paradigm. Section 3.4 provides the overall research design, which is split into three phases, each contributing to the defined research objectives or questions. It then provides an overview of the different data collection and analysis methods used for each phase. Finally, the research design is evaluated, and ethical aspects considered in Section 3.5, with a summary of the research design provided in Section 3.6.

3.2 Research Questions

As mentioned in chapter 2, there exist three knowledge gaps with respect to process design for portfolio management (see Section 2.5):

1. Lack of guidance on how and what to formalise in portfolio management processes
2. Limited understanding of inter-relationships between portfolio management processes
3. Lack of a comprehensive assessment approach for portfolio management processes

These three gaps lead to four research objectives (as the first knowledge gap is split into two research objectives) as follows:

1. Identification of key portfolio management processes, to enable portfolio decision-making
2. Formalisation of portfolio management processes, to define underlying sub-process, components and practices

3. Integration of portfolio management processes, to synergise these processes by understanding their inter-relationships
4. Assessment of portfolio management processes, to provide a diagnostic aid which can be deployed to enhance maturity levels of portfolio management processes

Consequently, these four research objectives lead to four sub-research questions respectively (with the overall research question synthesised subsequently):

RQ1: What are the key portfolio management processes that can be formalised?
RQ2: How may key portfolio management processes be formalised?
RQ3: How may key portfolio management processes be integrated?
RQ4: How may key portfolio management processes be assessed?

So, the overall research question addressed in this research is:

How may key portfolio management processes be formalised, integrated and assessed in order to improve portfolio management performance in technology-intensive firms?

The purpose of this research is to develop theoretically relevant and practically useful diagnostic aids which can be deployed by technology-intensive firms to identify areas and actions for improving overall portfolio management performance. Specifically, this research aims to contribute to knowledge regarding formalisation, integration and assessment of portfolio management processes. Answering the overall research question entails exploration of portfolio management process in technology-intensive firms. With this in mind, the next section discusses the philosophical positioning of this research.

3.3 Research Paradigm

The philosophical positions taken to answer the research question influence the research outcomes, and the way in which the outcomes are achieved. Understanding research philosophy offers two main benefits: (1) helping to clarify research design, such as data collection and analysis methods required to answer the research question; and (2) helping to suggest how to adapt the design according to constraints such as data access. The term '*research paradigm*' describes the philosophical position concerning the 'world view', the fundamental beliefs of the researcher with respect to reality, and how knowledge about reality can be obtained. The research paradigm consists of three parts (Easterby-Smith et al., 2008, 2012):

- **Ontology**: philosophical assumptions about the nature of reality
- **Epistemology**: general set of assumptions about the best ways of inquiring into the nature of the world
- **Methodology**: combination of methods used to enquire into a specific situation; the individual approaches for data collection and analysis are called methods

3.3.1 Ontological positioning of this research

Different scholars have proposed different schools of ontological positions in the natural and social sciences (e.g. Easterby-Smith et al., 2008; Yin, 2014). Since this research is concerned with organisational processes (particularly portfolio management), it is more appropriate to discuss the ontological positions with respect to social science. There are three main philosophical positions in social science: *representationalism, relativism* and *nominalism* (Easterby-Smith et al., 2008). The representationalism position assumes that reality is concrete but cannot be accessed directly and requires verification of predictions. Relativism assumes that reality depends on the view point of the observer and is determined through consensus between different viewpoints, and nominalism assumes that reality is all about human creations and depends on who establishes it.

This research assumes that there is not a concrete or single process of managing portfolio(s), rather it varies according to the contextual factors as outlined in the extant literature (see Section 2.4). Thus, to address the research questions defined in Section 3.2, this research would explore portfolio management processes in different organisations (i.e. viewpoints) while interacting with relevant portfolio management stakeholders such as portfolio decision-makers and coordinators. These human or social interactions (i.e. between the researcher and the stakeholders as informants) is potentially a way to develop diagnostic aids for formalising, integrating and assessing portfolio management processes by reaching consensus on portfolio management in different organisations at reasonable level of abstraction. Therefore, *this research is more oriented towards the relativism position in terms of ontology*. Moreover, the research claim here is that the diagnostic aids for portfolio management processes developed in this research are not considered to be the only (unique) plausible way of formalising, integrating or assessing portfolio management processes.

3.3.2 Epistemological positioning of this research

After identifying relativism as a relevant ontological position, it is important to consider the assumptions about ways of exploring portfolio management processes in this research (i.e. the epistemological position). There are two main schools of thought of epistemology in management research: *positivism* and *social constructionism* (Easterby-Smith et al., 2008).

The positivist view assumes that the observer (i.e. the researcher) is independent of what is being studied or researched and can objectively identify the reality with objective methods. The task here is to gather facts and measure how often certain patterns occur in human or organisational actions or behaviour. Research adopting this view primarily demonstrates causality by testing hypotheses. On the other hand, the social constructionism view assumes that the observer is part of what is being observed, and the task here is to construct reality by interpreting the experiences of people or stakeholder perspectives. It involves gathering rich data to increase general understanding of the complex situation. See Table 3.1 for a comparison of both views, which have strengths and weaknesses.

This research is primarily positioned towards the social-constructionism view, as it involves exploring complex portfolio management processes by interpreting expressions and actions of portfolio management stakeholders, rather than demonstrating casual relations. Moreover, with respect to knowledge gaps in the extant literature, it is more useful to adopt this because of two reasons. The first is that portfolio management processes are considered quite complex, boundedly rational and viewed as bargaining and negotiating events (Martinsuo, 2013). This leads to an increasing need to explore underlying components and practices of portfolio management processes as compared to determining casual linkages between different contextual factors of portfolio management. The second is that the researcher considers that contribution to knowledge concerning portfolio management can be made by filling knowledge gaps as described in Section 2.5, with the extant literature tending to use statistical methods such as surveys to objectively reveal the relationships of the formalisation, integration and evolution (continuous improvement) of portfolio management with its performance, but with limited guidance on how to operationalise such relationships in practice.

Table 3.1: Comparison of Positivism and Social-Constructionism Epistemological Positions (Easterby-Smith et al., 2008)

	Positivism	Social-Constructionism
The observer	must be independent	is part of what it is being observed
Human interests	should be irrelevant	are the main drivers of science
Explanations	must demonstrate causality	aim to increase general understanding of the situation
Research progress through	hypotheses and deductions	gathering rich data from which ideas are induced
Concepts	need to be defined so that they can be measured	should incorporate stakeholder perspectives
Units of analysis	should be reduced to simplest terms	may include the complexity of 'whole situations'
Generalization through	statistical probability	theoretical abstraction
Sampling requires	large numbers selected randomly	small number of cases chosen for specific reasons

3.3.3 Methodological positioning of this research

Closely linked with the ontological and epistemological positions, there are two methodological positions (or methods): *quantitative* and *qualitative* (Robson, 2002). Quantitative methodologies such as statistical experiments and surveys are useful for the research that adopts representationalism and positivism positions. Whereas, qualitative methodologies such as case studies and action research are more useful for research that adopts relativism and social constructionism positions. However, some methodology scholars also make the case for mixed methods involving both qualitative and quantitative methodologies (e.g. Creswell, 2009). Given the two philosophical positions of this research described above, the use of qualitative methods is more appropriate.

Because this methodology is particularly useful for exploring processes (such as portfolio management processes) which require detailed explanation and description from the stakeholders who experience them (Patton, 2002). Various qualitative methodologies and their classifications have been proposed by methodology scholars (e.g. Easterby-Smith et al., 2008; Creswell, 2009). Table 3.2 provides an overview of the five commonly used qualitative methodologies.

Table 3.2: List and Characteristics of Qualitative Methods

Source: Author (based on Easterby-Smith et al., 2008; Gill & Johnson, 2010 and Robson, 2011)

Methodology	Main Characteristic	Additional Characteristics
Action research	The researcher learns about and organization or social system by attempting to change it.	• The people most likely to be affected by the project take part in the research. • The results may not explain why the changes took place.
Cooperative inquiry	The researcher and the object of study become partners in the research process.	• The researcher gains access to understand how individuals decide. • This method aims to understand behaviours at individual level rather than at organisational level.
Ethnography	The researcher 'immerses' himself in a setting and become part of the group under study.	• Good for understanding meanings and significances that people give to their behaviour. • Data collection is likely to be prolonged over time.
Narrative methods	The researcher collects organizational stories. The researcher constructs and transmits stories.	• Stories are useful to examine relationships between individuals and the wider organisation.
Case studies	Looks in depth at one, or small number of, organisations, events, or individuals over time.	• Allows the combination of a number of data collection sources and analytical approaches. • Case studies are not necessarily studies of individuals.
Grounded theory	The researcher develops theory by looking at the same event or process in different settings or situations.	• Highly dependant on the judgement of the researcher. • Particularly useful in unexplored areas of research where the theoretical approach is not clear or non-existent.

Out of the six methods outlined in Table 3.2, case studies and action research are more appropriate than others for the purpose of this research because the other methods such as ethnography, cooperative inquiry and narrative methods focus on individuals rather than organisations, and moreover, there is a time limitation under which this doctoral research has to be conducted and completed (3 years).

The case study method is particularly useful for answering 'how' type research questions (Yin, 2014). Yin (2014) defines a case study as "*an empirical inquiry that investigates a contemporary phenomenon (the "case") in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident*". Given the ongoing scholarly and managerial interest in portfolio management (Kwak & Anbari, 2009; Martinsuo, 2013), it can be considered as a contemporary phenomenon. Also, the extant literature suggests that portfolio management should be investigated with respect to its context (e.g. Martinsuo, 2013). Among various types of case studies, the multi-case study approach is often considered more compelling and robust. *This research adopts an exploratory, multi-case study approach in which portfolio management processes in different organisations are explored*. This approach is particularly applied for developing a diagnostic aid for formalising and integrating portfolio management processes.

Action research is helpful for implementing and testing new ideas to check the potential of value generation for organisations (Kaplan, 1998). In action research, the researcher attempts to change the phenomenon which is being researched in the organisation by becoming a part of it or engaging with the people who would be affected by the research (i.e. portfolio management stakeholders). There are multiple approaches to action research, such as action science, action inquiry, appreciative inquiry, and participatory learning and action. However, this research follows the procedural action research developed by Platts (1993). This has three stages: (1) creating the process; (2) testing and refining the process by application in a small number of organisations; and (3) investigating the wider applicability of the process (adapted from Platts, 1993). This method is used to develop a diagnostic aid for assessing portfolio management processes to improve them. Moreover, the researcher undertook a four-month internship with a portfolio management office of an European pharmaceutical company. During this engagement, the researcher became part of portfolio management processes in the company. The purpose was to develop a deep understanding of portfolio management processes and practices, and to refine the diagnostic aid developed for formalising portfolio management processes.

As mentioned previously, research methods relate to practical activities such as data collection and analysis. It would be now useful to explore the relevant qualitative methods used in case study and action research. The data collection methods used in this research are:

- **Interviews**: These are the most common methods used in the case study approach. An interview involves collection of data through guided conversations. There are various aspects which might need to be considered for conducting interviews, such as will the interview will be open-ended, semi-structured or fully structured, and how many interviews are needed; can an interview be recorded or not (depending on the permission of interviewees); who will be the relevant interviewees (i.e. people who are part or knowledgeable about the research topic in their organisations); will the interview be conducted face-to-face or via other channels; will the interview be with one interviewee or a group of interviewees (or focus group)? Interviews help in focusing directly on the research topic and seek to provide explanations as well as personal views, including perceptions, attitudes and meanings attached to them by the interviewees.

- **Focus Groups**: These is a type of interview which is conducted with group of relevant interviewees moderated by the researcher, in which the researcher deliberately tries to invoke the views of the interviewees on the research topic in a structured manner. The major benefit of conducting focus groups is that they help in producing more diverse views such as meanings that people use, or collectively constructing reality about the research topic as compared to single interviews, more efficiently.

- **Documentation**: This method seeks to collect data explicitly by collecting relevant documents such as ones describing formal processes, roles and responsibilities and progress reports. Documents can be either obtained directly from the informants in the research or collected from online platforms such company web portals and financial reports. The benefits of documentation include corroboration of evidence from multiple sources, verification of spelling and job titles of people and other organisational elements that might have been mentioned in interviews or focus groups in case studies.

- **Direct and Participatory Observations**: These methods seek to collect data by means of the researcher observing the context of the research topic in real-time during the field work. Such observations complement the above methods, such as interviews. Direct and participatory observations are done in passive and active modes, respectively. In participatory observation, the researcher might become the part of situation or actions being studied. These observations provide the opportunity or ability to perceive reality from the 'inside' viewpoints rather than being external to it, and potentially help in better interpretation of the data about the research topic in case studies.

- **Workshops**: A workshop-based approach is a recommended mode of engagement for deploying/applying management tools (e.g. Kerr et al., 2013; Phaal et al., 2007; Platts, 1993), which is one of the core aspects of action research. Workshops are engagement mechanisms for solving problems via group interactions. Workshops aim to bring together stakeholders for capturing, sharing and structuring knowledge concerning issues faced by an organisation (Phaal et al., 2007). A workshop provides an opportunity for participants to put forward views in front of peers, promotes active participation and increases confidence and commitment levels for implementing recommendations resulting from the interaction.

The data analysis methods used in this research (also commonly used in the above methodologies) are:

- **Grounded Analysis**: According to Easterby-Smith et al. (2008), grounded analysis involves six steps: (1) familiarisation by reading transcripts and notes taken during data collection; (2) reflection on data against extant literature; (3) conceptualisation, which involves identification and grouping of data codes into concepts; (4) cataloguing concepts, in which database of concepts and their categories are made; (5) re-coding, in which concepts and categories are reviewed; (6) linking, building a framework by linking categories; and (6) re-evaluation, in which the framework is evaluated by peers.

Another variant of grounded analysis includes three prime steps, known as open coding, axial coding and selective coding (e.g. Strauss and Corbin, 1990; Cho & Lee, 2014).

- **Content analysis**: According to Cho & Lee (2014), the steps taken in content analysis are (as shown in Figure 3.1) open coding of the interview transcripts and field notes and undertaking iterative coding to develop categories or themes from the data.

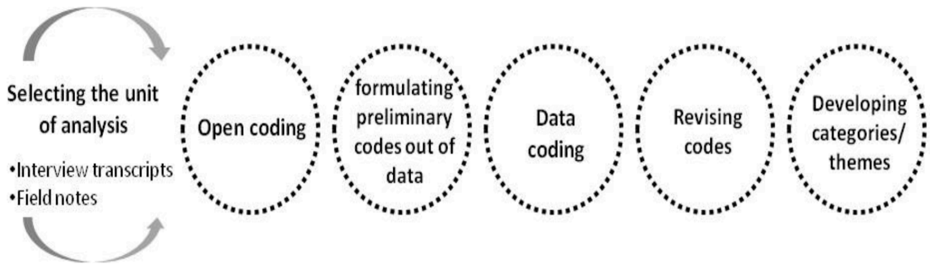


Figure 3.1: Steps in Content Analysis (Cho & Lee, 2014)

- **Descriptive analysis**: it aims to provide summary statistic that quantitatively describes or summarizes the data. For example, mean, median and mode are most frequently used to describe and report the data and its samples.

Overall this section clarifies that this research is ontologically, epistemologically and methodologically positioned towards the relativism, social-constructionism, and qualitative methods (case study, action research and relevant associated methods) respectively. The next section outlines the overall research design, describing how these data collection and analysis methods are used for addressing each of four the research questions (defined in Section 3.2).

3.4 Research Design

The philosophical position of this research (as described in Section 3.3) helps to clarify the research design needed to answer the research questions. According to Creswell (2009), research designs are "*plans and the procedures for research that span the decisions from broad assumptions to detailed methods of data collection and analysis*". Easterby-Smith et al. (2012) provided a list of aspects to be considered while using these types of methods:

- **Data**: identify the main sources of data; how will interviews be recorded/transcribed?

- **Sampling**: explain the sampling strategy; will it be opportunistic, emergent or other?

- **Access**: what is the strategy for gaining access to individuals and organisations?

- **Analysis**: what are the arrangements for coding, interpreting and making sense of data?

- **Ethics**: is there any danger that anyone will be harmed by the research?

- **Practicalities**: how will the researcher share interpretations; who pays for transcriptions?

Following the above definition of research design and considering the associated aspects, the research design for this PhD study is shown in Table 3.3. The overall research has been divided into three phases leading to four results: Phase I research leads to Result I (identification of key portfolio management processes), Phase II research leads to Result II (formalisation of key portfolio management processes) and Result III (integration of the key portfolio management processes), and Phase III research leads to Result IV (assessment of key portfolio management processes).
Building upon the conceptual framework (see Figure 2.18):

- Phase I data collection includes 9 exploratory interviews, 2 focus groups, developing a framework comprising five key portfolio management processes (Result I) (see Figure 4.1).
- Phase II data collection builds on the result of Phase I, drawing on 10 case studies, 17 interviews and 1 focus group. It results in a comprehensive framework describing five key portfolio management processes, sub-processes, and their components (Result II) (See Figure 5.1). Another result of Phase II is the logic framework proposing inter-relationships between portfolio management processes (Result III) (see Figure 6.1).
- Building upon the results of Phase II, the Phase III data collection includes 7 pilot studies of the deployment of the diagnostic tool developed for assessing portfolio management processes (Result IV) (see Figure 7.1).

Overall data access was gained by collaborating with the companies participating in the STIM consortium[19] at the University of Cambridge, and by making direct LinkedIn[20] contacts with relevant portfolio management stakeholders from different companies. Two data sampling strategies were used in this research: opportunistic and purposive (the selection criteria are mentioned where appropriate).

The remainder of this section summarises the methods used for deriving Results I, II, III and IV. Before that, it is necessary to outline how literature review reported in Chapter 2 was conducted, leading to development of the conceptual portfolio management process framework.

3.4.1 Literature review and Portfolio Management Process Framework V.0

As mentioned in Chapter 2, portfolio management is an interdisciplinary concept and therefore, relevant literature on portfolio management in the disciplines of Strategy, Innovation and Operations was reviewed[21]. The literature review method involves: **Database Keyword Search**: As portfolio management has been studied in the variety of management domains, hence different terminologies exist for the same. Therefore, a search through popular academic databases (accessed between year 2015 and 2018) such as SCOPUS (www.scopus.com), Web of Science (https://apps.webofknowlege.com), Google Scholar (www.scholar.google.co.uk) was conducted using the terminologies such as R&D portfolio, Innovation Portfolio, Product Portfolio, New Product Development Portfolio, Project Portfolio, NPD Portfolio, Product

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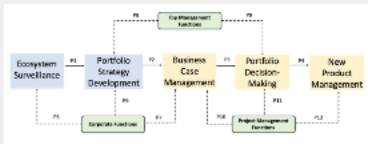
[19] The STIM (Strategic Technology and Innovation Management) consortium is a practice-oriented research and networking collaboration between companies and the Centre for Technology Management at the University of Cambridge. Further information can be found on www.ifm.eng.cam.ac.uk/ctm/stim (accessed between 2015 and 2018). The STIM companies were invited to take part in this research. The data was collected from the interested companies.

[20] LinkedIn is the one of the largest professional networking platforms with a mission to connect the world's professionals to make them more productive and successful. Further information can be found on www.linkedin.com (accessed between 2015 and 2018). By using the keywords such Portfolio Manager, Project Portfolio, R&D Portfolio, Innovation Portfolio in role titles and/or job descriptions in the profiles of the LinkedIn users, the researcher identified the relevant portfolio management stakeholders who can potentially inform this research. Then the researcher contacted them on one-to-one basis and discussed with them if they would be interested in participating in this research. Those who were interested in participating, further information about research was shared, and eventually some of them became informants in this research.

[21] As mentioned in Section 1.1, portfolio management has been studied in various management disciplines, therefore multiple keywords, databases and other methods such as citation analysis are used to locate and cover the relevant literature. The aim is to develop descriptive and scoping reviews (Paré et al., 2015)

Table 3.3: Research Design

*Stage I and II of Phase II results into the development of Portfolio Management Framework V.2 and V.3 respectively

Research Objectives	**Data Collection & Analysis**				**Results**
RO-1: Identification of portfolio management processes	**Phase I**				**Result I (Chapter -4)**
	I[st] Focus Group	9 Exploratory Interviews		2[nd] Focus Group	 (See Figure 4.1)
Portfolio Management Process Framework V.1					
RO-2: Formalisation of portfolio management processes	**Phase II**				**Result II (Chapter -5)**
	Stage I	Stage II		Stage III	
	9 Case Studies	17 Exploratory Interviews	10[th] Case Study	3[rd] Focus Group	 (See Figure 5.3)
*Portfolio Management Process Framework V.4					
RO-3: Integration of portfolio management processes	Insights from Literature Review		Insights from Stage I-III		**Result III (Chapter -6)**  (See Figure 6.1)
Portfolio Management Process Framework V.5					
RO-4: Assessment of portfolio management processes	**Phase III**				**Result IV (Chapter -7)**
	4 Workshop-based Pilot Studies		3 Non-Workshop-based Pilot Studies		 (See Figure 7.1)

Pipeline, Product Decisions, Multi-project management etc. **General Search**: Search engine such as Google was used to find and review industrial reports on portfolio management, relevant industrial events on portfolio management, company websites, reports and news articles etc. **Forward and Backward Citations**: scanned the references in the relevant articles to find further literature. For example, the Strategy discipline investigated portfolio management from the perspective of strategic decisions and their processes, and the Innovation discipline was explored from the perspective of new product development and types of decisions such as project selection and termination. The Operations discipline outlined the roles of supporting structures such as project management office for portfolio management. The way portfolio management is carried out by firms is impacted by the uncertainties in their external environment, potentially leading to challenges such as portfolio overload and strategic dilution (see Section 2.4).

Three aspects of process design (portfolio management, formalisation, integration and evolution) are considered relevant for addressing the sources of these challenges (see Section 2.5). To further explore these aspects, a conceptual framework called as Portfolio Management Process Framework V.0 was developed based on the synthesis of different portfolio management process models in both theory and practice (see Sections 2.2 & 2.6). The framework has three main components:

- Portfolio Planning
- Portfolio Decision-Making
- Portfolio Management Stakeholders

3.4.2 Result I: Identification of Portfolio Management Processes (Framework V.1)

Result I is the framework identifying five key portfolio management processes: *Ecosystem Surveillance, Portfolio Strategy Development, Business Case Management, Portfolio Decision-Making and New Product Management* (see Figure 4.1). The framework also indicated portfolio management stakeholders: *Top Management Team* and *Corporate Functions*, driving these portfolio management processes (more details about the framework are provided in Chapter 4). This framework builds upon the framework V.0 (see Section 2.6) by conducting total of 9 interviews and 2 focus groups (Phase I). Additionally, the direct observation method was also used in this fieldwork when the researcher visited companies for conducting interviews. Details of Phase I are outlined in the Table 3.4, with the data collected in the Phase I analysed using the content analysis method in which the data is displayed into data matrix of four 'conceptual bins' (according to Miles & Huberman, 1994): portfolio planning, portfolio decision-making, and stakeholders (based on framework V.0). As a result, the five key portfolio management processes and two portfolio management stakeholders were identified. Therefore, Result I aimed to answer the sub-research question seeking to identify key portfolio management processes.

Table 3.4: Details of Phase I's Data Collection & Analysis

PHASE -I	**1st Focus Group**	**9 Interviews**	**2nd Focus Group**
Number of Informants	12	9	17
Number of companies	9	8	17
Sampling Strategy	Opportunistic	Purposive	Opportunistic
Data Access	STIM Consortium	Companies contacted via LinkedIn	Collaboration with a Consulting Firm
Data Analysis	**Content Analysis**		
Location	United Kingdom	India, United Kingdom, United States	United Kingdom
Other Notes	See Appendix 3A for the informants' roles, their company's description and other details.		

3.4.3 Result II: Formalisation of Portfolio Management Processes (Framework V.4)

Result II is the comprehensive framework describing sub-processes, components, and practices of the five key portfolio management processes and stakeholders (see Figure 5.3) and more details about the framework are covered in Chapter 5). This framework builds upon Result I by conducting 10 case studies, 17 interviews and 1 focus group (Phase II). The researcher also used documentation, direct and participatory observation methods while conducting case studies and interviews. The details of Phase II are provided in Table 3.5. The development of this framework in Result II is divided into three stages chronologically:

- **Stage I Framework Development**: The purpose of this stage was to conduct in-depth exploration of the framework V.1 in Result I. A total of 9 case studies were conducted in this stage, resulting in the revised and comprehensive framework V.2, outlining sub-processes, components and practices of the five key portfolio management processes & stakeholder functions.
- **Stage II Framework Refinement**: The purpose of this stage was to refine the framework V.1 developed in Stage I. A total of 17 interviews and 10 in-depth case studies with a large international pharmaceutical company were conducted, and framework V.3 was developed
- **Stage III Framework Verification**: This purpose of this stage was to evaluate the framework V.3 developed in Stage II. A focus group with industry practitioners was conducted, and framework V.4 was developed, which is Result II

Table 3.5: Details of Phase II's Data Collection and Analysis

PHASE II	*Framework Development*	*Framework Refinement*		*Framework Verification*
	9 Case Studies	**17 Interviews**	**1 Case Study (10th)**	**1 Focus Group (3rd)**
Number of informants	18	19	6	5
Number of companies	9	17	1	4
Sampling Strategy	Purposive	Opportunistic	Purposive	Opportunistic
Data Access	STIM Consortium & Companies contacted via LinkedIn	STIM Consortium & Companies contacted via LinkedIn	Internship found via LinkedIn	STIM Consortium
Data Analysis	**Content Analysis**			
Location	United Kingdom, Denmark, Sweden	Japan, Netherlands, United States, Denmark, United Kingdom	Germany, Switzerland, United States	United Kingdom
Other Notes	Case study selection criteria and protocol were used (See Appendix 5A for protocol)	Companies include both case and non-case companies. More details about the process is discussed in Chapter-5	The researcher did an internship in portfolio management office of a leading European pharmaceutical company	A short questionnaire was used to get scores (1 to 5) on completeness, usability, quality, consistency, adaptability of the framework
	See Appendix 3B for the informants' roles, their company's description and other details.			

The data collected in this Phase II (Stages I, II & III) were analysed using the content analysis method, with the steps shown in the Figure 3.1. Result II (framework V.4) aimed to answer the sub-research question seeking how to formalise portfolio management processes.

3.4.4 Result III: Integration of Portfolio Management Processes (Framework V.5)

Result III is the framework describing the interrelationships between portfolio management processes and their stakeholders (see Chapter 5 for more details). This framework builds upon the data collected in Phase II and the literature review insights. The practices underpinning the portfolio management process framework in Result II were analysed using the grounded analysis method and exploratory relationships linking the portfolio management processes are developed based on Result II data and the extended literature review. As a result, a framework V.5 proposing relationships between the processes and stakeholders has been developed. Therefore, Result III aimed to answer the sub-research question seeking how to integrate portfolio management processes.

3.4.5 Result IV: Assessment of Portfolio Management Processes (Portfolio Management Diagnostic Tool)

Result IV is the assessment tool developed for identifying strengths or weaknesses of the portfolio management processes (for more details, see Chapter-7). The design of the tool includes scoring of portfolio management practices outlined in Result III and four assessment criteria: relevance, importance, consistency and execution quality (adapted from Menke, 2013). This assessment method can be deployed in both workshop-based and non-workshop-based approaches. A total of 7 pilot studies of deployment of this tool have been undertaken using both the approaches (Phase III). The details of Phase III are provided in the Table 3.6 as given below. The data collected from the workshops were subjected to descriptive analysis. As a result, companies found the assessment tool useful in diagnosing their portfolio management processes and identifying improvement actions. Therefore, Result IV aimed to answer the sub-research question seeking how to assess portfolio management processes.

Table 3.6: Details of Phase III's Data Collection and Analysis

PHASE III	Non-Workshop based Approach	Workshop-based Approach
Number of Cases	4	4
Number of Informants	7	25
Number of companies	3	4
Sampling Strategy	Opportunistic	
Data Access	STIM Consortium & Companies contacted via LinkedIn	
Data Analysis	**Descriptive Analysis**	
Location	Sweden, Germany, Denmark	United Kingdom, Denmark, Japan,
Other Notes	A non-workshop-based process is developed for assessing portfolio management processes	A workshop-based process is developed for assessing portfolio management processes
	See Appendix 3C for the informants' roles, their company's description and other details.	

The following section evaluates the research design and outlines measures taken to ensure the research was ethically conducted.

3.5 Evaluation of Research Design

The quality of the qualitative research design (as used in this study, see Section 3.4) can be evaluated using four types of tests, used for case studies (Yin, 2014):

- **Internal validity**: for explanatory or casual studies only, and not for descriptive or exploratory studies: establishing a causal relationship, whereby certain conditions are shown to lead to other conditions as distinguished from spurious relationships

This research intended to develop diagnostic aids for formalising, integrating and assessing portfolio management processes, and is exploratory and descriptive in nature. Therefore, the test of 'internal validity' is not applicable to this research.

- **Construct validity**: identifying correct operational measures for the concepts being studied

To ensure construct validity in this research, multiple methods (see the research design in Figure Table 3.3) and sources of evidence have been used for collecting data. For example, where possible, multiple interviews were conducted with multiple stakeholders in the same company (see Case Study details in Appendix 3B). Furthermore, key case study interviewees were asked to review the depiction of portfolio management processes in their respective firms for their feedback and corrections of any data misinterpretations. In addition, the researcher used methods such as documentation, participatory and direct observations to complement evidence collected in interviews and cases studies in particular. All these measures potentially helped to reduce the impact of subjectivity and biases such as respondent bias.

- **External validity**: defining the domain to which a study's findings can be generalised

External validity is concerned with whether the research results are generalisable or make sense in different contexts to those of participating companies. For ensuring external validity of this research, two primary measures were taken. Firstly, the data on portfolio management processes was collected from multiple companies operating in multiple industry sectors (see Appendix 3A, 3B, 3C for companies' descriptions). This means that the research results here can potentially be generalised to a reasonable extent in multiple contexts such as industry sector. Secondly, where possible the selection criteria were used in interviews and case studies (e.g. see section 5.2) to support replication of results in similar contexts.

- **Reliability**: demonstrating that operations of a study, such as the data collection procedures, can be repeated with the same results

The reliability test concerns transparency and consistency of data collection and analysis methods deployed in the overall research design. To ensure that this research is reliable, where appropriate, protocols (e.g. for case study, exploratory interviews, workshops) were developed, which helped the researcher to conduct research in a transparent and consistent manner (for instance, see a protocol used in case studies leading to Result II in Appendix 5A).

Ethical considerations

Apart from these four tests, an important aspect of the research design is that the research should be conducted in an ethical and professional manner, and in particular leads to no harm caused to research informants and their companies. This research requires companies to reveal information about their portfolio management processes and portfolio decisions, which is generally quite sensitive and confidential in nature. Therefore, the following measures were taken to ensure ethical research and to maintain data confidentiality and security:

- The data collected[22] is anonymised by substituting, for instance real names of the informants and companies with dummy names in resulting documents/reports
- Where appropriate, non-disclosure agreements[23] (NDAs) were signed between the researcher and the companies participating in this research. A total of 5 such NDAs were signed with the participating companies. In absence of an NDA, the researcher promised to use the data shared by the companies in a confidential and anonymised manner. Also, prior consent of informants was obtained before recording any interviews in this research.

3.6 Summary of Research Design

The chapter outlines various aspects of research design such as research questions, philosophical positions, data collection and analysis methods, research design and ethical considerations. The overall research question is split into four sub-questions dealing with identification, formalisation, integration and assessment of portfolio management processes. This research is ontologically, epistemologically and methodologically oriented towards relativism, social-constructionism, and qualitative methods (case study, action research and associated methods such as focus groups, interviews, workshops), respectively. A total of 3

[22] As a part of the researcher development program at the University of Cambridge, the researcher attended the trainings on avoiding plagiarism and doing ethical research.

[23] The Research Operations Office within the University of Cambridge (www.research-operations.admin.ac.uk, accessed between 2015 and 2018) facilitated the process of signing non-disclosure agreements with the companies. Moreover, member companies in STIM consortium and the University of Cambridge have signed an NDA as well, which in turn implies that any researcher (as the case in this research) engaging with these companies have to follow guidelines set by the NDAs.

focus groups, 10 case studies, 26 interviews, and 4 workshops were conducted in Phases I, II, and III. The methodological details of the derivation of the Results I, II, III and IV (each corresponding to one of the four sub-research questions) are then discussed, following which the research design is evaluated and measures taken to ensure this research was ethically conducted are described. The next chapter presents Result I, which aimed to answer the sub-research question seeking to identify key portfolio management processes.

CHAPTER 4 RESULT I: IDENTIFICATION OF PORTFOLIO MANAGEMENT PROCESSES

This chapter first introduces the background to Result I in terms of relevant knowledge gap addressed, basis and methodology used for its derivation. It then presents Result I, which is the framework identifying key portfolio management processes and their stakeholders. Then the theoretical and managerial implications of Result I are discussed, followed by a summary.

Contents

4.1 Introduction to Result I

The purpose of this chapter is to present and discuss Result I, which is the framework identifying key portfolio management processes and their stakeholders (see Figure 4.1). Section 4.2 outlines the background of Result I, followed by Section 4.3 which presents the framework with more details. Then theoretical and managerial implications of Result I are provided in Section 4.4, followed by a summary in Section 4.5.

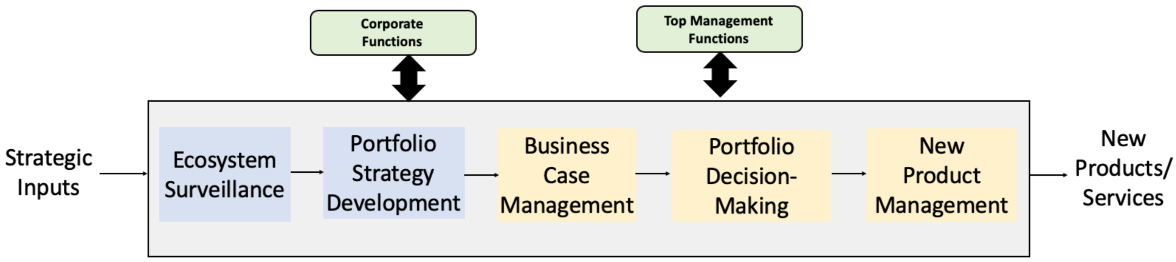


Figure 4.1: Result I: Identification of Portfolio Management Processes

4.2 Background to Result I

The section introduces the background to Result I in three parts: (1) the relevant knowledge gap addressed by Result I; (2) basis used for the derivation of Result I; and (3) methodology, which includes data collection and analysis methods used, leading to Result I.

4.2.1 Knowledge gap addressed by Result I

As discussed in Section 2.5, there exists three knowledge gaps with respect to process design for portfolio management (i.e. formalisation, integration and assessment of portfolio management processes). Among these three gaps (as mentioned in Section 3.2), this chapter is concerned with the first, which is the *lack of guidance on what and how to formalise in portfolio management.*

Before discussing further, a brief recap of the need to fix this gap is provided. The extant literature has already provided evidence about the positive relationship between portfolio management formalisation and portfolio management performance (e.g. Spieth & Lerch, 2014;

Jugend & da Silva, 2014; Cooper et al., 2001), however failed to provide guidance on operationalisation of this relationship.
Additionally, the surveys by the PwC Survey (2014) and PMI (2014) indicate that almost half of the participating firms lack formal portfolio management processes, and thus eventually likely to have lower performance on average (see Section 2.4). Therefore, providing a practical aid to formalise portfolio management could be useful to firms striving to improve the performance.

Two research objectives are set to address this gap:

- Identification of key portfolio management processes (i.e. 'What' to formalise)
- Formalisation of key portfolio management processes (i.e. 'How' to formalise)

Result I is concerned with the former, which is about identifying key portfolio management processes that enable portfolio decisions. The latter will be discussed as Result II in Chapter 5. Therefore, the sub-research question (as mentioned in Section 3.2) addressed here is:

What are the key portfolio management processes that can be formalised?

'Key' portfolio management processes in this research refer to portfolio management processes that consists of substantial number of tasks related to portfolio management and have implications for portfolio management performance.

4.2.2 Basis used for derivation of Result I

The basis used for answering the above question is the Portfolio Management Process Framework V.0 as discussed in Section 2.6. The reason is that it was synthesised from a number of prominent portfolio management definitions and process models discussed in both theory and practice and comprehensively covers various aspects of portfolio management (see Section 2.2), and provides a structured approach to answer this question.

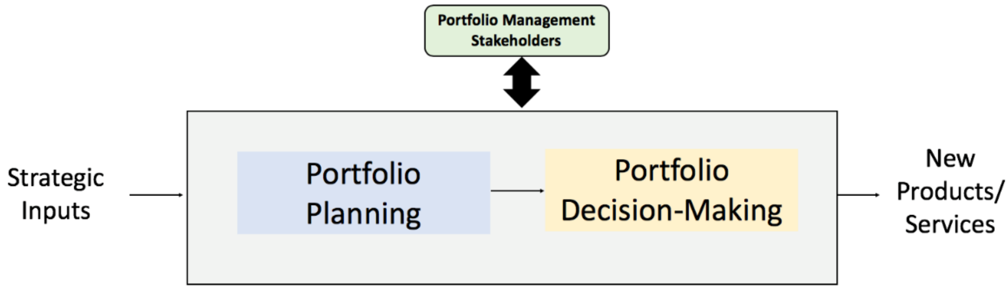


Figure 4.2: Portfolio Management Process Framework V.0 (adapted from Figure 2.18)

The framework V.0 has three main blocks: Portfolio Planning, Portfolio Decision-Making and Portfolio Management Stakeholders.

- *Portfolio Planning* consists of tasks such as making strategic choices regarding new product development strategy, deciding strategic goals and benefits to be achieved as the core purpose of doing portfolio management.
- *Portfolio Decision-Making* has further two parts: Portfolio Selection consists of tasks such project assessment, selection, prioritisation and Portfolio Steering, consists of tasks such as (re) allocating resource to projects, project execution and terminations.
- *Portfolio Management Stakeholders*: the stakeholders driving the above portfolio management processes.

4.2.3 Methodology of Result I

A total of 2 focus groups and 9 exploratory interviews were conducted for deriving Result I (i.e. Phase I, see Table 3.3 and Appendix 3A for more details). In both focus groups and interviews, the primary basis of data collection was the three components of the framework V.0 as described above. To analyse collected data, the approach of content analysis was used. The Figure 4.3 below presents the steps carried out in the Phase 1 data analysis.

Table 4.1 presents the details of data analysis of Phase I. The 1st column outlines three concepts of the framework V.0, the 2nd column provides corresponding practice codes (i.e. the codes representing portfolio management practices) developed from Phase I data, and the 3rd column outlines themes generated for each of these concepts (i.e. the framework V.1).

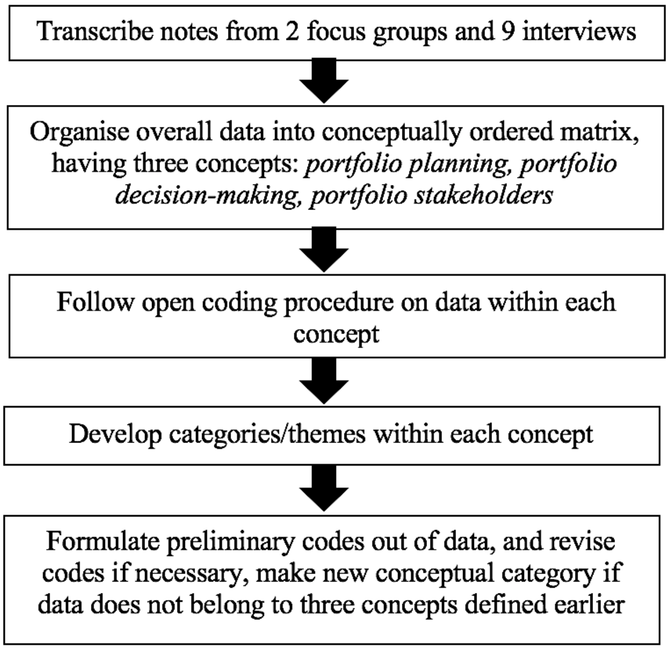


Figure 4.3: Steps of Content Analysis in Phase I (Source: Author, based on the steps of content analysis outlined in Cho & Lee, 2014; Miles & Huberman, 1994)

Table 4.1: Content Analysis of Phase I data

Note: The number(s) mentioned in *Italics* and brackets after each practice code represent Informant ID of interviewees in Phase I (see Appendix 3A). Both focus group discussions were not recorded, and it was not possible for the researcher to identify particular Informant for every discussion note made due to large number of informants. As a result, it was not possible to link the above codes to the Informant IDs from both the focus groups. Therefore, the above practice codes should not be read as a result of 9 interviews only.

Portfolio Management Process Framework V.0	Practice codes generated from Phase I data (2 Focus Groups and 9 Interviews)	Portfolio Management Process Framework V.1
	• Do market and technology research *(16, 18, 20)* • Search public patent databases *(16)* • Search academic and scientific literature *(14)*	**ECOSYSTEM SURVEILLANCE**

PORTFOLIO PLANNING	• Attend industrial conferences (e.g. by R&D, Sales teams) *(13, 14, 18)* • Set up online portals for customers to lodge their complaints *(13, 15)* • Frequently visit customer sites (e.g. by R&D team) *(13, 19)* • Collaborate with universities in area of mega-trends *(14, 18, 20, 21)*	
	• Localise business strategy *(13)* • Translate high level objectives into grass-root levels *(13)* • Make employees aware of strategic opportunities *(13)* • Develop and use strategic buckets *(17, 18)* • Set preference for platform-based projects *(16, 20)* • Align new ideas with customer roadmaps *(13)* • Development of technology & product roadmaps *(16, 18)* • Identify gaps in portfolio *(13, 20, 21)* • Promote 'out of box' thinking among staff *(13)* • Carry out front end activities before taking regular projects • Reward breakthrough innovations • Generate ideas in multifunctional workshops *(13, 14)*	**PORTFOLIO STRATEGY DEVELOPMENT**

<table>
<tr><td rowspan="2">PORTFOLIO DECISION-MAKING</td><td>Develop project charters to identify its resources, objectives, milestones, scope (14, 15)
Understand feasibility and visualise complexity of projects
Provide business training to technical staff
Consider organisational capabilities before pursuing ideas (13, 14)
Use real options method for project assessment
Use multifunctional criteria to assess projects (13, 14, 16, 18, 20)
Determine of financial value of projects (16)</td><td>BUSINESS CASE MANAGEMENT</td></tr>
<tr><td>Conduct elevator pitch presentations (by project proposers) during decision-making (13)
Use portfolio visuals such as bubble charts (17)
Terminate projects when no money is coming from them, competitors have done better job, fundamental limitation of knowledge, no more solving business needs (14, 20)
Use of ‘heuristics’ during decision-making (16)
Monitor portfolio performance indicators (20)
Balance commercial and technical perspectives (17, 18)
Balance incremental and radical innovation (16)
Prioritise and reprioritise projects (13, 16, 20)
Adjust portfolio review frequency as</td><td>PORTFOLIO DECISION-MAKING</td></tr>
</table>

	needed • Communicate portfolio decisions and related information to stakeholders	
	• Use buffered resources for resource allocation • Use gated process for funding allocation *(16, 20, 18, 19)* • Use light weight stage gates for small projects *(16)* • Identify sources of changes in projects *(16)* • Use formal knowledge management to learn from past projects *(14, 16, 18)* • Track sales after launching products	**NEW PRODUCT MANAGEMENT**
PORTFOLIO MANAGEMENT STAKEHOLDERS	• Buy-in for portfolio management processes • Coach project managers *(15)* • Change in portfolio composition with change in top management team and their dispositions *(13, 18)*	**TOP MANAGEMENT TEAM**
	• Share information between product management & R&D *(13)* • Collaborate cross-functionally for gathering external environmental information, project assessment and executions (*13, 14)*	**CORPORATE FUNCTIONS**

As a result of data analysis, modifications were made to the framework V.0, with the revised version termed framework V.1 (Figure 4.4):

- Portfolio Planning (V.0) is split into two processes: *Ecosystem Surveillance (V.1)* and *Portfolio Strategy Development (V.1)*.

- Portfolio Decision-Making (V.0) is split into three stages: *Business Case Management (V.1),* which can be considered as a pre-decision-making process; *Portfolio Decision-Making (V.1)*; and *New Product Management (V.1)*, which can be considered as post-decision-making process.
- Portfolio Management Stakeholders (V.0) is split into two groups: *Top Management Functions (V.1)* and *Corporate Functions (V.1).*
- A sequence between portfolio management processes has been added, together with links between these processes and portfolio management stakeholders

The next section discusses these modifications in more detail.

4.3 Result I: Portfolio Management Process Framework V.1

This section will first provide a brief overview of the framework V.1, and then discusses the modifications mentioned in Section 4.2. The framework V.1 consists of five key portfolio management processes: *Ecosystem Surveillance, Portfolio Strategy Development, Business Case Management, Portfolio Decision-Making, and New Product Management*.

The sequence between these processes are indicated to be linear in this framework but further in-depth exploration of overall portfolio management is needed to ascertain this sequence or presence of any other sequence(s). These processes are driven by two stakeholder functions: Top Management and Corporate Functions.

The framework V.1 follows an 'Input-Process-Output' logic as strategic inputs drive these five portfolio management processes being carried out by the two stakeholder functions, and results into new products or services being introduced into market(s). However, how these stakeholders interact with the processes is not evident from Phase I data.

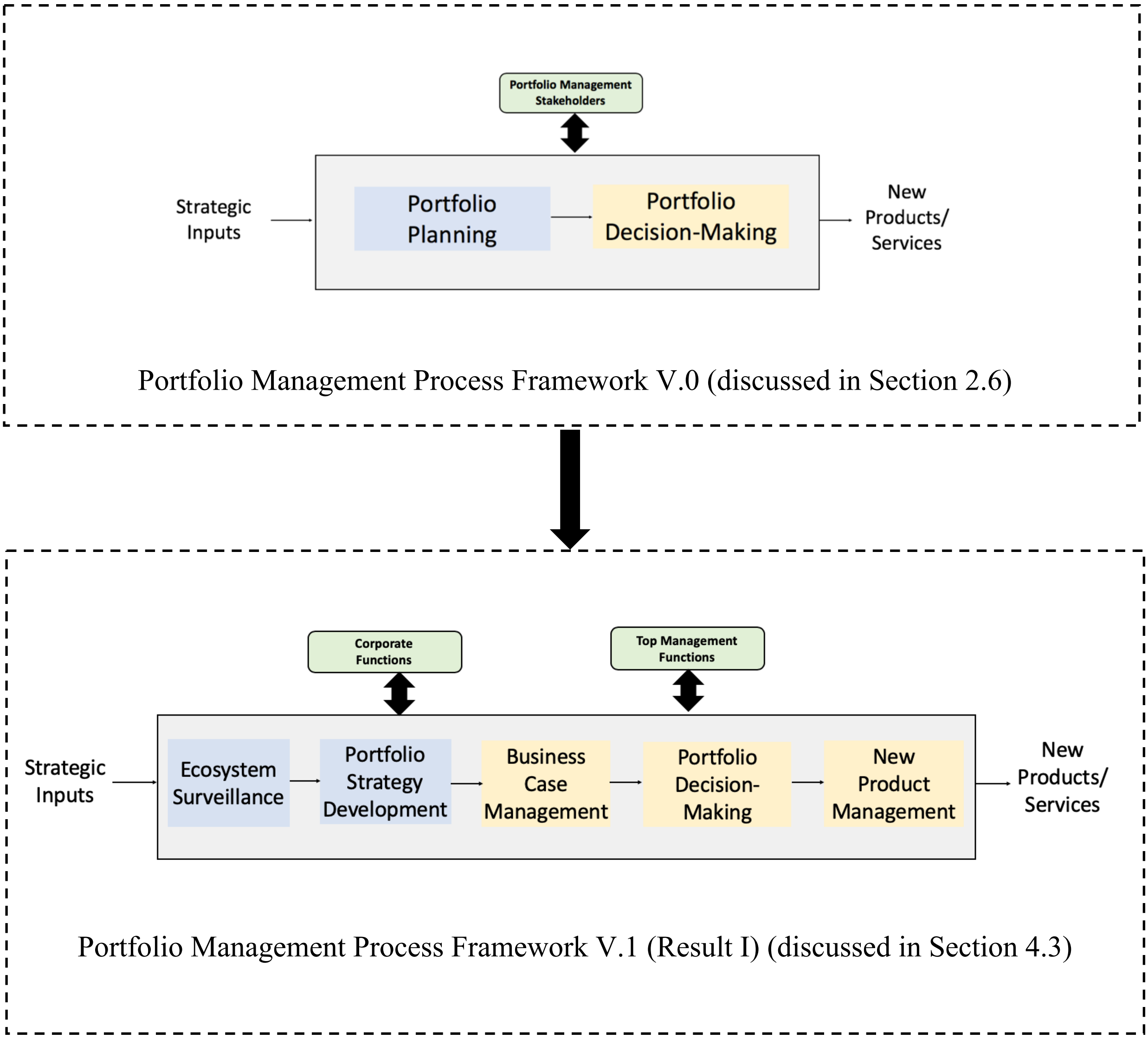


Figure 4.4: Portfolio Management Process Framework V.0 and V.1

As mentioned in Section 4.2, the framework V.1 is the result of four modifications to the framework V.0. It would be now useful to discuss these modifications in more detail.

- Portfolio Planning is split into two processes: *Ecosystem Surveillance* and *Portfolio Strategy Development* (see Figure 4.5).

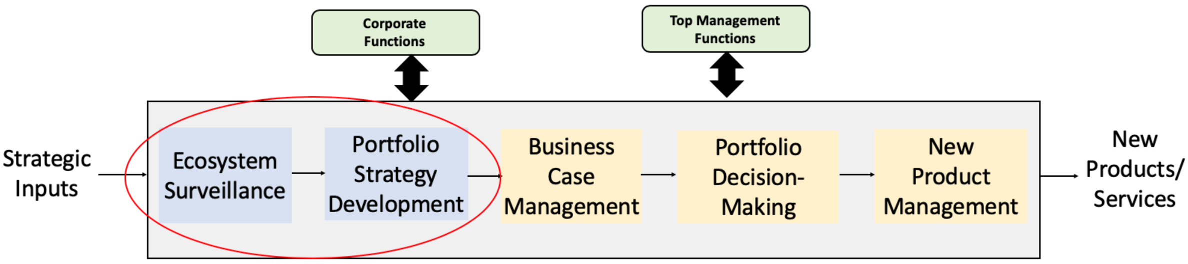


Figure 4.5: Ecosystem Surveillance and Portfolio Strategy Development in Framework V.1

Ecosystem Surveillance: refers to the series of tasks which involves collection of information about the business ecosystem[24] of an organisation such as market trends, technology opportunities, customer complaints, which can be used in other processes such as portfolio strategy development. The enablers of this process include cross-functional collaboration such as between R&D and Sales, and collaborative projects undertaken with universities to explore mega-trends. See Table 4.1 for set of practices used operationalising this process. For instance, Informant 13 (see Appendix 3A for more details about informants) while describing this process mentioned that he had set up a portal for customers to lodge their pain points which are directly accessible by the R&D unit of his firm. This initiative eventually helps in generating new ideas for projects and fostering customer visibility. Another example of this process was given by Informant 14, that in order to gather information about market trends (such as new material in this case), he attends academic conferences and reads academic literature. If he discovers promising new technology, he proposes it to senior management, where strategic direction for this technology is discussed, and if considered useful, a collaborative project with the university is launched to de-risk that new technology. Similar tasks of developing collaborative projects with universities was mentioned by Informants 20 and 21. It is important to note that Ecosystem Surveillance at portfolio level is different from market or technology intelligence carried out at NPD levels. This is because at the portfolio level, the objective of ecosystem surveillance is to support the development of strategy for overall portfolio (unlike for a specific product in development) and also to shape the direction of portfolio emergence with project ideas and to ensure NPD pipeline does not dry up.

Portfolio Strategy Development: refers to a set of tasks such as setting strategic direction(s) for a portfolio and its decisions, identifying new project opportunities to fill any portfolio gaps and allocating budget for portfolio implementation. See Table 4.1 for set of practices which can be used to operationalise this process. For example, Informant 18 mentioned that although there is no well formalised portfolio strategy development process in his firm, technology and product roadmaps were created and as a result, one of the strategic imperatives for a portfolio was the preference for the products that could be launched in a six-month timeframe, and

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[24] This research follows the definition of 'Business Ecosystem' put forward by Moore (1993), which states that Business Ecosystem is a "*economic community supported by a foundation of interacting organisations and individuals—the organisms of the business world. The economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organisms also include suppliers, lead producers, competitors, and other stakeholders*".

another was a need for undertaking projects for developing technology platforms. A second example is Informant 16's company, which aims to be the market leader in power generation and transmission products, and as a result, development of technology platform projects was set as a strategic priority.

- Portfolio Decision-Making is split into three processes: *Business Case Management*, *Portfolio Decision-Making*, and *New Product Management* (as indicated in Figure 4.6).

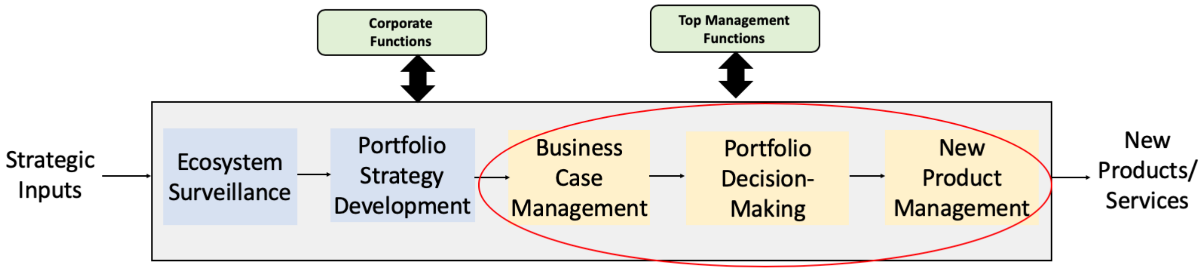


Figure 4.6: Business Case Management, Portfolio Decision-Making, New Product Management in Framework V.1

Business Case Management: refers to series of tasks such as preparation and assessment of project business cases[25] to be considered during portfolio decision-making. It can be considered as a pre-decision-making process. This process includes business case preparation such as development of project charters to identify resources needed to implement it, to check whether the firm has capabilities to undertake that project or not.

Most Phase I informants indicated that they used multifunctional criteria and methods to determine the value of projects. See Table 4.1 for a set of practices which can be used to operationalise this process. For example, Informant 14 mentioned that once the project charter (e.g. for a new material technology) was developed, which include identification of objectives and resources need to implement that project, a decision by the portfolio management committee was taken. While describing a particular case, he mentioned that four work packages were developed for the new material technology project, which include understanding that technology, making a use case for it, evaluating which technology properties are desired, and

[24] This research follows the definition of 'Business Case' put forward by Kopmann et al. (2015) which states that *"... business case is a document that provides the necessary information to enable management to make decisions about project prioritisation and funding. It contains estimates of the benefits, timescales, resource requirements (including costs), and risks of a project*".

actually testing the technology in the field. The funding decisions were based on the status of execution of these work packages.

Portfolio Decision-Making: refers to the set of tasks undertaken to decide whether to invest/continue to invest/terminate projects, labelled as project selection and termination decisions. This process also includes the monitoring of portfolio management performance, such as its value, balance and strategic alignment. Once portfolio decisions are taken, projects are prioritised and relevant information about the portfolio is communicated to its stakeholders. See Table 4.1 for series of practices which can be used to operationalise this process.

For example, Informant 13 mentioned that during portfolio decision-making events, the project proposer makes an elevator pitch, following which a decision on a project is taken. Informant 14, while reflecting on portfolio decision-making in his firm, reported that projects have been terminated due to fundamental limitation of technical knowledge. A project can also be terminated if a competitor has done a better job in the market or technology domain which a project was targeting (as described by the Informant 20).

New Product Management: refers to the tasks which are undertaken to allocate resources to the prioritised projects and implement those projects while performing relevant pre and post launch NPD Stage-Gate activities (see Section 2.2 for more details). Table 4.1 outlines a set of practices which might be used to operationalise this process.

For example, Informants 16, 18, 19 and 20 mentioned the use of gated processes for resource allocation. Gated processes can be configured according to project type (as mentioned by Informant 16). Using formal knowledge management systems to learn from the projects carried out in the past was suggested to be an important task of this process.

- Two portfolio management stakeholders are identified in the framework V.1, which are: *Corporate Functions* and *Top Management Functions* (see Figure 4.7).

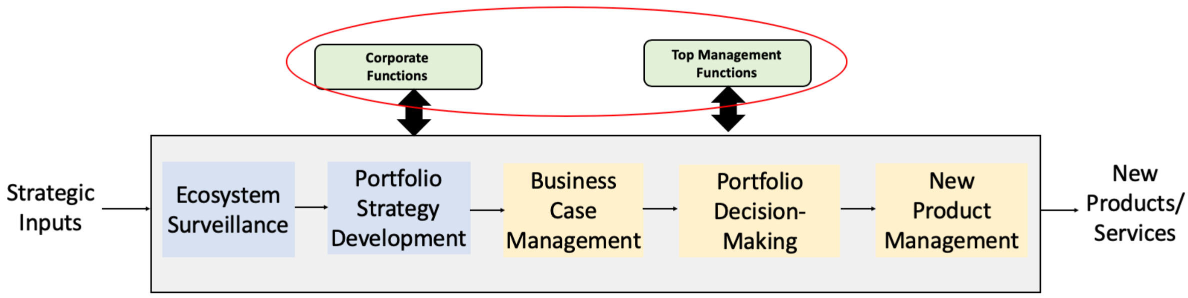


Figure 4.7: Corporate Functions and Top Management Functions in Framework V.1

Corporate Functions: refers to the group of functional stakeholders such as R&D, Marketing and Finance that drive the portfolio management processes discussed above. The functions of these stakeholders include tasks such as sharing of information between them and collaboration with each other for activities such as project assessment. For example, Informant 13 mentioned that R&D and product management stakeholders share information about customer pain points with each other, following which project ideas are generated, leading to definition of new projects.

Top Management Functions: refers to the group of stakeholders who are responsible for making portfolio decisions and driving overall portfolio management processes. The portfolio decision-maker(s) could have a considerable influence on portfolio performance. For instance, one of the informants from the 2nd focus group mentioned that high attrition rates of portfolio decision-makers in his firm led to the portfolio value being compromised.

He explained that since new decision-makers stay for short time in that company, and pressure to create value for the company leads them to approve low risk projects generating financial value in the short term while comprising longer term value. A similar challenge of low risk profiles of top management was reported by Informant 13.

- Addition of sequence between portfolio management processes, and links between these processes and portfolio management stakeholders (see Figure 4.8).

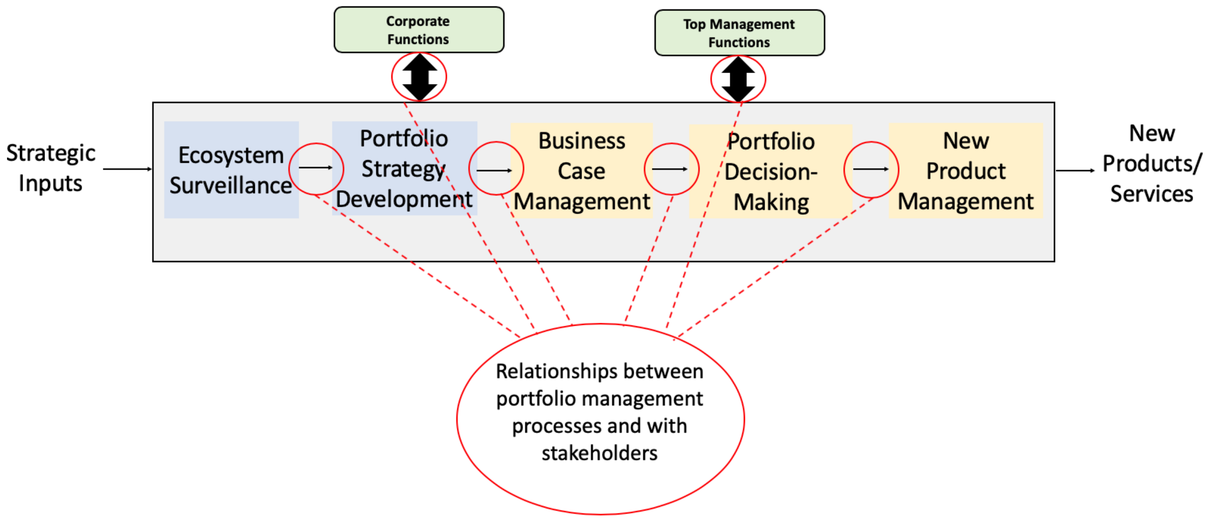


Figure 4.8: Relationships between Portfolio Management Processes and Stakeholder Functions in Framework V.1

The relationships in the framework V.1 as indicated in Figure 4.8 has two components: 1) the sequence of portfolio management processes, and 2) the link between portfolio management processes and stakeholders.

Sequence of portfolio management processes: The framework V.1 indicates a linear sequence between the portfolio management processes. For example, Informant 20 mentioned that the information generated as a result of Ecosystem Surveillance helps in Portfolio Strategy Development. He mentioned that the portfolio is analysed with respect to industrial mega-trends, and if there are very few or no projects exist catching those trends in a portfolio (i.e. portfolio gap), a strategic action was warranted. However, more data is needed to ascertain this sequence or presence of any sequence(s) between portfolio management processes. This component of the relationship is further explored in Chapters 5 and 6.

Link between portfolio management processes and stakeholders: Since Phase I was explicitly focused on revealing key portfolio management processes, as a result, insights about the interactions of the portfolio management stakeholders with the processes are not very clear. However, Phase I does suggest some such interactions. For example, Corporate Functions such as R&D, Marketing together drive the process of Ecosystem Surveillance (as mentioned by Informant 13, 14). On the other hand, Top Management is responsible for Portfolio Strategy Development and Portfolio Decision-Making (as mentioned by Informants 16, 18, 20). To clarify such interactions, in-depth exploration of portfolio management processes is needed, which is carried out in Phase II, described in Chapter 5 and 6.

This section briefly presented Result I, which is the Portfolio Management Process Framework V.1. The next section will discuss the implications of Result I.

4.4 Discussion of Result I

This section discusses the theoretical and managerial implications of Result I, followed by its limitations and considerations.

4.4.1 Theoretical Implications

As mentioned in Section 2.5, portfolio management formalisation has implications for portfolio management performance. So far, the extant literature focuses on causal relevance of portfolio management formalisation in terms of its methods and processes (e.g. Jugend & da Silva, 2014; Spieth & Lerch, 2014; Teller et al., 2012; Kock et al., 2014), as shown in Figure 4.9 below.

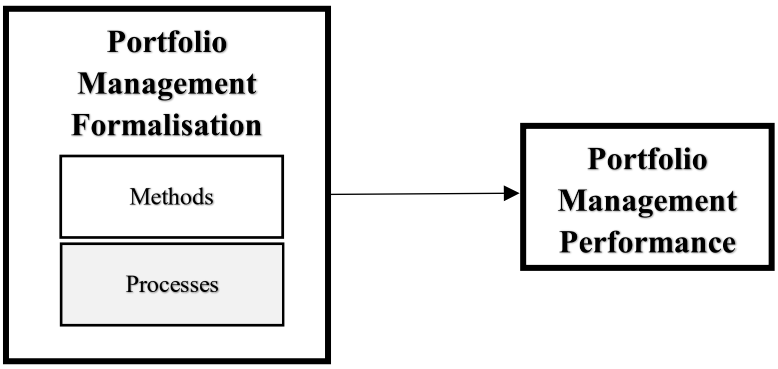


Figure 4.9: Portfolio Management Formalisation and Performance (Source: Author, based on insights from e.g. Jugend & da Silva, 2014; Spieth & Lerch, 2014)

Although this type of causal logic is no doubt a useful insight, it ignores the processes which need to be formalised to reap performance benefits. *Result I particularly expanded the process construct of portfolio management formalisation by identifying five key portfolio management processes which could be formalised for improving portfolio management performance* (see Figure 4.10). Another implication of Result I is that it combines these five key portfolio management processes which are typically investigated separately and argued to be antecedents of portfolio management performance in different management disciplines. Result I could also explain the source of difference between the firms having formal overall portfolio management (55%) and the firms having formal NPD process (69%) as indicated in the benchmarking survey by Barczak et al. (2009). Based on Result I, it can be argued that such differences exist because formalising the NPD process is not a sufficient condition for formalised portfolio management, and other processes such as Ecosystem Surveillance, Portfolio Strategy Development, Business Case Management and Portfolio Decision-Making also need to be formalised in parallel.

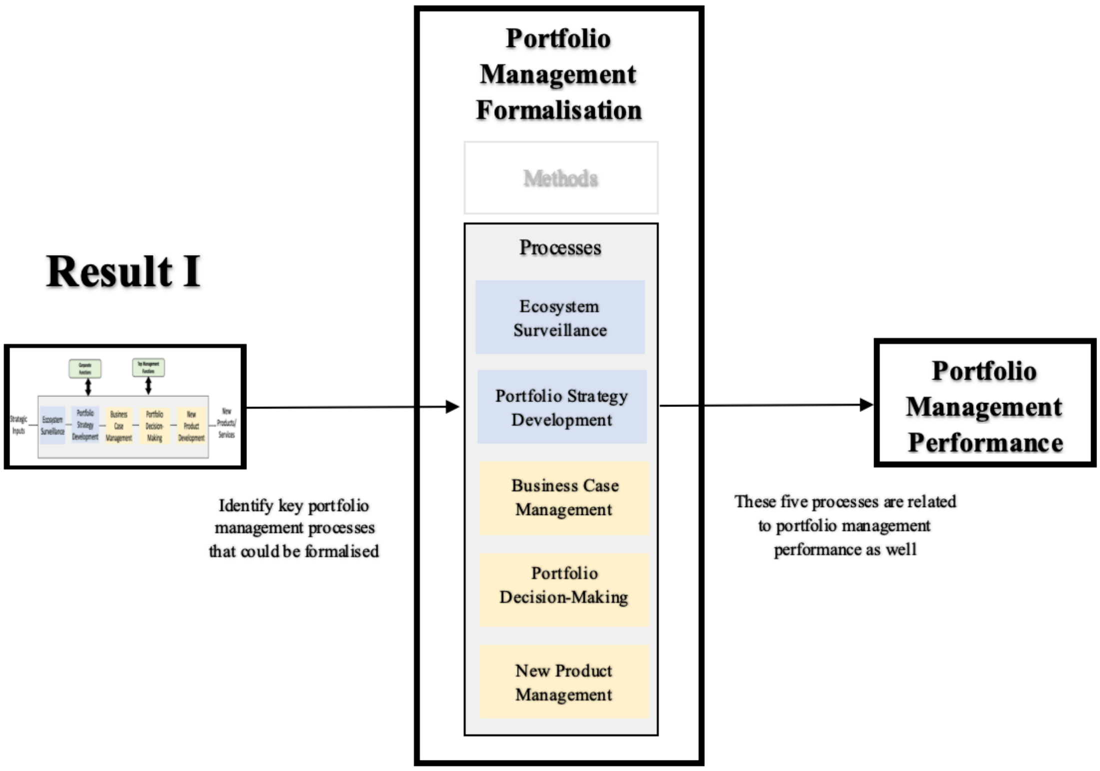


Figure 4.10: Implications of Result I for Portfolio Management Formalisation (Source: Author)

As indicated in Section 4.3, combining these processes as indicated in Result I raises the point about their integration (i.e. relationships) in terms of sequence(s) (of their execution) and inter-dependencies (i.e. impact of varying one portfolio management on the other) and are discussed in Chapters 5 and 6 respectively. The extant literature will now be discussed with respect to each of the key portfolio management processes in terms of their formalisation and performance implications.

Ecosystem Surveillance: Result I introduce the construct of Ecosystem Surveillance as one of the key processes of portfolio management. This construct is closely related to the concept of Absorptive Capacities (ACAP) (e.g. Zahra & George, 2002). ACAP refer to the capability of firm that enables them to innovate by acquiring and recognising the value of external knowledge, assimilate that that knowledge internally and apply it to commercial ends (e.g. Cohen & Levinthal, 1990; Killen et al., 2012). A number of studies have argued for a correlation between absorptive capacities and firm performance (e.g. Lane et al., 2006; Tsai, 2001). Particular to portfolio management literature, only Biedenbach and Muller (2012) found the positive influence of absorptive capacity for portfolio management performance empirically. In their study, they argued that utilisation of external information is essential for project and portfolio management performance. They suggested that for developing up-to-date product aligned with market needs, external information such as customer needs is needed, and this information enables proper assessment of project proposals and supports portfolio balance and prioritisation. Therefore, *Result I support the above findings regarding Absorptive Capacity (e.g. Lane et al., 2006; Biedenbach and Muller, 2012) and expand the underpinning argument in a way that formalising Ecosystem Surveillance will have impact on portfolio management performance*.

Portfolio Strategy Development: Result I revealed the construct of Portfolio Strategy Development as one of the key processes of portfolio management. This is closely related to the central tenet of the Strategy literature, which states that formalised strategic planning has implications for firm performance (e.g. Thune and House, 1970; Ansoff et al., 1970). Particular to portfolio management literature, Cooper and his colleagues (1998, 2001) have emphasised the need for developing portfolio strategy and suggested the use of strategic buckets (see Section 2.2 for more details). Along the similar lines, Meskendahl (2010) introduced the concept of strategic portfolio orientation and Kang & Montoya (2014) framed the concept of portfolio strategy as product development strategy, market entry strategy and portfolio components. The implications of portfolio strategy for portfolio management performance is well noted in the literature (e.g. Cooper et al., 2001; Kang & Montoya, 2014; Klingebiel & Rammer, 2013; Klingebiel & Joseph, 2015). Therefore, *Result I support the above findings regarding portfolio strategy (e.g. Meskendahl, 2010; Cooper et al., 2001; Kang & Montoya, 2014; Klingebiel & Rammer, 2013) and expands the underpinning argument in a way that formalising Portfolio Strategy Development will have impact on portfolio management performance*.

Business Case Management: Result I introduced the construct of Business Case Management as one of the key processes of portfolio management. This construct is related to the concept of 'investment initiative', which has been studied in resource allocation literature (e.g. Bower, 1970; Burgelman, 1983). As stated by Maritan & Lee (2017), "*How an investment initiative is defined [i.e. business case] when it is initially proposed has significant consequences of other aspects of the resource allocation process [i.e. portfolio decision-making], including how the initiative is evaluated [i.e. business case assessment] and the support that it receives from organizational actors*". Specific to portfolio management domain, the Business Case Management is closely related to construct 'Business Case Control' (Kopmann et al., 2015), which refers to portfolio-level control and monitoring of project business cases. Even though, the development of quality business cases has remained a challenge for firms (e.g. Cooper et al., 2001), its implication for firm performance has been noted by Kopmann and his colleagues (2015). They found that business case control is positively associated with portfolio management performance. The rationale behind such a relationship is that business cases contribute to increasing portfolio value by enabling informed portfolio decisions, improving resource allocation in accordance to priorities and enabling early detection of unprofitable investments. Therefore, *Result I support the above finding regarding management of business cases (e.g. Kopmann et al., 2015) and expands the underpinning argument in a way that formalising Business Case Management will have impact on portfolio management performance*.

Portfolio Decision-Making: Result I revealed the construct of Portfolio Decision-Making as one of the key processes of portfolio management. This construct is grounded in the Strategy Decision-Making literature, of which the central tenet is that formal strategy decision-making is positively co-related with firm performance (e.g. Thune and House, 1970; Ansoff et al., 1970; Eisenhardt & Bourgeois II, 1988). Other related constructs include procedure rationality (Dean and Sharfman, 1996), strategic rationality, and decisional rationality (Schwenk, 1995). Particular to the portfolio management literature, Kester et al. (2014) is one of few such studies which explore the types of portfolio decision-making processes and revealed that 'Evidence-Based Decision-Making' is one of the such processes. Evidence-Based Decision-Making is closely linked with rational and formalised portfolio decision-making. It refers to the explicit use of a combination of inputs and methods to obtain understanding of data (such as business cases and strategic priorities) for making portfolio decisions. However, the construct of Portfolio Decision-Making in Result I does relate to Evidence-Based Decision-Making, without implying that other types of decision-making are irrelevant. For example, heuristics or gut-feeling based portfolio decisions was one of the portfolio management practices that frequently surfaced in Phase I data. The construct here rather consists of setting up of systematic procedures for making portfolio decisions. Therefore, *Result I support the above finding regarding formal or rational strategic decision-making (e.g. Eisenhardt & Bourgeois II, 1988; Kester et al., 1994) and expands the underpinning argument in a way that formalising Portfolio Decision-Making will have impact on portfolio management performance*.

New Product Management: Result I revealed the construct of management of New Product Management as one of the key processes of portfolio management. This construct is grounded in the Innovation literature, which has captured significant attention of scholars in last few decades (e.g. Cooper et al., 2001; Barczak et al., 2009). The formalisation of this process has been noted as one of the best practices and has implications for portfolio management performance (e.g. Cooper et al., 2001; Griffin, 1997). *Result I support this finding in a way that formalising this process will have impact on portfolio management performance*.

4.4.2 Managerial Implications

Result I has some managerial implications as well. For example, the portfolio management practices mentioned in Table 4.1 can be used as a quick checklist to formalise portfolio management processes (although more research is needed to refine these practices). Another implication is that managers should consider making deliberate investment for carrying out the process of Ecosystem Surveillance, which not only improves the input quality to other processes but also helps in improving portfolio management performance. It also helps in building up a usable knowledge base and enhancing learning capabilities. Firms looking to formalise portfolio management should take note that only formalising the NPD process is insufficient for formalising the overall portfolio management system. Rather, they should consider formalising the other four portfolio management processes as well, in parallel. Consequently, the Result I framework could also be used as a starting point for improving portfolio management maturity.

4.4.3 Limitations

One of the main limitations of Result I is that it does not comprehensively explain how to formalise these five portfolio management processes. This is because Phase I data is quite exploratory in nature and does not involve in-depth investigation of portfolio management processes. However, Result II (using Phase II data) in Chapter 5 addresses this limitation.

A second limitation of Result I is that it does not provide guidance on the degree of formalisation of each of the portfolio management processes; or in other words, it does not answer the question 'do all these processes need the same level of formalisation to make the portfolio management system work?' It can be argued that the degree of formalisation depends on the context and needs of an organisation as the context in which portfolio management is carried out has implications for its process design (e.g. Martinsuo, 2013). Addressing this limitation would entail separate research efforts and hence considered as future research work.

Another limitation is that Result I do not reveal conditions or contingency factors which could influence formalisation of portfolio management. For example, a firm with a small portfolio size may not benefit from fully formalising these portfolio management processes as this could be over bureaucratic and time consuming and would impede the benefits of appropriate formalisation of portfolio management. Identifying such contextual factors is not the core focus of this research but is related, and considered as future research work. Even though Result I revealed two stakeholder functions which drive these processes, the researcher believes that further in-depth investigation is needed to ascertain if there are any other relevant stakeholder functions, and to explore the functions of these groups, as this was not the prime focus of Phase I data. Result II in Chapter 5 addresses this limitation as well.

4.5 Summary of Result I

This chapter addresses the sub-research question, *what are the key portfolio management process that can be formalised*. Using Portfolio Management Process Framework V.0 (described in literature review (Section 2.6), a total of 2 focus groups and 9 interviews were conducted in Phase I. Content analysis of the Phase I data led to Result I, which is the framework V.1. It presents five key portfolio management processes:

- Ecosystem Surveillance: gathering external information such as market trends and bringing that information into organisation
- Portfolio Strategy Development: setting strategic direction(s) for portfolio decisions
- Business Case Management: preparing and assessing business cases of projects on which decision has to be made
- Portfolio Decision-Making: making project selection and termination decisions and monitoring portfolio performance
- New Product Management: allocating resources to selected projects and implement those projects using NPD Stage-Gate activities

Two relevant portfolio management stakeholder functions are identified: Top Management Functions and Corporate Functions.

The theoretical implication of Result I is that it expands the process construct of portfolio management formalisation by identifying five key portfolio management processes, which could be formalised for improving portfolio management performance. The value of Result I is that it holistically brings together various portfolio management processes fragmentedly discussed in the extant literature. The managerial implication of Result I is that it outlines a set of practices which can be used to formalise the five key portfolio management processes.

However, the limitation of Result I is that it does not provide guidance on formalising these portfolio management processes. Also, it does not clarify the relationships between these processes and their stakeholders. That is, what is the sequence of these processes, how do these processes relate to each other, which stakeholder function interacts with which portfolio management process, or are there any other stakeholder functions which are relevant for portfolio management processes? To address these limitations, Phase II data collection was carried out, leading to Results II and III are discussed in Chapter 5 and 6 respectively.

CHAPTER 5 RESULT II: FORMALISATION OF PORTFOLIO MANAGEMENT PROCESSES

This chapter presents Result II, the framework which describes underlying sub-processes, components, practices and relevant stakeholders of the five key portfolio management processes (as identified in Result I). It starts with the introduction of the background to Result II in terms of relevant knowledge gap addressed. It then presents each of the three stages (along with associated basis and methodology) associated with the derivation of Result II. Finally, the chapter closes with the outline of theoretical and managerial implications of Result II, followed by a summary.

Contents

5.1 Introduction to Result II

The purpose of this chapter is to present and discuss Result II, which is the framework that describes underlying sub-processes, components, practices and relevant stakeholders of the five key portfolio management processes (as identified in Result I). Section 5.2 outlines the background to Result II. As the derivation of Result II was divided into three stages, Sections 5.3, 5.4 and 5.5 discuss Stage I (framework development; framework V.2), Stage II (framework refinement; framework V.3) and Stage III (framework verification; framework V.4), respectively. Section 5.6 outlines the theoretical and managerial implications, and limitations of Result II. Finally, a summary of this chapter is provided in Section 5.7.

There are three levels of Result II (framework V.4, developed iteratively from V.1), each differing on the basis of the level of information provided in the framework.

- The first level presents Result II with lowest level of detail, outlining key portfolio management processes and stakeholders (see Figure 5.1). For example, the key processes are Ecosystem Surveillance, Portfolio Strategy Development, Business Case Management, Portfolio Decision-Making and New Product Management. It includes three stakeholder functions: Corporate Functions, Top Management Functions and Project Management Functions. It also indicates the potential relationships between processes and stakeholder functions. For example, Top Management Functions can be related to Portfolio Strategy Development and Portfolio Decision-Making.

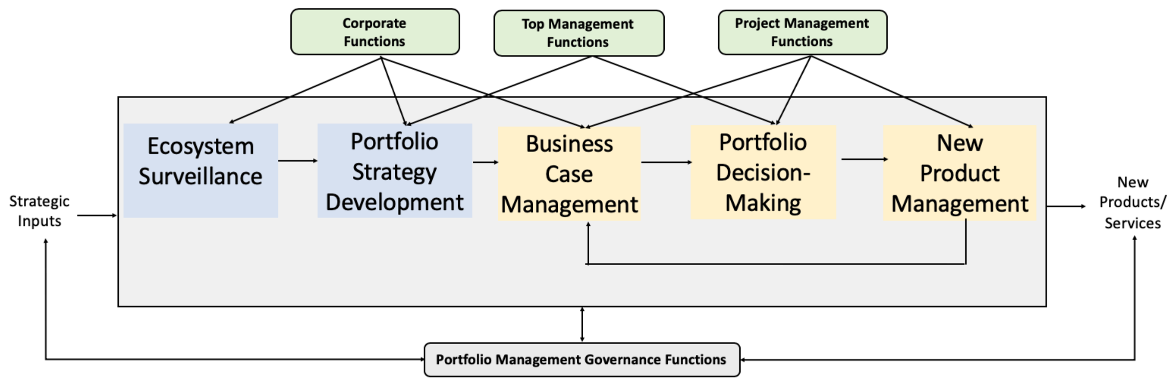


Figure 5.1: First Level of Result II (Portfolio Management Process Framework V.4)

- The second level presents Result II with medium level of detail, outlining sub-processes of the five key portfolio management processes (see Figure 5.2). For example, the process of Ecosystem Surveillance includes two sub-processes: Information Gathering and Business Requirement Identification. Similarly, the process of Business Case Management includes Business Case Preparation and Business Case Assessment.

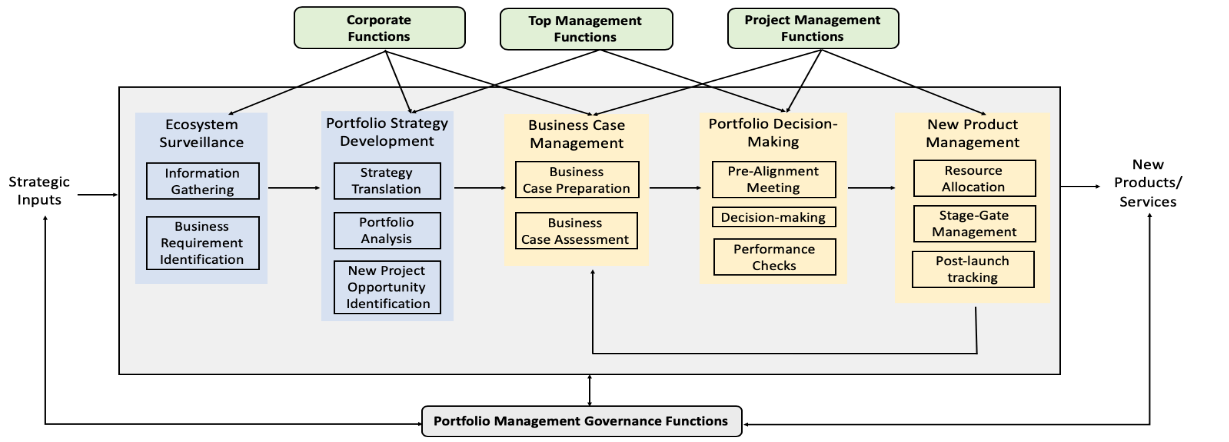


Figure 5.2: Second Level of Result II (Portfolio Management Process Framework V.4)

- The third level presents Result II with highest level of detail, outlining components (and underlying practices) of the sub-processes of the key portfolio management processes and stakeholder functions (see Figure 5.3).

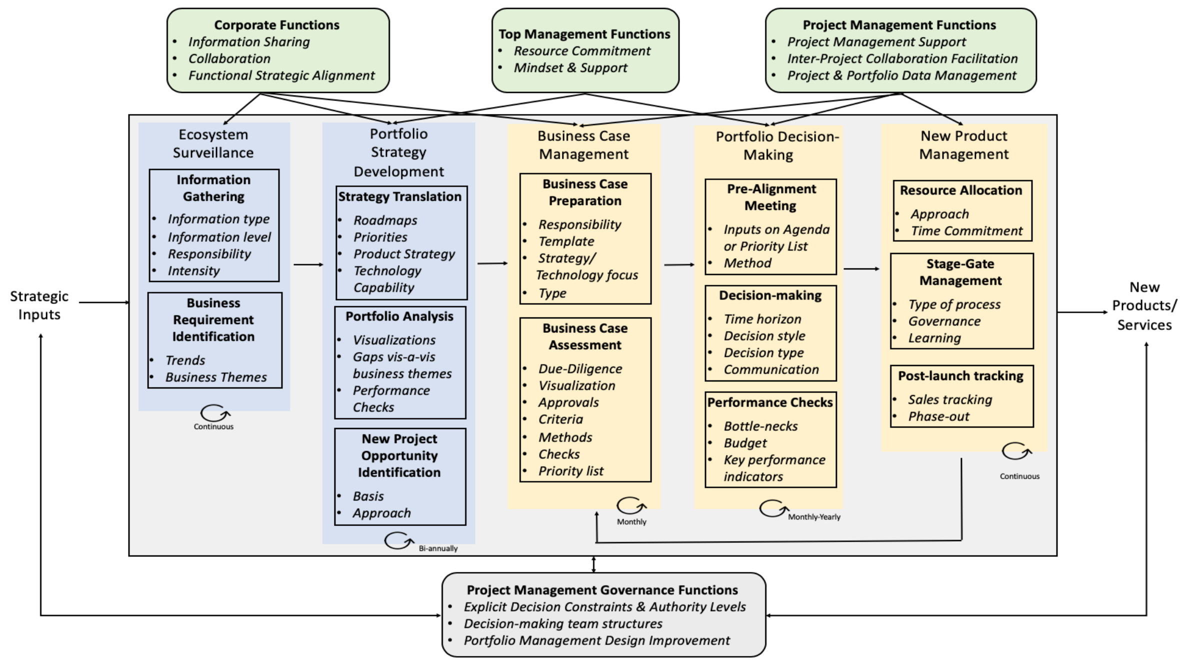


Figure 5.3: Third Level of Result II (Portfolio Management Process Framework V.4)

For example, the sub-process Information Gathering includes components such as Information Type, Information Level, Responsibility and Intensity. Similarly, the sub-process Business Case Assessment includes components such as Due-Diligence and Methods. For the purpose of discussions through the rest of the Sections in this chapter, the third level of Result II will be used as it contains the most granular level of detail.

5.2 Background to Result II

The section introduces background to Result II in terms of the relevant knowledge gap addressed. As discussed in the Section 2.5, out of three knowledge gaps with respect to process design for portfolio management, this chapter is concerned with the first gap, which is a *lack of guidance on what and how to formalise in portfolio management*. Result I have already addressed the 'what' part of this gap and Result II in this chapter will address the 'how' part of the gap. Therefore, the sub-research question (as mentioned in Section 3.3) addressed here is:

How may key portfolio management processes be formalised?

Before discussing further, it would be useful to briefly recap the need to answer this question. The extant literature has already provided evidence about the positive relationship between portfolio management formalisation and portfolio management performance (e.g. Spieth & Lerch, 2014; Cooper et al., 2001). In this regard, Result I extended this relationship and provided some guidance by revealing five key portfolio management processes that could be formalised, which have implications for the performance as well. However, the limitation of the extant literature and Result I is the lack of guidance on 'how' to formalise these key processes, and this is where Result II aims to contribute by extending Result I, and consequently revealing sub-processes, stakeholders, components and practices associated with these processes. Therefore, providing a practical aid such as Result II to support portfolio management formalisation could be useful for firms striving to improve the performance.

As mentioned in Table 3.3, the derivation of Result II was based on Phase II data collection, which was divided into three stages. Stage I builds upon Result I by conducting 9 in-depth case studies, leading to the development of the framework V.2. Stage II aims to refine the framework V.2 and conducted 17 stand-alone interviews with academic and industry informants in addition to the 10th in-depth case study with the European pharmaceutical company. The result of Stage II was the framework V.3. Finally, in Stage III a focus group with 5 industrial informants was conducted to evaluate the framework V.3 and to identify further refinement opportunities, leading to framework V.4 (i.e. Result II). The next Section 5.3 discusses Stage I in more detail.

5.3 Stage I: Portfolio Management Process Framework V.2

This section presents the Stage I (framework development), which builds upon the framework V.1 (i.e. Result I) as shown in Figure 5.4 and leads to the development of the framework V.2. This section has three sub-sections, Sections 5.3.1 and 5.3.2 introduce the basis and methodology basis used for deriving the framework V.3, and then Section 5.3.3 presents the framework V.2 with more details.

5.3.1 Basis used for derivation of the Portfolio Management Process Framework V.2

The basis used was the framework V.1 (i.e. Result I) as shown in Figure 5.4. This is because it provides a structured direction to address the knowledge gap regarding 'how' to formalise portfolio management process. The framework V.1 has already identified key portfolio management processes that could be formalised. Another reason is that it incorporates both theoretical and practical insights on portfolio management definitions and process models.

The framework V.1 is based on the framework V.0, which builds upon theoretical insights drawn from the extant literature in the domains of Strategy, Innovation and Operations (see Sections 2.2 & 4.4). Furthermore, framework V.1 is also based on insights drawn from the experience of 38 industrial informants (from 33 companies), thus reflecting a reasonable amount of knowledge about portfolio management in practice as well.

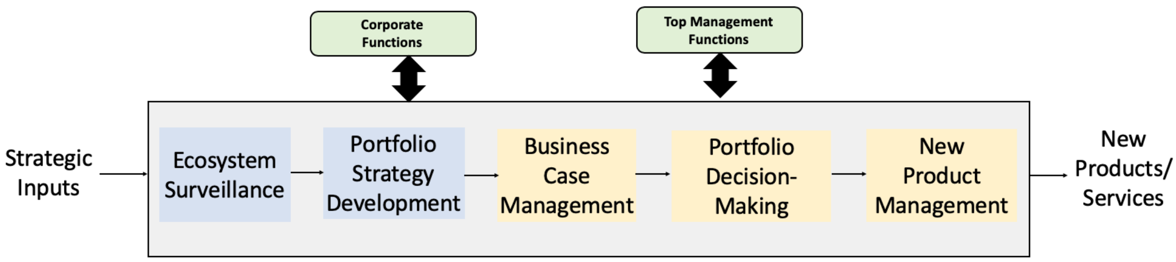


Figure 5.4: Portfolio Management Process Framework V.1 (adapted from Figure 4.1)

5.3.2 Methodology of the Portfolio Management Process Framework V.2

The overall methodology for deriving framework V.2 can be divided into a series of steps as described in Table 5.1. Total of 6 steps (A-F) were taken, starting from selection of case firms to completion of data analysis, leading to the framework V.2. The following section will discuss each of these steps in more detail.

Table 5.1: Stage I methodology

STAGE I METHODOLOGY	
A	*Selection of case firms*
B	*Selection of relevant informants in case firms*
C	*Development of case study protocol*
D	*Conducting the case study interviews*
E	*Analysis of case study data*
F	*Development of the Portfolio Management Process Framework V.2*

A. Selection of case firms

A total of 9 in-depth case studies were conducted in Stage 1, exploring overall portfolio management process (as unit of analysis) in technology-intensive firms. See Table 3.5 and Appendix 3B for more details). The selection of the case firms was based on the following criteria:

- **Technology-Intensive firms**: These are firms which operate in technology-intensive industries. Following the OECD manual[26] on technology intensity measures, the technology-intensive firms in this study are defined as the firms which invest substantially in R&D such as technological innovation and operate in highly uncertain market and technical environments. Due to this uncertainty, the need for effective portfolio management becomes critical for these firms. Therefore, potential cases were firms which operate in medium to high technology industries (as classified in the OECD manual) such as pharmaceutical, medical instruments, electrical machinery and apparatus.

- **Firm Size (No. of employees):** for technology-intensive firms, it is important to employ a large proportion of scientists, engineers and technologists. The potential cases were the firms having at least 2,000 employees in total.

- **Use of formal portfolio management processes**: As this research is about exploring portfolio management processes which are currently being carried out in technology-intensive firms, the potential cases were firms which have had portfolio management processes in place for at least (or more than) a year.

- **Continuous improvement of portfolio management process**: As this research aims to develop techniques for assessing portfolio management processes, it was considered useful to choose firms in which the process of overall portfolio management has evolved and been assessed over time. This helps in understanding existing techniques used for assessing portfolio management process in the potential case firms.

- **Geography of firm's operations**: the case candidates were firms which operated globally or at a multinational level. The reason behind not setting up geographical constraints was that previous research has indicated that national culture could impact portfolio management practices.

[26] The OECD manual is available on: https://www.oecd.org/sti/ind/48350231.pdf (accessed between 2015 and 2018)

Choosing a particular geography would constrain the findings of this research. Moreover, this research is not focused on revealing portfolio management practices in specific geographies, but rather aims to explore the practices globally.

Considering these criteria, potential firms were invited to take part in this research (more information about how the firms were contacted and invited is given in Chapter 3), and as mentioned in Table 5.2, a total of 9 firms satisfied all four criteria and were finally selected as case firms (see Appendix 3B). After selecting the firms, the next step was to select the relevant informant's in the case firms.

Table 5.2: Case Selection Details

	CASE SELECTION CRITERIA				
	Technology Intensive Firm	**Firm Size**	**Use of formal portfolio management process**	**Continuous improvement of portfolio management process**	**Geography of firm's operations**
Case 1	✓ (Electrical Machinery)	✓ (2,000-5,000)	✓ (< 2 years)	✓ (Yes)	✓ (Global)
Case 2	✓ (Electrical Machinery)	✓ (10,000-20,000)	✓ (< 2 years)	✓ (Yes)	✓ (Global)
Case3	✓ (Apparatus)	✓ (20,000-50,000)	✓ (> 5 years)	✓ (Yes)	✓ (Global)
Case 4	✓ (Medical Device)	✓ (2,000-5,000)	✓ (> 5 years)	✓ (Yes)	✓ (Global)
Case 5	✓ (Pharmaceutical)	✓ (2,000-5,000)	✓ (< 2 years)	✓ (Yes)	✓ (Global)
Case 6	✓ (Medical Device)	✓ (20,000-50,000)	✓ (> 5 years)	✓ (Yes)	✓ (Global)
Case 7	✓ (Medical Device)	✓ (2,000-5,000)	✓ (< 2 years)	✓ (Yes)	✓ (Global)
Case 8	✓ (Medical Device)	✓ (2,000-5,000)	✓ (< 2 years)	✓ (Yes)	✓ (Global)
Case 9	✓ (Electrical Machinery)	✓ (>50,000)	✓ (3-4 years)	✓ (Yes)	✓ (Global)

B. Selection of relevant informants in case firms

The primary criteria for selecting the informants in the case studies were that they possessed and could reveal the required information on portfolio management processes in their firms.

Consistent with the studies in the extant literature (e.g. Rank et al., 2015; Unger et al., 2012), portfolio decision-makers and portfolio co-ordinators were considered as the relevant informants. Therefore, before conducting any case interviews, it was ensured that either the informant(s) takes part in the portfolio decision-making or coordinates a portfolio in the case firms. As mentioned in Table 5.3, most of the informants in this study were portfolio decision-makers, this indicates the quality of data collected as it represents the 'inside' view of portfolio management processes.

Table 5.3: Selection of relevant informants in the case firms

Case	Informant Designation	Portfolio Decision-Maker	Portfolio Management Co-ordinator
Case 1	Vice President, R&D	✓	
	Director, Product Portfolio Management	✓	
	Manager, Product Portfolio		✓
Case 2	Senior R&D Director. Project & Planning	✓	
	Head of Global Portfolio Management Office	✓	
Case 3	Global Portfolio Manager, R&D	✓	
	Incubation Portfolio Manager	✓	
Case 4	Senior Vice President, Portfolio	✓	
	Vice President, Portfolio Lead	✓	
	Vice President, Portfolio	✓	
	Vice President, Portfolio Plan	✓	
Case 5	Manager, R&D Portfolio & Strategy		✓
Case 6	Project Portfolio Manager, Manufacturing Devices	✓	
Case 7	Director, Innovation Portfolio	✓	
	Director, Innovation Planning	✓	
	Project Portfolio Manager	✓	
Case 8	Director, Innovation Project Management	✓	
Case 9	Global Innovation Operations Manager		✓

C. Development of case study protocol

As suggested by Yin (2014), to increase reliability of research involving multiple case studies, a case study protocol needs to be developed that outlines the questions that will be asked of the case study informants.

This helps the researcher to remain consistent in approach, including unit of analysis for the research. Therefore, a case study protocol aimed at exploring portfolio management processes was developed, as presented in Appendix 5A.

D. Conducting the case study interviews

As mentioned in Appendix 3B, each of the case studies involved one or two interviews with one or more relevant informants using the developed case study protocol. Most of the interviews were conducted face-to-face, with the researcher visiting the informants in their firms, and where permissible, interviews were recorded.

On average, each interview lasted for about 1.2 hours. Relevant documents regarding portfolio management processes were requested and collected (where possible) during the interviews. Another method used for data collection during fieldwork was direct observations, which provided the researcher with an opportunity to perceive organisational settings in which portfolio management processes are carried out in the case firms.

E. Analysis of case study data

The steps taken to analyse the data collected from case study interviews are shown in Figure 5.5. The data analysis starts from the transcription of interviews and associated notes and ends with the development of the framework V.2. It also includes the analysis of portfolio management processes in individual case firms as well as across the case firms.

Figure 5.6 describes the data analysis structure used for single case as well as cross case analysis. Figure 5.7 represents snapshots of the visuals of the portfolio management processes for each of the cases. The cross-case analysis of the each of the portfolio management process constructs is shown in Table 5.4, 5.5, 5.6, 5.7, 5.8 and 5.9.

Appendix 5B shows a sample of coding of one of the interview transcripts.

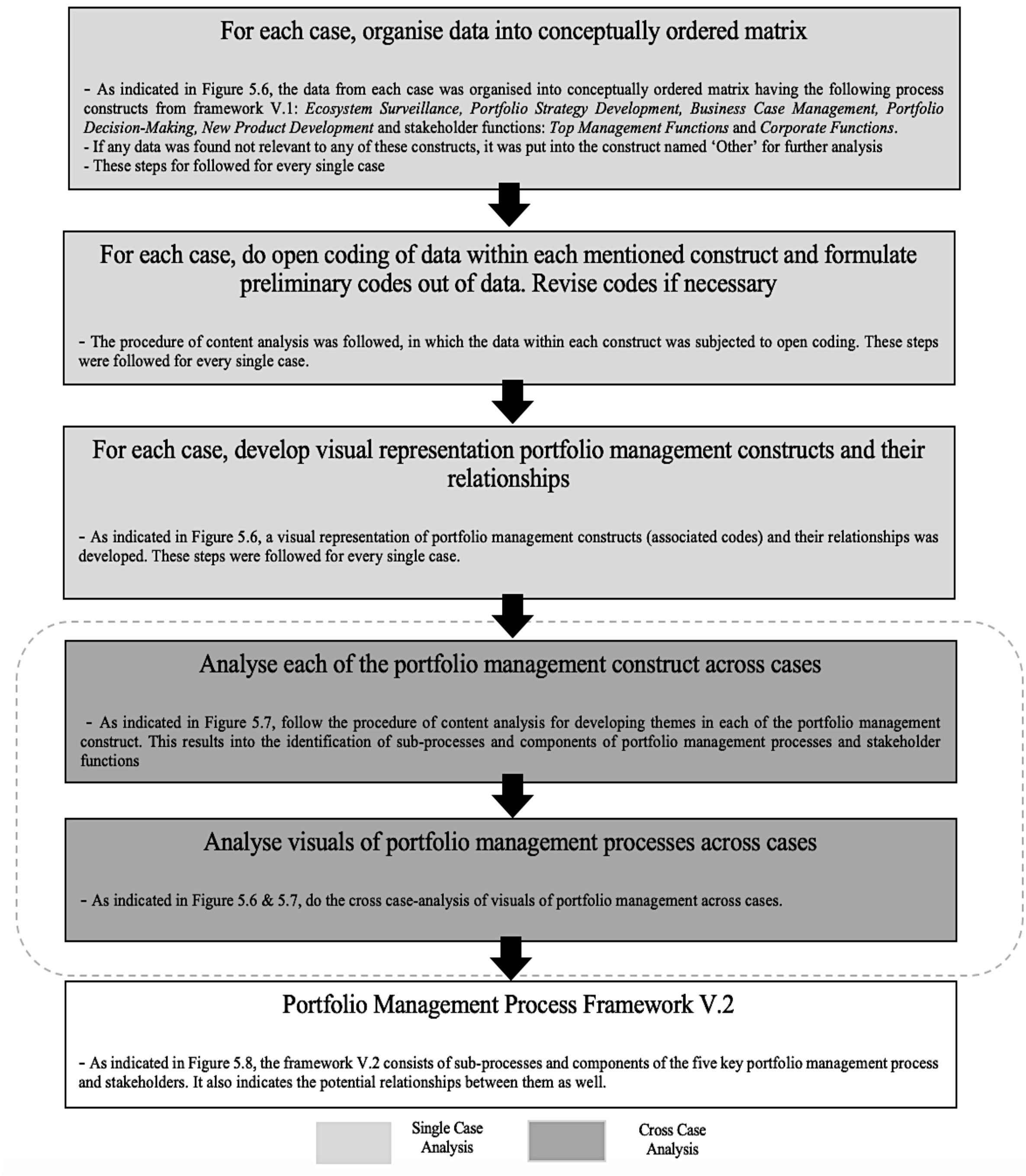


Figure 5.5: Steps of Data Analysis of Case Study Interviews

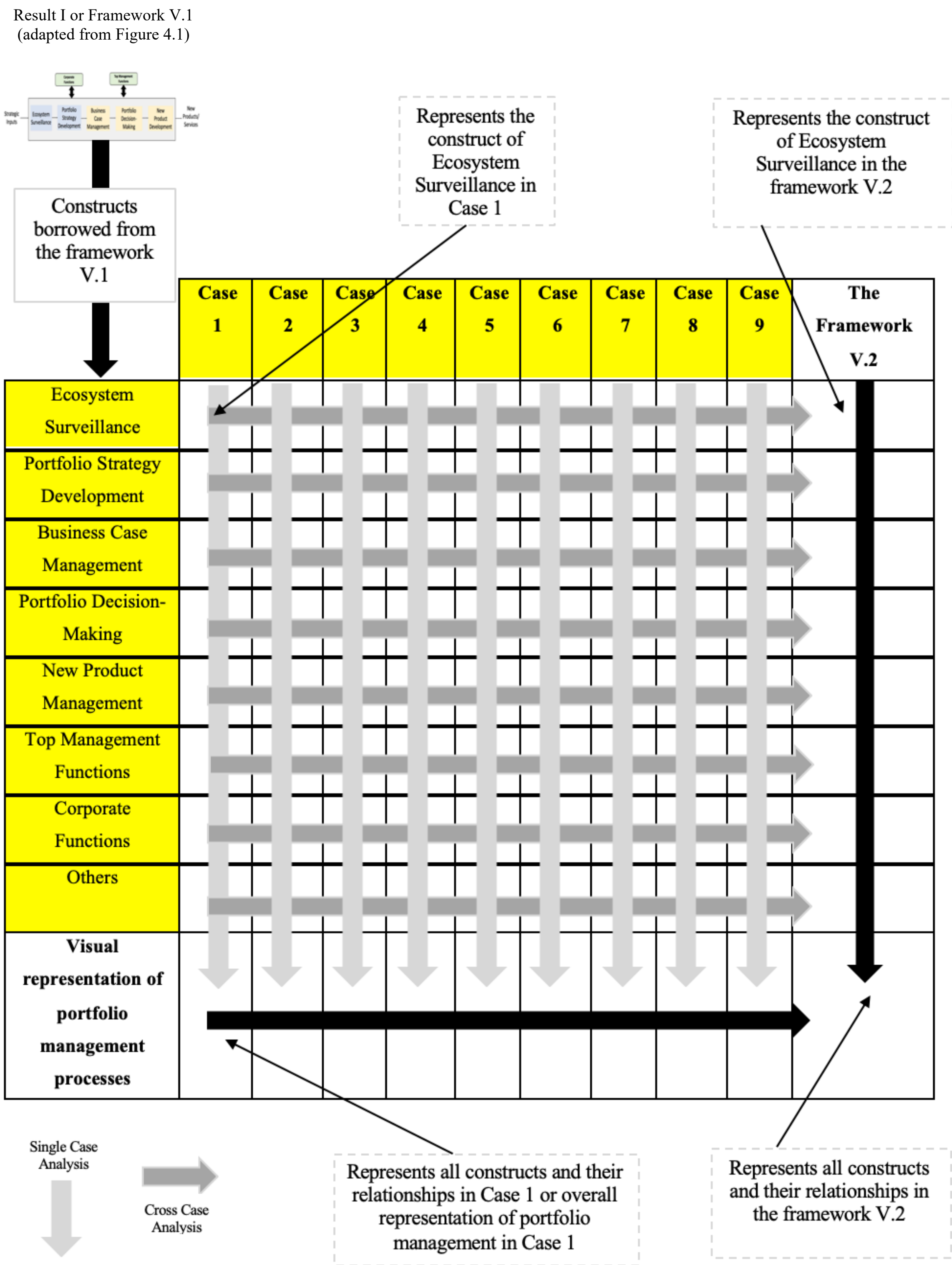


Figure 5.6: Data Analysis Structure for Case Study Interviews

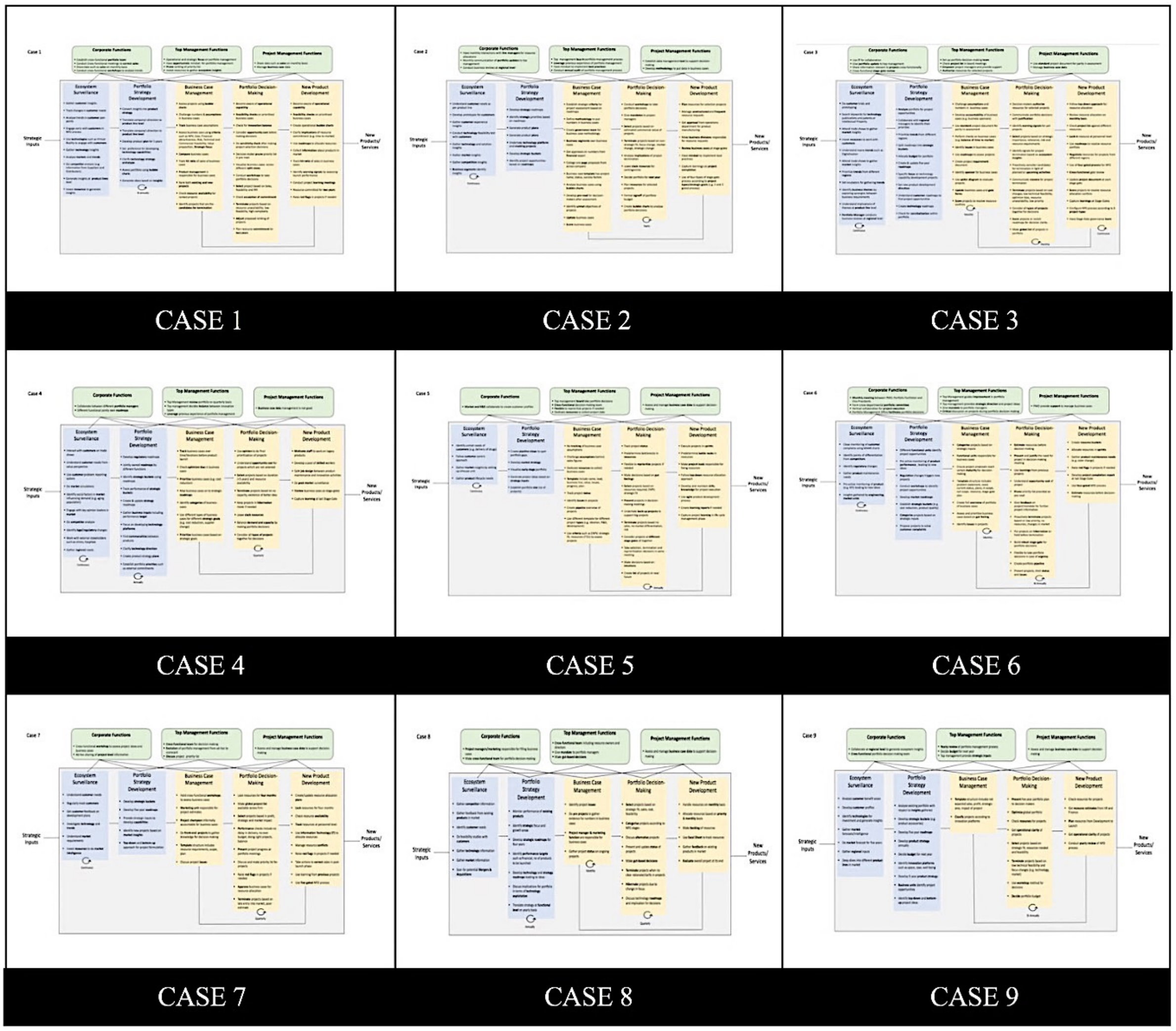


Figure 5.7: Thumbnail Visuals of Portfolio Management Processes in Case Companies

For more detail on the practices associated with each of the constructs, refer to Tables 5.4, 5.5, 5.6, 5.7, 5.8 and 5.9. After data analysis, the last step (F) in the Stage I methodology (see Table 5.1) was the development of the Portfolio Management Process Framework V.2, which is discussed in the next sub-section.

5.3.3 Portfolio Management Process Framework V.2

This sub-section presents the framework V.2 as shown in Figure 5.8 (along with framework V.1 for comparison).

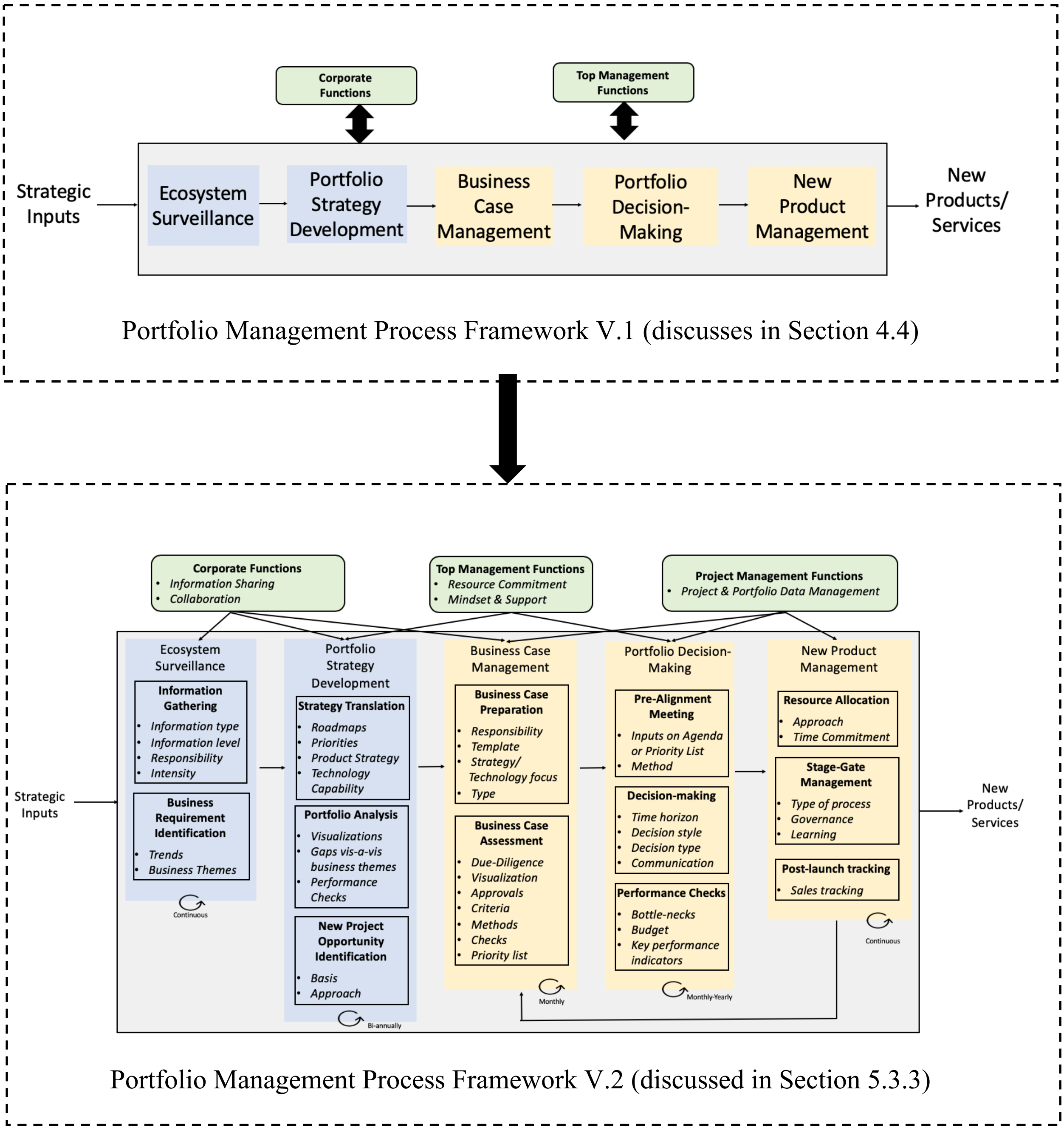


Figure 5.8: Portfolio Management Process Framework V.1 and V.2

On comparing above frameworks, it can be inferred that framework V.2 is primarily the result of seven modifications made to framework V.1. The following sections will discuss each of these seven modifications in more detail, explaining the constructs of the framework V.2 as well.

1. ***Ecosystem Surveillance (V.1) has been expanded into two sub-processes (and associated components): Information Gathering (V.2) and Business Requirement Identification (V.2).***

Ecosystem Surveillance refers to the series of tasks which involves collection and analysis of information about the business ecosystem of an organisation (also see Section 4.3). As a result of the case studies, this key process of portfolio management has been expanded into two sub-processes: Information Gathering and Business Requirement Identification (as indicated in Figure 5.9). For more details on the derivation of these sub-processes, their components and associated practices, see Table 5.4.

Information Gathering involves collection of information about the business ecosystem of an organisation. It has four main components: *Information Type, Information Level, Responsibility* and *Intensity*. Business Requirement Identification involves analysis of the collected information and identifying its implications for a business. It has two components: *Trends* and *Business Themes*. The frequency of ecosystem surveillance is indicated to be continuous as found across the case studies.

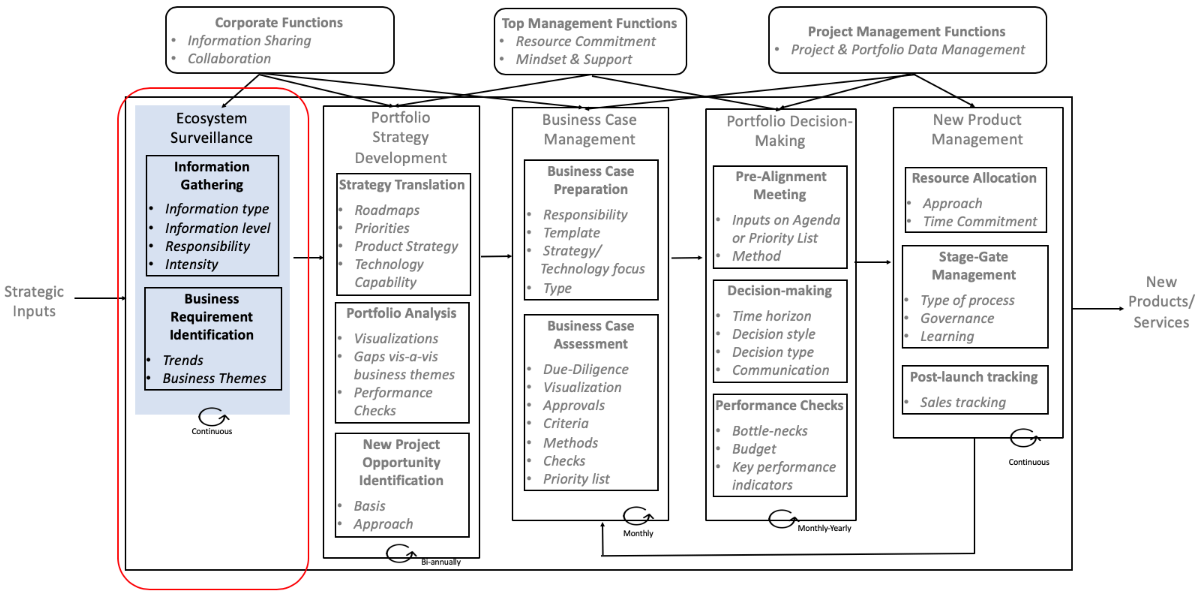


Figure 5.9: Ecosystem Surveillance of Framework V.2

Components of Information Gathering:

- *Information Type* refer to the type of information which can be collected about various entities in an ecosystem of a business. It includes information about customer, technology, market, competitor, legal and regulatory aspects. As mentioned in Table

Table 5.4: Sub-processes and components of Ecosystem Surveillance

Ecosystem Surveillance									Portfolio Management Process Framework	
Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Sub-Processes /*Components*	V.2
▪ Gather customer Insights ▪ Track changes in customer needs ▪ Analyse trends in customer pain points ▪ Engage early with customers in NPD process ▪ Use technologies such as Virtual Reality to engage with customers ▪ Gather technology Insights ▪ Analyse markets and trends ▪ Do competitor analysis (e.g. information from Suppliers and Distributers) ▪ Generate Insights at product lines level ▪ Invest resources to generate Insights	▪ Understand customer needs as per product line ▪ Develop prototypes for customers ▪ Gather customer experience insights ▪ Conduct technology feasibility test with customers ▪ Gather technology and solution insights ▪ Gather market insights ▪ Gather competition insights ▪ Business segments identify insights	▪ Do customer trials and prototyping ▪ Search keywords for technology publications and patents or Intellectual Property ▪ Attend trade shows to gather market insights ▪ Invest resources to work with customers ▪ Understand macro trends such as Digitalisation ▪ Attend trade shows to gather market insights ▪ Prioritize trends from different regions ▪ Set incubators for gathering trends ▪ Identify business themes by exploring synergies between business requirements ▪ Understand implications of themes at product line level ▪ Portfolio Manager conducts business reviews at regional level	▪ Interact with customers on trade shows ▪ Understand customer needs from value perspective ▪ Use customer problem reporting system ▪ Do market simulations ▪ Identify social factors in market influencing demand (e.g. aging population) ▪ Engage with key opinion leaders in market ▪ Do competitor analysis ▪ Identify legal/regulatory changes ▪ Work with external stakeholders such as clinics, hospitals ▪ Gather regional needs	▪ Identify unmet needs of customers (e.g. delivery of drugs) ▪ Follow customer centric approach ▪ Gather market insights by setting up inhouse-unit ▪ Gather product lifecycle needs	▪ Close monitoring of customer complains using MAAR charts ▪ Identify points of differentiation from competitors ▪ Identify regulatory changes ▪ Gather product maintenance needs ▪ Pro active monitoring of product (e.g. KPI) leading to new ideas ▪ Insights gathered by engineering, market units	▪ Understand customer needs ▪ Regularly meet customers ▪ Get customer feedback on development plans ▪ Investigate technology and trends ▪ Understand market requirements ▪ Invest resources to do market intelligence	▪ Gather competitor information ▪ Gather feedback from existing products in market ▪ Identify customer needs ▪ Do feasibility studies with customers ▪ Gather technology information ▪ Gather market information ▪ Scan for potential Mergers & Acquisitions ▪	▪ Analyse customer benefit areas ▪ Develop customer profiles ▪ Identify technologies for investment and generate insights ▪ Gather market forecasts/intelligence ▪ Do market forecast for five years ▪ Gather regional inputs ▪ Deep dives into different product lines in market	Information Gathering • *Information Type* (Customer, Technology, Market, Competitor, Legal, Regulatory) • *Information Level* (Product Line, Regional) • *Responsibility* (Portfolio Manager, Engineering unit, Marketing Unit, Business Segments) • *Intensity* (Resources) Business Requirement Identification • *Trends* (e.g. Digitalisation) • *Business Themes*	Information Gathering • *Information Type* • *Information Level* • *Responsibility* • *Intensity* Business Requirement Identification • *Trends* • *Business Themes*

5.4, various practices related to this component include tracking changes in customer needs, gathering information about competitors from suppliers and distributors, identifying unmet customer needs, close monitoring of customer complaints and identifying regulatory changes.

- *Information Level* specifies the level and scope of the information that can be collected about at ecosystem, and the instances found across the cases are product line and regional levels. The associated practices include generating ecosystem insights at the product line level and conducting business reviews at the regional level.
- *Responsibility* refers to the accountability of the stakeholder(s) for collecting these types of information. Instances of this component across cases was found to be portfolio manager, engineering unit, marketing unit and business segments. It should be noted that the component of information level and responsibility for information gathering depends on the structure of an organisation.

- *Intensity* refers to the amount of resources allocated by top management to carry out the process of Information Gathering. Across cases, intensity of information gathering was found to be a common issue in portfolio management.

Components of Business Requirement Identification*:*

- *Trends* refers to identification of patterns across the different types of the ecosystem information that has been collected. The associated practices include identifying trends in customer complaints, identifying micro and macro trends in an ecosystem, for example, digitalisation of products and services and prioritising trends identified across different regions.
- *Business Themes* refers to the identification of themes around which a company should consider doing its business. It also involves analysis of trends and understanding their implications for the existing business of a company. The associated practice includes exploring synergies between business requirements, setting up incubators for identifying potential firms for mergers and acquisitions.

The role of Ecosystem Surveillance in overall portfolio management is quite important as found across the cases. The information collected about an ecosystem helps in validating and updating the various information about ongoing projects in a company, which have implications for selection/termination decisions on those projects. It supports the development of portfolio strategy, identification of new business or project opportunities and business issues such as low sales of existing products, which can help in increasing portfolio value. It also identifies opportunities for expansion of portfolio(s) by identifying potential products/services (of other companies) that have synergies with existing products or technology of a company.

2. ***Portfolio Strategy Development (V.1) has been expanded into three sub-processes (and associated components): Strategy Translation (V.2), Portfolio Analysis (V.2) and New Project Opportunity Identification (V.2).***

Portfolio Strategy Development refers to the series of tasks which involves setting strategic goals and directions for portfolio decisions, determining gaps in portfolio and identifying new project opportunities that could be needed to implement the strategy or fix portfolio gaps (also see Section 4.3). As a result of case studies, this key process of portfolio management has been expanded into three sub-processes: Strategy Translation, Portfolio Analysis and New Project Opportunity Identification (as indicated in Figure 5.10). For more details on the derivation of these sub-processes, their components and associated practices, see Table 5.5.

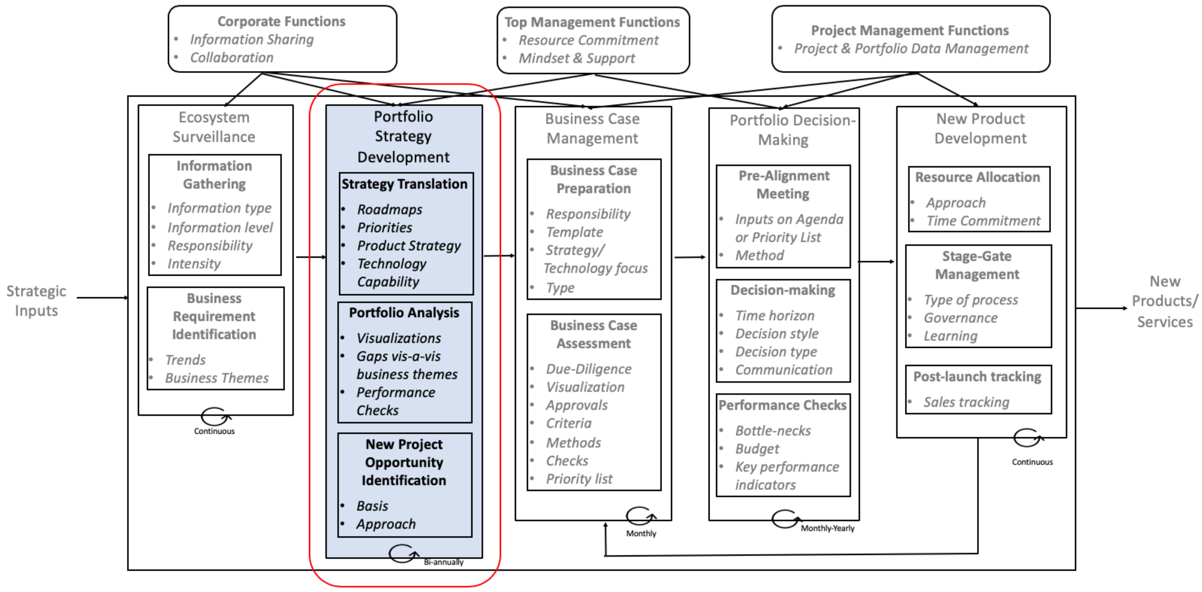


Figure 5.10: Portfolio Strategy Development of Framework V.2

Strategy Translation involves breaking down high-level strategy into portfolio goals and setting directions for portfolio decisions. It has four main components: *Roadmaps, Priorities, Product Strategy* and *Technology Capability*. Portfolio Analysis involves analysis of portfolio(s) to spot gaps with respect to strategy or business themes (as identified in Ecosystem Surveillance), and performance in existing portfolio(s). It has three components: *Visualisation, Gap vis-à-vis Business Themes* and *Performance Checks*. New Project Opportunity Identification involves determining new project opportunities or generating ideas that could be needed to achieve strategic goals or fix portfolio gaps. It has two components: *Basis* and *Approach*. The frequency of portfolio strategy development is indicated to be bi-annually to annually as found across the case studies.

Components of Strategy Translation:

- *Roadmaps* includes joint development and maintenance of short to long term plans related to market, technology and strategy by different functions of an organisation. As mentioned in Table 5.5, practices associated with this component include development of technology roadmaps, market roadmaps and regulatory roadmaps. It also includes understanding customer roadmaps to find new project opportunities.

- *Priorities* includes setting up of strategic priorities or buckets for an overall portfolio. The associated practice includes identification of priorities based on roadmaps, splitting roadmaps into strategic buckets and identifying regional business priorities or trends.

Table 5.5: Sub-processes and components of Portfolio Strategy Development

Portfolio Strategy Development									Portfolio Management Process Framework	
Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Sub-Processes /*Components*	V.2
▪ Convert insights into **product strategy** ▪ Translate company's direction to **product line level** ▪ Translate company's direction to **product line level** ▪ Develop product **plan for 5 years** ▪ Set preference for developing **technology capabilities** ▪ Clarify **technology strategy archetype** ▪ Assess portfolio using **bubble charts** ▪ Generate ideas based on **insights**	▪ Develop **strategy** roadmaps ▪ Identify **strategic** priorities based on roadmaps ▪ Generate product **plans** ▪ Generate product **plans** ▪ Undertake **technology platform** and **enabling projects** ▪ Develop **strategic buckets** ▪ Identify project opportunities based on **roadmaps**	▪ **Analyse** portfolio for project opportunities ▪ Collaborate with **regional** managers to identify their priorities ▪ Prioritize **trends** from different regions ▪ Split roadmaps into **strategic buckets** ▪ Allocate **budget** for portfolio ▪ Create & update five year **roadmaps** ▪ Specific **focus** on technology capability development projects ▪ Set new product development **direction** ▪ Understand **customer** roadmaps to find project opportunities ▪ Create **technology** roadmaps ▪ Check for **cannibalization** within portfolio	▪ Develop **regulatory** roadmaps ▪ Jointly owned **roadmaps** by different functions ▪ Identify **strategic buckets** using roadmaps ▪ Track performance of **strategic buckets** ▪ Create & update **strategy** roadmaps ▪ Gather **business inputs** including performance **target** ▪ Focus on developing **technology platforms** ▪ Find **commonalities** between products ▪ Clarify **technology direction** ▪ Create product strategy **plans** ▪ Establish portfolio **priorities** such as external commitments	▪ Create **pipeline views** to spot portfolio gaps ▪ Develop **market strategy** ▪ Visualise **early stage** portfolio ▪ Generate project ideas based on **strategy inputs** ▪ Establish portfolio **size** (no of projects)	▪ Different **functional units** identify project opportunities ▪ Pro active monitoring of **product performance**, leading to new ideas ▪ **Regulation** changes triggers new projects ▪ Conduct **workshops** to identify project opportunities ▪ Develop **market roadmaps** ▪ Establish **strategic buckets** (e.g. cost reduction, product quality) ▪ **Categorise** projects based on strategic inputs ▪ Propose projects to solve **customer complaints**	▪ Develop **strategic buckets** ▪ Develop five year **roadmaps** ▪ Provide strategic inputs to develop **capabilities** ▪ Identify new projects based on **market insights** ▪ **Top-down** and **bottom-up** approach for project formulation	▪ Monitor performance of **existing products** ▪ Identify **strategic** focus and growth areas ▪ Develop **strategic roadmaps** for four years ▪ Identify **performance targets** such as financial, no of products to be launched ▪ Develop **technology** and **strategy roadmaps** leading to ideas ▪ Discuss implications for portfolio in terms of **technology exploitation** ▪ Translate strategy at **functional level** on yearly basis	▪ Analyse existing portfolio with respect to **insights** gathered ▪ Develop **strategic buckets** (e.g. product accessories) ▪ Develop five year **roadmaps** ▪ Develop **product strategy** annually ▪ Decide **budget** for next year ▪ Identify **innovation platforms** such as space, case, well-being ▪ Develop 5-year **product strategy** ▪ **Business units** identify project opportunities ▪ Identify **top-down** and **bottom-up** project ideas	**Strategy Translation** • *Roadmaps* (Customer, Strategy, Regulatory, Market, Technology) • *Priorities* (Strategic, Regional, Trends) • *Product Strategy* (Product Plans & Lines, Similarities & Differences, Budget, Direction, Commonalities. Functional Level) • *Technology Capability* (Technology strategy archetype, Platform & Enabling Projects, Focus, Technology Exploitation, Innovation Platforms) **Portfolio Analysis** • *Visualisations* (Bubble Charts, Strategic Buckets, Early-Stage, Categorise) • *Gaps vis-à-vis business themes* (Pipeline views) • *Performance Checks* (Bubble Charts, Cannibalisation, Business Inputs, Targets, Size, Existing Products) **New Project Opportunity Identification** • *Basis* (Insights e.g. Regulation, Market and Customer Complaints, Roadmaps, Analysis, Strategy Inputs,) • *Approach* (Functional units/Business Units, Workshops, Top-Down or Bottom-Up)	**Strategy Translation** • *Roadmaps* • *Priorities* • *Product Strategy* • *Technology Capability* **Portfolio Analysis** • *Visualisations* • *Gaps vis-à-vis business themes* • *Performance Checks* **New Project Opportunity Identification** • *Basis* • *Approach*

- *Product Strategy* refers to development of product development plans or setting direction for product development based on roadmaps and priorities. The associated practice includes use of ecosystem insights for developing product strategy, translating high-level strategic objectives at product line level, gathering business inputs and finding commonalities between existing products and new product plans.
- *Technology Capability* refers to setting up direction for technology development. The associated practice includes include development of technology roadmaps, clarifying technology strategy such as its archetype for a business unit or a company, setting preference for technology platform and enabling project and identifying opportunities for technology exploitation.

Components of Portfolio Analysis:

- *Visualisation* refers to the analysis of portfolio(s) (e.g. using bubble charts) to generate portfolio insights. The associated practices are use of bubble charts and strategic buckets methods, creating pipeline views and categorising projects based on strategic inputs.
- *Gaps vis-à-vis business themes* refers to identification of gaps in portfolio(s) with respect to business themes developed as a result of Ecosystem Surveillance. The associated practices are identifying the number of projects related to particular business themes and understanding their implications for strategic goals.
- *Performance Checks* refers to monitoring of individual projects and overall portfolio performance indicators. The associated practices are checking for the risk of cannibalisation (e.g. sales) among projects in a portfolio, tracking performance of strategic buckets, size of portfolio and monitoring product performance. A portfolio budget can be decided based on Strategy Translation and Portfolio Analysis.

Components of New Project Opportunity Identification:

- *Basis* refers to starting point or base used for generating ideas or identifying new project opportunities to implement strategy or to fix gaps in portfolio(s). The associated practices are generating ideas based on ecosystem information such as customer complaints, regulatory changes and identifying project opportunities based on roadmaps or strategic inputs or insights from portfolio analysis.
- *Approach* refers to the use of different mechanisms and organisational structures such as stakeholders for identifying new project opportunities. The associated practices are use of both top-down (e.g. strategic preferences set by senior management) and bottom-up (e.g. project ideas based on exploration of new technology) structures for generating new project ideas and seeking ideas from different corporate functions or business units. Cross-functional workshops is one of the methods which can be used for project ideation.

The role of Portfolio Strategy Development in overall portfolio management is found to be critical across the case companies. For example, it supports the development of multi-functional criteria based on roadmaps for assessing projects and setting of strategic and performance targets to be achieved for a portfolio. It also helps in identifying opportunities for increasing portfolio value by focusing on development of technology platform and enabling projects. It supports development and assessment of business cases aligned with strategy by indicating their fit with strategic priorities or roadmaps. The development of roadmaps and setting portfolio priorities helps to communicate the strategic direction of a company and its portfolio. An analysis of portfolio could result in spotting of portfolio gaps at an early stage, which could be strategic or operational in nature. Identifying new project opportunities reduces the risk of drying up of the portfolio pipeline and hence its value.

3. ***Business Case Management (V.1) has been expanded into two sub-processes (and associated components): Business Case Preparation (V.2) and Business Case Assessment (V.2).***

Business Case Management refers to the series of tasks which involves preparation and assessment of business cases to enable portfolio decision-making (also see Section 4.3). As a result of the case studies, this key process of portfolio management has been expanded into two sub-processes: Business Case Preparation and Business Case Assessment (as indicated in Figure 5.11). For more details on derivation of these sub-processes, their components and associated practices, see Table 5.6. Business Case Preparation involves developing new

business cases and updating existing business cases related to different project types. It has four main components: *Responsibility, Template, Strategy/Technology Focus* and *Type.* Business Case Assessment involves analysis of a value of individual business case and identification of its merits and demerits when compared with other business cases. It has seven components: *Due-Diligence, Visualisation, Approvals, Criteria, Methods, Checks* and *Priority list.* The frequency of business case management is indicated to be monthly as found across the case studies.

Components of Business Case Preparation:

- *Responsibility* refers to the accountability and sponsorship of business cases by the relevant stakeholder(s) in a company. The instances of this component include product management unit, business segments, function units such as marketing or project champion. Defining the responsibility of business cases depends on the structure of an organisation.

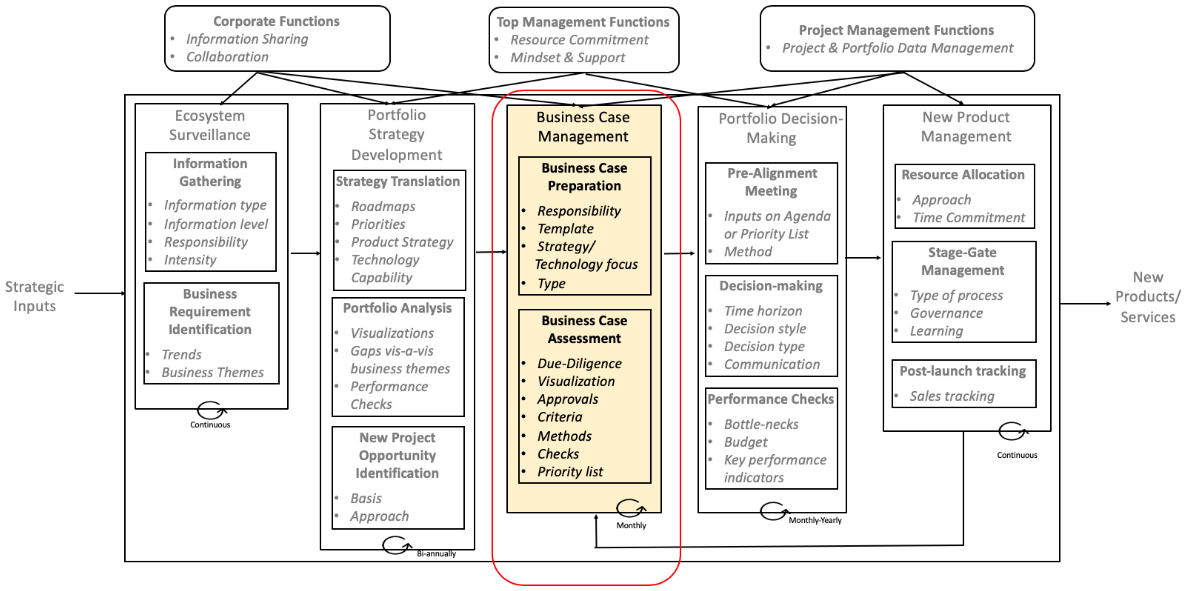


Figure 5.11: Business Case Management of Framework V.2

Table 5.6: Sub-processes and components of Business Case Management

Business Case Management									Portfolio Management Process Framework	
Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Sub-Processes /*Components*	V.2
▪ Assess projects using **bubble charts** ▪ Challenge numbers & **assumptions** in business cases ▪ **Track** business case assumptions ▪ Assess business case using **criteria** such as NPV, Cost, Financial attractiveness, Risk, Technical and Commercial Feasibility, Value proposition, **Strategic focus** ▪ **Compare** business cases ▪ Track **hit ratio** of sales of business cases ▪ **Product management** is responsible for business cases ▪ Rank both **existing and new projects** ▪ Check **resource availability** for ranked projects ▪ Identify projects that are the **candidates for termination**	▪ Establish strategic **criteria** for project assessment based on roadmaps ▪ Define **methodology** to put numbers in business cases ▪ Create **governance team** for business case methodology ▪ **Business segments** own business cases ▪ Get approvals on numbers from **financial** expert ▪ College one **page** proposals from across company ▪ Business case **template** has project name, status, success factors ▪ Analyse business cases using **bubble charts** ▪ Develop **pre-read** for decision-makers after assessment ▪ Identify **unmet** objectives of projects ▪ **Update** business cases ▪ **Score** business cases	▪ Challenge **assumptions** and numbers in business cases ▪ Develop **accountability** of business cases (e.g. business sponsors) ▪ Use **standard** project document for parity in assessment ▪ Perform checks on business cases (e.g. **balance of time to market**) ▪ Identify **issues** in business cases ▪ Use **roadmaps** to assess projects ▪ Create project **requirement** document ▪ Identify **sponsor** for business cases ▪ Use **spider diagram** to evaluate projects ▪ **Update** business cases and **gate forms** ▪ **Score** projects to resolve resource conflicts	▪ **Track** business cases over time/iterations before product launch ▪ Check **optimism bias** in business cases ▪ **Prioritize** business cases (e.g. cost reduction) ▪ Map business cases on to strategic **roadmaps** ▪ Identify **categories** of business cases ▪ Use different types of business cases for different **strategic goals** (e.g. cost reduction, supplier change) ▪ **Prioritize** business cases based on strategic goals	▪ No **tracking** of business case assumptions ▪ Challenge **assumptions** behind sales figures ▪ Dedicate **resources** to collect business cases ▪ **Template** include name, lead, business line, value, issues, progress, plan ▪ Track project **status** ▪ Identify **issues** in projects ▪ Create **pipeline** overview of projects ▪ Use different template for different project **types** (e.g. ideation, R&D, development) ▪ Use **criteria** such as ENPV, strategic fit, resources (FTEs) to assess projects	▪ **Categorise** projects based on strategic inputs ▪ **Functional units** responsible for business cases ▪ Ensure project proposals reach certain **maturity** for decision-making ▪ **Template** structure includes problem statement, need, current status, plans, in scope, out scope, resource, stage-gate plan ▪ Create full **overview of** portfolio of business cases ▪ Assess and prioritise business cases based on **gut feeling** ▪ Identify **issues** in projects	▪ Hold cross-functional **workshops** to assess business cases ▪ **Marketing unit** responsible for project estimates ▪ **Project champion** informally accountable for business cases ▪ Do **front-end projects** to gather knowledge for decision-making ▪ **Template** structure includes resource requirements, scope, plan ▪ Discuss project **issues**	▪ Identify project **issues** ▪ Do **pre-projects** to gather evidence for numbers in business cases ▪ **Project manager & marketing function** are responsible for business cases ▪ Gather project **status** on ongoing projects	▪ **Template** structure includes net expected sales, profit, strategic area, impact of project ▪ **Classify** projects according to innovation platforms	**Business Case Preparation** • *Responsibility* **(Product Management, Business Segments, Accountability, Sponsor, Functional Unit, Marketing Unit, Project Champion)** • *Template* **(Methodology, Governance Team, Structure such as name, status, Standard, Update)** • *Strategy/Technology Focus* **(Strategic Focus/Goals, Roadmaps)** • *Type* **(Gate-Form, Page, Front-end, Pre-Projects)**	**Business Case Preparation** • *Responsibility* • *Template* • *Strategy/Technology Focus* • *Type*
									Business Case Assessment • *Due-Diligence* **(assumptions, track, hit ratio, optimism bias)** • *Visualisation* **(Bubble Charts, Pipeline views, Spider Diagram, Categories, Classify)** • *Approvals* **(Financial, Resources)** • *Criteria* **(E.g. Cost, NPV, Feasibility)** • *Methods* **(Compare, Score, Workshops)** • *Checks* **(hit-ratio, issues, resource availability, unmet objectives, maturity)** • *Priority List* **(Existing & New Projects, candidates for termination, Pre-read, gut-feeling)**	**Business Case Assessment** • *Due-Diligence* • *Visualisation* • *Approvals* • *Criteria* • *Methods* • *Checks* • *Priority List*

- *Template* refers to the structure of information provided in the business cases. The template for business cases needs to be aligned with the information requirement of decision-making on projects. The associated practices are defining a quantitative methodology for business cases, creating a governance team for business cases, and includes project information such as title, sponsor, lead, status, progress, issues, value, scope and stage-gate plan.
- *Strategy/Technology Focus* refers to the alignment of business cases with strategic and technology priorities or goals. The associated practices are mapping of business cases on strategy or technology roadmaps and categorising business cases according to strategic buckets.
- *Type* refers to development and use of 'standard' templates or forms for different project types. Practices associated this component include use of different template for front-end projects (e.g. one-page proposal) and project in development.

Components of Business Case Preparation:

- *Due-Diligence* involves challenging the assumptions (e.g. behind the potential sales number) underlying the information provided in the business cases. The associated practices are tracking business case assumptions, identifying unmet objectives of projects, tracking ratios of sales in business cases, and reducing optimism bias behind business case information.
- *Visualisation* refers to analysis of the individual business cases and portfolio as a whole. The associated practices are use of different types of bubble charts, use of spider diagrams for individual business cases, creating pipeline views of portfolio, and classifying and analysing business cases according to strategic buckets.
- *Approvals* involves increasing credibility of business cases by making explicitly approvals behind information in business by respective corporate functions. The associated practices are taking approvals from finance unit on proposed cost structure of a project, checking with resource managers about availability of resources needed to implement a project. Approvals can be obtained, for example, by making relevant check boxes explicit and mandatory in business case templates.
- *Criteria* refers to the basis on which an individual business case can be evaluated. The case studies indicated companies often used multi-functional criteria to evaluate a

business cases such as its value. Also, the assessment criteria can be identified based on strategic or technology roadmaps. The instance of this component includes financial (e.g. cost, sales), risk, technical, commercial feasibility and required resources for its implementation.

- *Methods* refer to the techniques used for assessing and comparing business cases. The associated practices are scoring business cases based on fit with assessment criteria, conducting cross-functional workshops, use of techniques such as NPV (and comparing business cases using bubble charts.
- *Checks* involves generating information about project issues to support informed portfolio decision-making. The associated practices are tracking of ratios of sales in business cases, checking availability of resources needed to execute projects, identifying unmet project objectives and performance issues, and ensuring business case information is 'mature' enough for informed decision-making.
- *Priority List* involves assigning priorities to the business cases based on their assessment. The associated practices are assigning priority to both new and existing business cases all together, identifying candidates for project termination, use of heuristics in assigning priorities and developing pre-read for decision-makers.

The role of Business Case Management in overall portfolio management is found to be critical across the case companies. For example, use of business case template ensures consistency in information type across business cases and supports transparency and parity in assessment, doing due-diligence improves business case quality and enables more realistic assessment, indicating the degree of confidence on project and portfolio value. Another implication of identifying an owner of business cases and making explicit functional approvals is that it increases the sense of responsibility and commitment to implement business cases successfully among the stakeholders.

Another benefit of Business Case Management is that it can prevent operational bottlenecks as it assesses business cases based on resource availability and reduces the risk of 'fire-fighting'. The major implication of business case management is for portfolio decision-making. Undertaking two sub-processes of business case management supports informed and evidence-based decision-making on projects. For example, identifying 'bad' projects as a result of developing a priority list can enable their early termination, resulting in saving resources for more valuable projects, potentially leading to increased portfolio value.

4. ***Portfolio Decision-Making (V.1) has been expanded into three sub-processes (and associated components): Pre-Alignment Meeting (V.2), Decision-Making (V.2) and Performance Checks (V.2)***

Portfolio Decision-Making refers to the series of tasks which involves taking selection, termination or hold decisions on projects in the context of their assessed values, portfolio priorities and performance (also see Section 4.3). As a result of the case studies, this key process of portfolio management has been expanded into three sub-processes: Pre-Alignment Meeting, Decision-Making and Performance Checks (as indicated in Figure 5.12).

For more details on derivation of these sub-processes, their components and associated practices, see Table 5.7. Pre-Alignment meeting refers to the meeting between portfolio decision-makers to discuss their respective inputs on pre-read, understand and frame required decisions before actual decision-making. It has two components: *Inputs on Agenda/Priority List* and *Method.* Decision-Making refers to the actual decision-making event that involves making portfolio decisions such as project selection, termination or hibernation. It has four main components:

Time Horizon, Decision-Style, Decision Type and *Communication.* Performance Checks involves monitoring and optimising project and portfolio performance. It has three components: *Bottle-Necks, Budget* and *Key Performance Indicators.* The frequency of portfolio decision-making is indicated to be monthly to annually as found across the case studies.

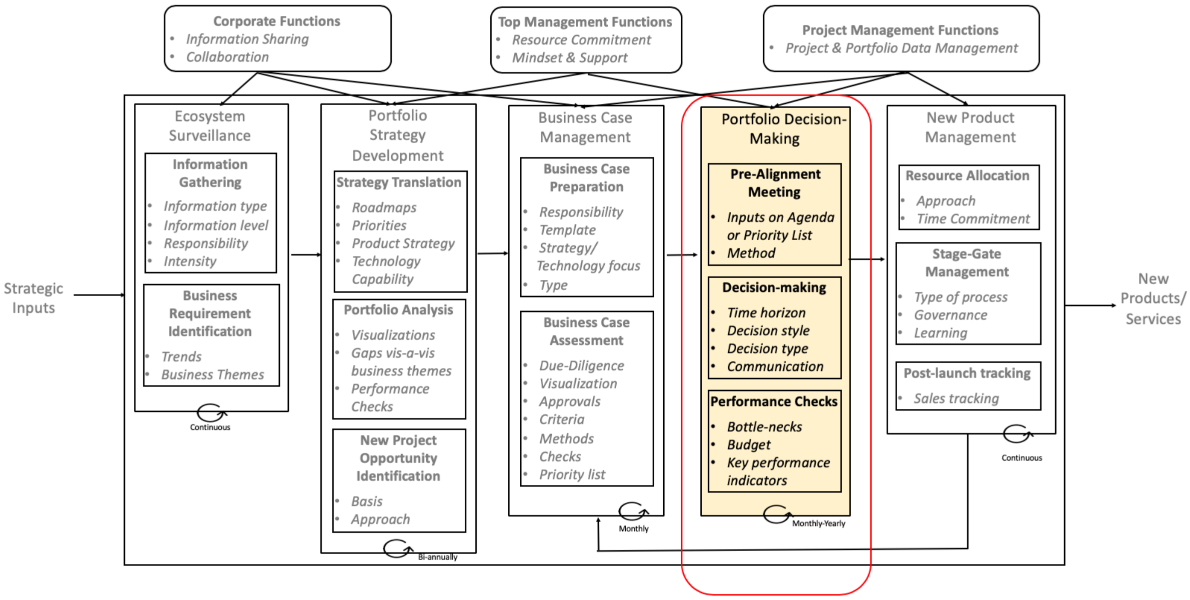


Figure 5.12: Portfolio Decision-Making of Framework V.2

Table 5.7: Sub-processes and components of Portfolio Decision-Making

Portfolio Decision-Making									Portfolio Management Process Framework	
Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Sub-Processes /Components	V.2
▪ Become aware of **operational capability** ▪ **Feasibility checks** on prioritised business cases ▪ Check for **innovation balance** ▪ Consider **opportunity cost** before making decisions ▪ Do **sensitivity check** after making project selection decisions ▪ Decision-maker **prune** priority list in pre-read ▪ Visualise business cases across different **split views** ▪ Conduct **workshops** to take portfolio decisions ▪ **Select** project based on Sales, feasibility and IRR ▪ Check **escalation of commitment** ▪ **Terminate** projects based on resource unavailability, low feasibility, high complexity ▪ **Adjust** proposed ranking of projects ▪ Plan resource **commitment** for **two years**	▪ Conduct **workshops** to take portfolio decisions ▪ Give **mandates** to project managers ▪ **Select** projects based on estimated commercial value of projects ▪ **Terminate** projects based on non-strategic fit, focus change, market change, strategic change ▪ Analyse **implications** of project termination ▪ Leave **slack resources** for contingencies ▪ Decide portfolio for **next year** ▪ Plan **resources** for selected projects ▪ Formal **signoff of** portfolio budget ▪ Create **bubble charts** to analyse portfolio decisions	▪ Decision-makers **authorize** resources for selected projects ▪ Communicate portfolio decisions with **justification** ▪ Identify **warning signals** for pet projects ▪ **Select** projects based on strategic importance, relevance, risk and resource requirements ▪ Identify signals for project termination based on **ecosystem insights** ▪ Proactively consider candidates for termination in light of planned or **upcoming activities** ▪ Communicate **reasons** for project termination ▪ **Terminate** projects based on cost changes, low technical feasibility, optimism bias, resource unavailability, low priority ▪ Consider all **types of projects** together for decisions ▪ **Score** projects or revisit roadmaps for decision clarity ▪ Make **global list** of projects in portfolio	▪ Use **opinion** to do final prioritization of projects ▪ Understand **opportunity cost** for projects which are not selected ▪ **Select** projects based on duration (<5 years) and resource availability ▪ **Terminate** projects based on no capacity, existence of better idea ▪ Keep projects in **hibernation** mode if needed ▪ Leave **slack resources** ▪ Balance **demand and capacity** by making portfolio decisions ▪ Consider all **types of projects** together for decisions	▪ Track project **status** ▪ Predetermine bottlenecks in **resources** ▪ Flexible to **reprioritize** projects if needed ▪ Make decisions based on **gut feelings** ▪ **Select** projects based on resources required, ENPV, strategic fit ▪ **Present** projects in decision-making meetings ▪ Undertake **back-up projects** to support big projects ▪ **Terminate** projects based no sales, no market differentiation, risk ▪ Consider projects at **different stage gates** all together ▪ Take selection, termination and reprioritization decisions in same meeting ▪ Make decisions based on **intuitions** ▪ Create **list** of projects in near future	▪ Estimate **resources** before decision-making ▪ **Present** and **justify** the need for project in decision-making meeting ▪ Use **learnings** from previous projects ▪ Understand **opportunity cost** of project ▪ **Prune** priority list provided as pre-read ▪ Give **feedback** on project/mandate for further project information ▪ Proactively **terminate** projects based on low priority, no resources, changes in market ▪ Put projects on **hibernation** or hold before termination ▪ Build **robust stage-gate** for portfolio decisions ▪ Flexible to take portfolio decisions in case of **urgency** ▪ Create portfolio **pipeline** ▪ Present projects, their **status** and **issues**	▪ Lock resources for **four months** ▪ Make **global project list** available across firm ▪ **Select** projects based in profit, strategic and market impact ▪ **Performance** checks include no delay in delivery, no over budget, doing right projects, balance ▪ **Present** project progress at portfolio meetings ▪ Discuss and make priority list for projects ▪ Raise **red flags** in projects if needed ▪ **Approve** business cases for resource allocation ▪ **Terminate** projects based on late entry into market, poor estimates	▪ **Select** projects based on strategic fit, sales, cost, feasibility ▪ **Categorise** projects according to NPD stages ▪ Discuss **alternative** projects ▪ Present and update **status** of projects ▪ Make **gut-based decisions** ▪ **Terminate** projects when no clear rationale/clarify in projects ▪ **Hibernate** projects due to change in focus ▪ Discuss technology **roadmaps** and implication for decisions	▪ **Present** five year portfolio plan to decision-makers ▪ **Optimise** global portfolio ▪ Check **resources** for projects ▪ Get **operational clarity** of projects ▪ **Select** projects based on strategic fit, resources needed and feasibility ▪ **Terminate** projects based on low technical feasibility and focus changes (e.g. technology, market) ▪ Use **workshop** method for decisions ▪ **Decide** portfolio budget	**Pre-Alignment Meeting** • *Inputs on Agenda/Priority List* (Operational Capability, Feasibility Checks, Prune or Adjust, Upcoming Activities) • *Method* (Split views, workshops, Bubble Charts, Present, Pipeline, Categorise) **Decision-Making** • *Time Horizon* (Four Months, Next Year, Two Years, Urgency) • *Decision Style* (Opportunity Cost, Sensitivity Check,, Justification, Opinion, Score, Gut-Feeling, Intuitions, Learnings, Roadmaps) • *Decision Type* (Select, Terminate, Hibernate, Hold, Types of Projects, Reprioritize, Different Stage-Gate, Robust Stage-Gate, Alternative Projects) • *Communication* (Mandate, Justification, Justify Reasons, Global List, Feedback) **Performance Checks** • *Bottle-Necks* (Resources, Demand and Capacity Balance, Back-up projects, Operational Clarity) • *Budget* (Commitment, Slack Resources, Signoff , Authorise, Approve, Decide) • *Key Performance Indicators* (Innovation Balance, Warning signals, Status, Issues, Red Flags, Optimise)	**Pre-Alignment Meeting** • *Inputs on Agenda/Priority List* • *Method* **Decision-Making** • *Time Horizon* • *Decision Style* • *Decision Type* • *Communication* **Performance Checks** • *Bottle-Necks* • *Budget* • *Key Performance Indicators*

Components of Pre-Alignment Meeting:

- *Inputs on Agenda/Priority List* involves discussions between portfolio decision-makers on a pre-read or priority list and their alignment with the decision-making agenda. It also involves discussion on any portfolio related concerns such as issues or opportunities. The practices associated with this component include getting information operational capability for a portfolio, pruning or adjusting the priority list of projects and discussion on implications of upcoming major strategic or operational activities for a portfolio.
- *Method* refers to techniques used for holding discussions in Pre-Alignment Meeting. The associated practices are conducting workshops, visualising portfolio using bubble charts and strategic buckets and creating portfolio pipeline views.

Components of Decision-Making:

- *Time Horizon* refers to the time period for which the resource commitment is planned for projects and the portfolio. The instances of this component are planning resource commitment for four months to two years (depending on portfolio context) and finalising portfolio for a particular period (e.g. next fiscal year). Companies can exhibit opportunistic behaviour by holding extra-ordinary portfolio decisions in cases of urgency.
- *Decision Style* refers to the approach adopted for making portfolio decisions. Companies can follow different portfolio decision-making styles, such as taking decisions based on gut-feeling or intuition, opinion or can be more objective by assessing the fit of projects with roadmaps, doing sensitivity checks before making decisions, or understanding decision implications by using bubble charts. It also includes taking informed decisions by understanding opportunity costs and feasibility of projects. Other practices associated with this component include getting decision clarity by scoring projects, using learning from previous decisions and projects, considering all types of different projects together for decision-making, and presenting project reports in portfolio meetings. Portfolio decisions can be taken in a workshop style process involving cross-functional decision-makers.

- *Decision Type* refers to the type of portfolio decision, such as project selection, termination or hibernation followed by prioritisation. The associated practices are selecting projects based on commercial estimates such as potential sales, feasibility, IRR, terminating projects based on resource unavailability, low feasibility, high complexity, poor strategic fit, market or focus change, putting projects into hibernation mode if needed or before termination in case of no market differentiation, undertaking decisions based on stage-gates, and exploring the opportunities for alternative projects in the case of termination.
- *Communication* involves communicating portfolio decisions and mandates to relevant stakeholders such as project managers. The associated practices are communicating portfolio decisions, for example on a company's internal network, providing further mandate or feedback to project managers, such as justification or rationale for portfolio decisions, raising red flags or identifying issues in projects and making a global list of finalised projects available internally.

Components of Performance Checks:

- *Bottlenecks* refers to the task of ensuring that the portfolio does not suffer deadlocks (e.g. resources, delivery time) as a result of portfolio decisions. The associated practices are getting operational clarity such as estimation of resource availability, leaving slack resources to handle contingencies, balancing demand vs supply of resources, and discussing alternative or back-up projects.
- *Budget* refers to the activity related to finalisation or commitment of budget such as financial resources for overall portfolio implementation. The associated practices are signing-off portfolio budgets or resources formally, and authorising resources for selected projects or optimizing portfolio budget.
- *Key Performance Indicators* refers to monitoring of performance of individual projects and overall portfolio. Practices associated with this component include checking balance between innovation types, identifying warning signals for 'pet' projects, presenting project status and identifying issues, ensuring no delay in project delivery, and portfolio does not go overbudget and checking portfolio value and strategic alignment. It also includes the use of bubble charts and changes in project priorities as a result of corrective actions.

Portfolio Decision-Making is a central tenet of overall portfolio management. Making portfolio decisions such as project selection, termination and hibernation is a way of implementing strategy. The sub-process of Pre-Alignment Meeting between decision-makers helps in focusing on key aspects of portfolios such as issues or opportunities. Using roadmaps and learning from previous decisions or project support rationality in decision-making, communicating portfolio decisions and giving feedback to project managers, renders portfolio management transparent and enhances commitment towards strategic priorities from different stakeholders. Monitoring portfolio performance ensures that portfolio management goals are met, such as strategic alignment, value maximisation and balance.

5. ***New Product Management (V.1) has been expanded into three sub-processes (and associated components): Resource Allocation (V.2), Stage-Gate Management (V.2) and Post-Launch Tracking (V.2).***

New Product Management refers to the series of tasks which involves allocating resources to selected projects and implementing those projects while performing pre and post launch stage-gate activities (also see Section 4.3). As a result of case studies, this key process of portfolio management has been expanded into three sub-processes: Resource Allocation, Stage-Gate Management and Post-Launch Tracking (as indicated in Figure 5.13).

For more details on derivation of these sub-processes, their components and associated practices, see Table 5.8. Research Allocation refers to the allocation of resources to the projects selected during portfolio decision-making. It has two components: *Approach* and *Time Commitment.* Stage-Gate Management refers to execution of the selected projects according to relevant stage-gate processes.

It has three main components: *Type of Process, Governance,* and *Learning.* Post-Launch Tracking refers to the monitoring of the products' performance which are already launched into the market. The component of this sub-process is *Sales Tracking.* The frequency of New Product Management is indicated to be continuous as found across the case studies.

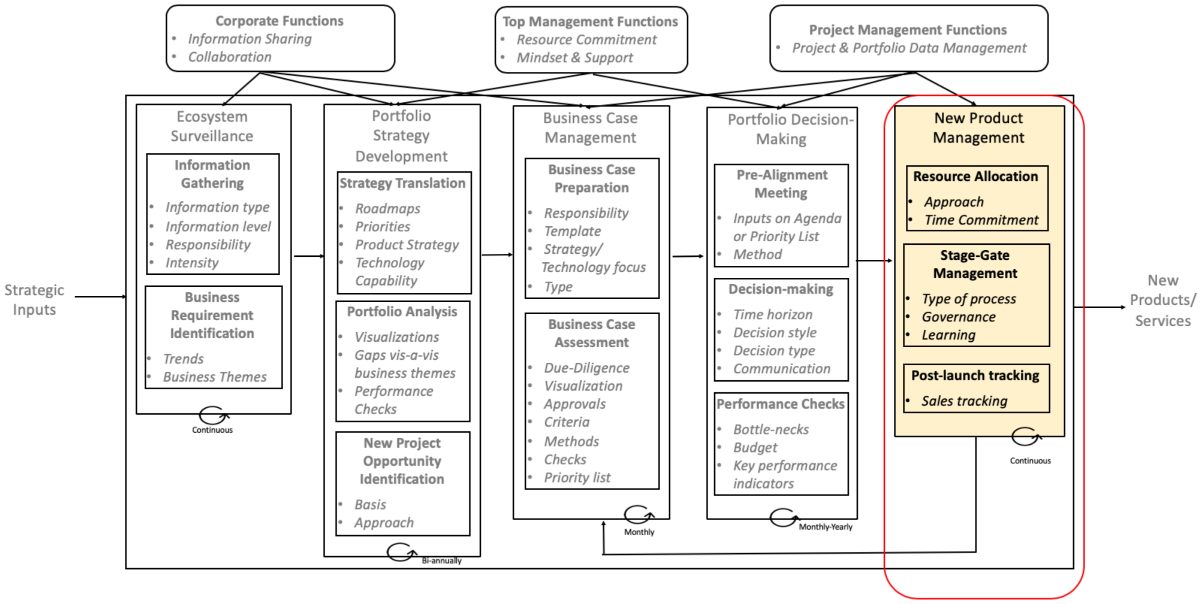


Figure 5.13: New Product Management of Framework V.2

Table 5.8: Sub-processes and components of New Product Management

New Product Management									Portfolio Management Framework	
Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Sub-Processes *Components*	v3
▪ Become aware of **operational capability** ▪ **Feasibility checks** on prioritised business cases ▪ Create operational **bubble charts** ▪ Clarify **implications** of resource commitment (e.g. time to market) ▪ Use **roadmaps** to allocate resources ▪ Collect **information** about products in market ▪ Track **hit-ratio** of sales in business cases ▪ Identify **warning signals** by assessing launch performance ▪ Conduct project **learning meetings** ▪ Resource committed for **two years** ▪ Raise **red flags** in projects if needed	• **Plan** resources for selection projects • Manage **unstructured** and **frequent** resource requests • Get **approval** from operations department for product manufacturing • Make **business divisions** responsible for resource requests • **Review business cases** at stage-gates • Have **mindset** to implement best practices • Capture learnings on **project completion** • Use of four-types of stage-gate process according to **project types/strategic goals** (e.g. 3 and 5 gated process)	▪ Follow **top-down approach** for resource allocation ▪ Review resource allocation on **monthly basis** ▪ Check **project list** against different resources ▪ **Lock-in** resource at personnel level ▪ Use **roadmaps** to resolve resource conflicts ▪ **Negotiate** resources for projects from different regions ▪ Use of **four gated process** for NPD ▪ **Cross-functional** gate review ▪ Update **project document** at each stage-gate ▪ **Score** projects to resolve resource allocation conflicts ▪ Capture **learnings** at Stage-Gates ▪ Configure NPD process according to 3 **project types** ▪ Have Stage-Gate governance **team**	▪ **Motivate staff** to work on legacy products ▪ Develop a pool of **skilled** workers ▪ Split **job design** between product maintenance and innovation activities ▪ Do **post-market** surveillance ▪ **Review** business cases as stage-gates ▪ Capture **learning** at last Stage-Gate	▪ Execute projects in **sprints** ▪ Predetermine **bottle necks** in resources ▪ Make **project leads** responsible for fixing resources ▪ Follow **top-down** resource allocation approach ▪ Develop and maintain **skills, knowledge** for project execution ▪ Use **agile** product development process ▪ Create **learning reports** if needed ▪ Capture project **learning** in life cycle management phase	▪ **Estimate** resources before decision-making ▪ Create **resource buckets** ▪ Allocate resources in **sprints** ▪ Gather **product maintenance needs** (e.g. color change) ▪ Raise **red flags** in projects if needed ▪ Develop **project completion report** at last Stage-Gate ▪ Use **four-gated** NPD process	▪ Create/update resource allocation **plans** ▪ **Lock** resources for four months ▪ Check resource **availability** ▪ **Track** resources at personnel level ▪ Use **Information Technology (IT)** to allocate resources ▪ Manage resource **conflicts** ▪ Raise **red flags** in projects if needed ▪ Take actions to **correct** sales in post-launch phase ▪ Use learning from **previous** projects ▪ Use **five-gated** NPD process	▪ Handle resources on **monthly** basis ▪ Allocate resources based on **priority & monthly** basis ▪ Make **backlog** of resources ▪ Use **Excel Sheet** to track resources ▪ Gather **feedback** on existing products in market ▪ **Evaluate** overall project at its end	▪ Check resources for projects ▪ Get **resource estimates** from HR and Finance ▪ **Plan** resources from Development to Launch ▪ Get **operational clarity** of projects ▪ Conduct **yearly review** of NPD process	**Resource Allocation** • *Approach* **(Top-Down, Operational Capability,, Implications, Roadmaps, Approval, Business Divisions, Lock-In, Negotiate Score, Motivate, Sprints, IT, Conflicts, Priority, Backlog)** • *Time Commitment* **(Two Years, Monthly)** **Stage-Gate Management** • *Type of Process* **(Project Types/Strategic Goals, Four/Five-Gated, Agile)** • *Governance* **(Red Flags, Review, Mindset, Cross-Functional, Team, Yearly Review)** • *Learning* **(Learning Meetings, Project Completion, Stage-Gates)** **Post-Launch Tracking** • *Sales Tracking* **(Information, Hit-Ratio, Earning signals, Post-Market, Product-Maintenance needs, Feedback)**	**Resource Allocation** • *Approach* • *Time Commitment* **Stage-Gate Management** • *Type of Process* • *Governance* • *Learning* **Post-Launch Tracking** • *Sales Tracking*

Components of Resource Allocation:

- *Approach* refers techniques or basis adopted for allocating resources to the projects selected during portfolio decision-making. The associated practices are conducting feasibility checks on business cases, creating operational bubble charts, clarifying implications of resource commitment, using roadmaps to allocate resources, managing frequent resource allocation requests, following a top-down approach (e.g. priority based) for resource allocation, negotiating on resource requests from different regions, pre-determining bottle-necks in resources and creating resource allocation buckets. It also includes the use of information technology for tracking the resources.

- *Time commitment* refers to the time period for which resources are allocated to projects. Instances of this component include allocating resources on a regular (e.g. monthly) basis and locking in resources for a period (e.g. four months).

Components of Stage-Gate Management:

- *Type of Process* refers to the configuration of stage-gate processes according to project types, e.g. using more or a smaller number of stage-gates according to project characteristics (e.g. radical vs incremental projects). The associated practices are using four to five stage-gate processes for different project types, using stage-gate process type according to strategic goals and executing projects in sprints (using agile methods).
- *Governance* refers to the measures taken to govern project execution according to relevant stage-gate process. Instances of this component include raising red flags or issues in projects, setting up cross-functional stage-gate governance team, reviewing business cases at stage-gates and adopting a mindset of implementing best practices in stage-gate process.
- *Learning* refers to the measures taken to build up base of knowledge or insights gained from execution of projects. The associated practices are conducting project learning meetings with project teams, capturing learnings on project by developing interim or project completion reports.

Components of Post-Launch Tracking:

- *Sales Tracking* refers to the monitoring of sales of existing products into market and taking corrective actions if necessary. Instances of this component include tracking success ratios of sales in business cases, identifying warning signals by assessing launch performance and gathering feedback on products in the market. It also includes determining product lifecycle management needs.

The role of New Product Management in overall portfolio management is important, supporting the execution of selected projects by allocating resources to them or ensuring smooth operations of projects. Configuring stage-gate processes according to project type ensures only relevant project execution activities are carried out, and post-market surveillance helps in correcting product sales, influencing overall portfolio value.

6. ***A new stakeholder function called 'Project Management Functions' (V.2) have been added to other two stakeholder functions: Corporate Functions (V.1) and Top Management Functions (V.1). Also, the components (V.2) of these three stakeholder functions have been identified.***

Portfolio Management Stakeholders refers to the group of stakeholders who are responsible for driving the key portfolio management processes. As a result of the case studies, three relevant portfolio management stakeholder functions have been identified: Corporate Functions, Top Management Functions and Project Management Functions (as indicated in Figure 5.14). For more details on the derivation of their components and associated practices, see Table 5.8 Corporate Functions refers to the functional stakeholders such as marketing, finance and operations personnel.

This function has two main components: *Information Sharing* and *Collaboration.* Top Management Functions refers to the stakeholders in a company who are responsible for making portfolio strategy and decisions. This function has two components: *Resource Commitment* and *Mindset & Support.* Project Management Functions refers to the stakeholders who are responsible for facilitating portfolio decisions by providing enabling information about project and portfolio. The component of this function is *Project & Portfolio Data Management.*

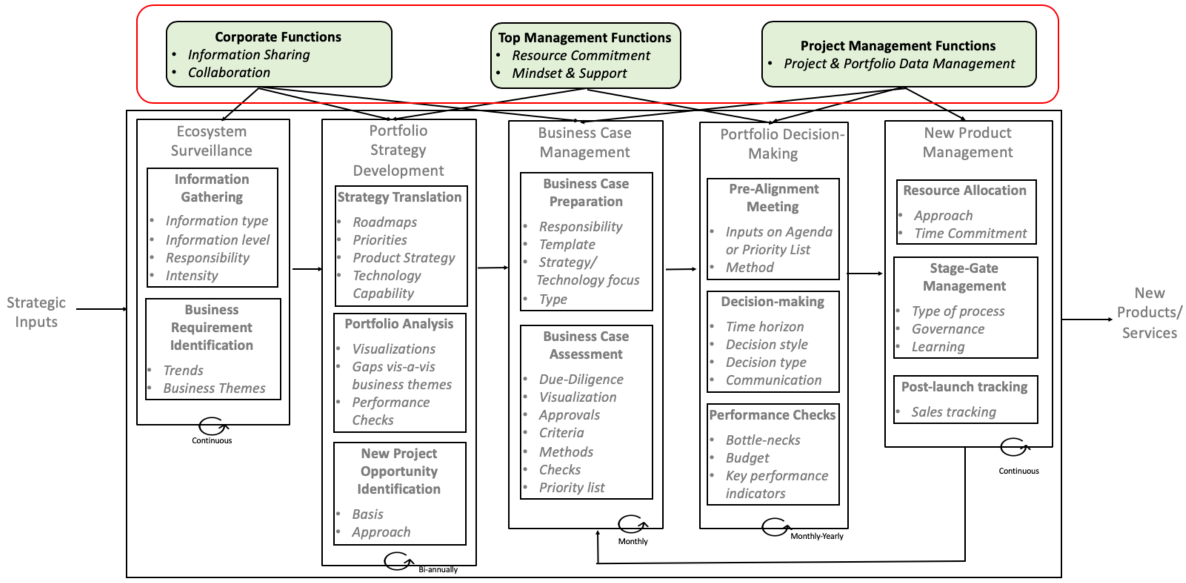


Figure 5.14: Portfolio Management Stakeholder Functions of Framework V.2

Components of Corporate Functions:

- *Information Sharing* refers to the joint efforts between different corporate functions for sharing relevant information related to projects and portfolios. This component is about the coordination between corporate functions. The associated practices are sharing project data such as sales and portfolio updates on a regular (e.g. monthly) basis.

- *Collaboration* refers to the collaboration between different corporate functions for driving portfolio management processes. Instances of this component include forming cross-function portfolio governance team, conducting workshops to assess projects, conducting business reviews with regional managers, jointly developing and owning strategy and product roadmaps, and collaboration between marketing & R&D to solve customer complaints.

Components of Top Management Functions:

Resource Commitment refers to the level of resources allocated by top management of a company to support implementation of a portfolio and its management processes. The instances of this component include allocating resources to carry out Ecosystem Surveillance, the level

Table 5.9: Components of Portfolio Management Stakeholder Functions

Corporate Functions, Top Management Functions, Project Management Functions									Portfolio Management Process Framework	
Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Stakeholder Functions/ *Components*	V.2
▪ Establish cross-functional **portfolio team** ▪ Conduct Cross-functional meetings to **correct sales** ▪ Share data such as **sales on** monthly basis ▪ Conduct cross-functional **workshops** to analyse trends	▪ Have monthly interactions with **line managers** for resource allocations ▪ Monthly communication of **portfolio updates** to top management ▪ Conduct business reviews at **regional level**	▪ Use **IT** for collaboration ▪ Give **portfolio update** to top management ▪ Share information relevant to **projects** cross-functionally ▪ Cross-functional **stage-gate review**	▪ Collaborate between different **portfolio managers** ▪ Different functional jointly own **roadmaps**	▪ **Market and R&D** collaborate to create customer profiles	▪ **Monthly meeting** between PMO, Portfolio Facilitator and Vice Presidents ▪ Form cross-departmental **portfolio committee** ▪ Vertical collaboration for **project execution** ▪ Portfolio Management Office **facilitates** portfolio decisions	▪ Cross-functional **workshop** to assess project ideas and business cases ▪ Ad-hoc sharing of **project level** information	▪ **Project managers/marketing** responsible for filling business cases ▪ Make **cross-functional team** for portfolio decision-making	▪ Collaborate at **regional level** to generate ecosystem insights ▪ **Cross-functional** portfolio decision-making team	**Corporate Functions** • *Information Sharing* (Sales, Portfolio Updates, Projects, Monthly Meetings, Facilitates) • *Collaboration* (Portfolio Team, Correct Sales, Workshops, Line Managers, Regional Level, IT Team, Portfolio Managers, Roadmaps, Market & R&D)	**Corporate Functions** • *Information Sharing* • *Collaboration*
▪ Operational and strategic **focus** on portfolio management ▪ Have **opportunistic** mindset for portfolio management ▪ **Prune** ranking of priority list ▪ Invest resources to gather **ecosystem insights**	▪ Top management **buy-in** portfolio management process ▪ **Leverage** previous experience of portfolio management ▪ Have mindset to implement **best practices** ▪ Conduct **annual audit of portfolio** management process	▪ Set up portfolio decision-making **team** ▪ Check **project list** in board meetings ▪ **Empower** project managers and provide support ▪ **Authorise** resources for selected projects	▪ Top Management **review** portfolio on quarterly basis ▪ Top management decides **balance** between innovation types ▪ **Leverage** previous experience of portfolio management	▪ Top management **board** take portfolio decisions ▪ **Cross-functional** decision-making team ▪ **Flexible** to reprioritize projects if needed ▪ Dedicate **resources** to collect project data	▪ Top Management guides **improvement** in portfolio management ▪ Top management provides **strategic direction** and project ideas ▪ Give **mandate to** portfolio managers ▪ **Critical** discussion on projects during portfolio decision-making	▪ **Cross-functional team** for decision-making ▪ **Evolution of** portfolio management from ad-hoc to scorecard ▪ **Discuss** project priority list	▪ **Cross-functional team** including resource owners and directors ▪ Give **mandate** to portfolio managers ▪ Make **gut-based decisions**	▪ **Yearly review** of portfolio management process ▪ Decide **budget** for next year ▪ Top management provide **strategic inputs**	**Top Management functions** • *Resource Commitment* (Ecosystem Insights, Stage-Gate Review, Cross-Functional, Flexible, Resources, Budget) • *Mindset & Support* (Focus, Opportunistic, Prune, Buy-in, Leverage, Best Practices, Annual Audit, Empower, Authorise, Mandate, Critical, Gut-Based Decisions, Strategic Inputs)	**Top Management functions** • *Resource Commitment* • *Mindset & Support*
▪ Share data such as **sales** on monthly basis ▪ Manage **business case** data	▪ Establish data management **tool** to support decision-making ▪ Develop **methodology** to put data in business cases	▪ Use **standard** project document for parity in assessment ▪ Manage **business case data**	▪ **Business case data** management is not good	▪ Assess and manage **business case data** to support decision-making	▪ PMO provide **support** to manage business cases	▪ Assess and manage **business case data** to support decision-making	▪ Assess and manage **business case data** to support decision-making	▪ Assess and manage **business case data** to support decision-making	**Project Management Functions** • *Project & Portfolio Data Management* (Sales, Business Case Data, tool, Methodology, Standard, Support)	**Project Management Functions** • *Project & Portfolio Data Management*

Of time and attention given by top management to portfolio decision-making and allocating budget for overall portfolio implementation.

- *Mindset & Support* refers to top management's perception and support for executing portfolio management processes. Practices associated with this component include exhibiting opportunistic behavior in portfolio decisions, buy-in for portfolio management processes, having a mindset to implement best portfolio management practices, auditing portfolio management processes annually, giving feedback to project managers, empowering project and portfolio managers, making portfolio decisions based on strategy and intuition, and having separate focus on strategic and operational aspects of portfolio management.

Components of Project Management Functions

- *Project & Portfolio Data Management* refers to approaches or techniques used for managing project data and processing that data to enable and inform portfolio decisions. Instances of this component include establishing data management tools to support portfolio decisions, developing methodology to incorporate data in business cases, using business case templates to gather project information, and processing the information to generate insights at project and portfolio levels.

These three stakeholder functions play an important role in overall portfolio management. For example, cross-functional assessment of business cases enhances cross-functional ownership and builds trust among the stakeholders; top management buy-in for portfolio management improves its overall effectiveness and enables continuous improvement and managing project and portfolio data helps in taking more objective, rational and informed portfolio decisions.

7. ***The sequence between key portfolio management processes have been identified and links between these processes and stakeholder functions are elaborated.***

As a result of the case studies, the sequence between key portfolio management processes and the links between three portfolio management stakeholder functions and portfolio management processes have been identified (as indicated in Figure 5.15). The sequence between portfolio management processes tends to be linear from Ecosystem Surveillance to New Product-- Management, and there is backward sequence from new product management to business case management. This backward feedback sequence denotes that as the NPD projects progresses, the new project information is updated in the business cases before being considered in portfolio decision-making process again. However, it is not necessary that all the projects progress at the same speed and hence, update in business case might not be required for next on cycle portfolio decision-making process.

Note that these sequences are indicative only, rather than generally valid for portfolio management in any type of company. In fact, a few cases (e.g. Case 1 and 2) revealed that extraordinary portfolio decision-making meetings do happen in urgent situations, which implies that the sequence needs to be flexible. The backward sequence indicates iterations between New Product Management and Portfolio Decision-Making. As the ongoing projects hit their respective stage-gates, business cases are updated along with other stage-gate forms, which are considered in portfolio decision-making meetings for their continuation or termination.

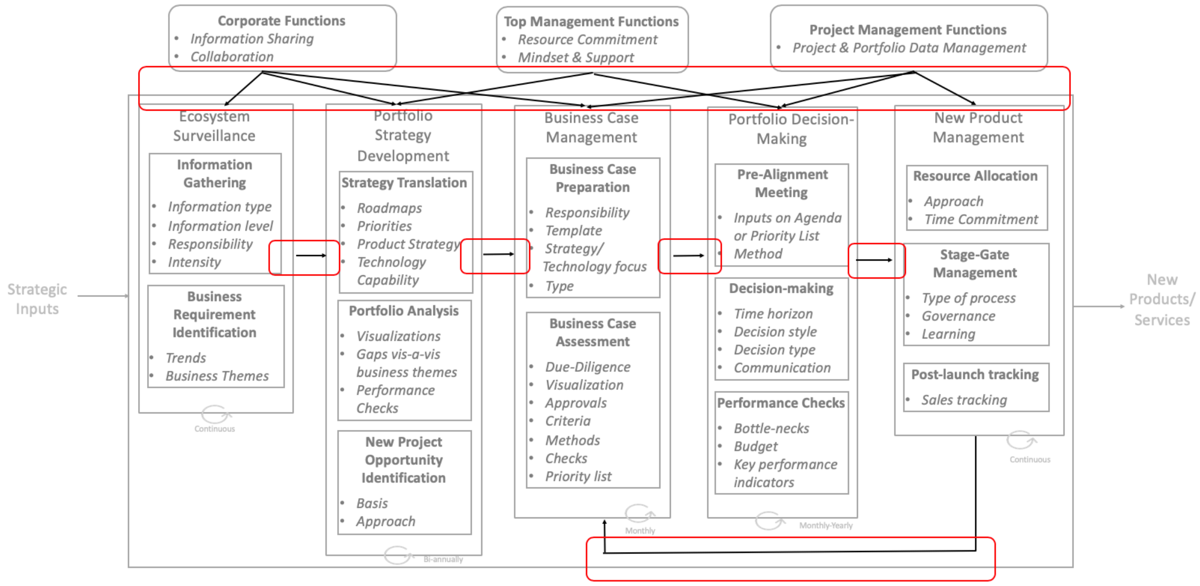


Figure 5.15: Sequence and Links between Portfolio Management Processes and Stakeholders in Framework V.2

The links between stakeholder functions and processes are also revealed. Corporate Functions are typically involved in Ecosystem Surveillance, Portfolio Strategy Development and Business Base Management. For example, different Corporate Functions collaborate to gather market and technology insights, jointly developed roadmaps as a part of portfolio strategy and collaborate to take portfolio decisions. Top management is primarily involved in Portfolio Strategy Development, in which the strategic goals and performance targets are set for a portfolio along with budget for its implementation and Portfolio Decision-Making, which involves project selection, termination or hibernation decisions, project prioritisation and resource authorisation. Project Management Functions involve in Business Case Management, which refers to the management of information in business cases and involves collaboration with project managers or business case sponsors. This function facilitates Portfolio Decision-Making and provide necessary information required by decision-makers to make portfolio decisions such as merits and demerits of projects, portfolio data and project updates. This function is also associated with New Product Management as it supports resource allocation, project execution using stage-gates, develop and provides necessary documentation and support for stage-gate management to project teams.

Overall, Stage I supports the development of the framework V.2 which identifies sub-processes, components and associated practices of key portfolio management processes and stakeholders. Although these nine in-depth case studies in Stage I help in exploring portfolio management in more detail, further verification is warranted. Stage II supports the refinement of framework V.2, in which 17 stand-alone academic and industrial interviews in addition to 10th in-depth case study with a European pharmaceutical company were conducted. As a result, a number of modifications have been made in the framework V.2, and the resulting framework is referred as Portfolio Management Process Framework V.3.

5.4 Stage II: Portfolio Management Process Framework V.3

This section presents Stage II (framework refinement), building upon the Portfolio Management Process Framework V.2 (Stage I), as shown in Figure 5.16, leading to the development of the framework V.3.

This section has three sub-sections: Sections 5.4.1 and 5.4.2 introduce the basis and methodology used for deriving framework V.3, respectively, and then Section 5.4.3 presents the framework V.3 with more details.

5.4.1 Basis used for derivation of the Portfolio Management Process Framework V.3

The basis used for developing framework V.3 was the framework V.2, as shown in Figure 5.16. The rationale is that it comprehensively captures both depth and breadth of portfolio management in practice and theory (see Section 5.3.1).

This is because framework V.2 was developed by conducting nine in-depth case studies on portfolio management processes using framework V.1, which itself is based on quite broad review of portfolio management practices (see Chapter 4). Moreover, the purpose of Stage II is to refine framework V.2.

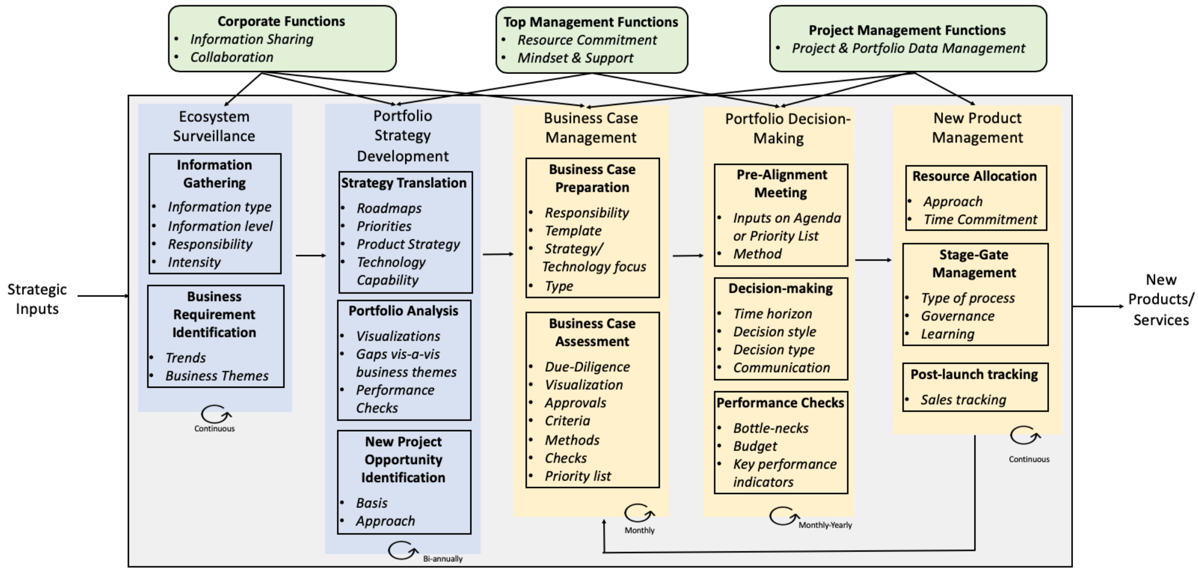


Figure 5.16: Portfolio Management Process Framework V.2 (adapted from Figure 5.8)

5.4.2 Methodology for deriving Portfolio Management Process Framework V.3

The overall methodology for deriving framework V.3 can be divided into a series of steps, as shown in Table 5.10. The first five steps (A-E) were followed for conducting stand-alone refinement interviews with academics and industrial practitioners, and the next five steps (F-J) were followed for conducting the 10th in-depth case study with a large European pharmaceutical company. Following analysis of data from both refinement interviews and the case study, the framework V.3 was developed (step K).

A. Selection of academic and industrial informants

A total of 17 interviews with academics (4) and practitioners (13) were conducted for refining the framework V.2. See Table 3.5 and Appendix 3B for more details on informants' roles and their company description. An opportunistic strategy was used for selecting both types of informants. However, for selecting academic informants, it was ensured that the informants have an active research interest and/or contribution in the area of portfolio management. The information about academic informants was collected from their university websites and

Table 5.10: Stage II Methodology

STAGE II METHODOLOGY		
A	*Selection of academic and industrial informants*	17 Refinement Interviews with academics and practitioners
B	*Developing refinement interview protocol*	
C	*Conducting framework refinement interviews*	
D	*Analysis of refinement interview data*	
E	*Findings of the refinement interviews*	
F	*Planning for 10th case study*	10th Case Study (with German Pharmaceutical company)
G	*Selecting 10th case study firm*	
H	*Collecting 10th case study data*	
I	*Analysis of 10th case study data*	
J	*Findings of 10th case study*	
K	*Development of Portfolio Management Process Framework V.3*	

research publications. For selecting industrial informants, it was ensured that they were a relevant portfolio management stakeholder (either as portfolio decision-maker or portfolio coordinator) in their company or had extensive experience in portfolio management. This information about industrial informants was based on their roles or profiles in their companies.

B. Developing refinement interview protocol

The framework V.2 describes portfolio management processes that can be formalised. The purpose of these refinement interviews was to determine whether the framework V.2 provided practical and procedural guidance for portfolio management formalisation and to identify framework refinement opportunities.

Considering these aims and the process aspects of portfolio management described in the framework V.2, an interview protocol was developed (as shown in Figure 5.17). The basis of the protocol was the criteria (for conducting process related research) suggested by Platts

(1993). A set of interview questions and feedback survey were developed based on the following five criteria:

- **Usability**: refers to intuitiveness of the framework
- **Completeness**: refers to depth & breadth (or scope) of information in the framework
- **Quality**: refers to ability of the framework to generate useful insights
- **Consistency**: refers to coherency (e.g. processes, content) of the framework
- **Adaptability:** refers to the configurability of the framework

The primary reason for adopting Platts (1993) criteria is because it has been used to test practicability of management process frameworks, and this is precisely the aim here to test practicability of the framework V.2 for portfolio management formalisation. The five criteria were found relevant for this study and hence adapted to gather feedback on the framework V.2.

C. Conducting framework refinement interviews

Out of 17 interviews with 19 informants, 15 interviews were conducted face-to-face, where the researcher visited the informant's place of work, with two interviews conducted using video conferencing. Since the purpose here is to refine framework, it was decided to not to record the interviews. As a result, extensive notes were taken during the interviews by the researcher. On average, each interview lasted about 58 minutes. Relevant documents regarding portfolio management processes were requested and collected (where permissible) during the interviews. A total of 14 feedback scores on the framework V.2 were considered valid and useful for analysis, as Informants 57, 58, 66 and 71 opted out from participating in the feedback survey due to other commitments and time limitations, and Informants 72 and 73 jointly provided feedback scores.

D. Analysis of refinement interview data

Since both interview questions and feedback questionnaire for the framework V.2 were based on the five criteria mentioned in Step B, the notes taken, and feedback scores were analysed with respect to these criteria. The following sections discuss the findings from the interview data.

Introduce the background to PhD research to the informant

- The researcher introduces the background of the research and describe research objectives. It was then followed by summary of Result I and the framework V.2 (i.e. Stage I). The researcher then introduced the objective of the discussion, i.e. Stage II

Introduce & describe Portfolio Management Process Framework V.2

- The researcher introduced and described each of the constructs of the framework V.2 (as shown in Figure 5.28). This discussion included brief overview of sub-processes, components and practices of five key portfolio management processes and the stakeholder functions.

Follow the below set of interview questions

- After describing the framework V.2, the following questions were asked to the informants:

  - What is the level of intuitiveness of the framework in terms of designing or improving an overall portfolio management approach – how self-explanatory is it (i.e. usability)?
  - Does the framework have an appropriate level of depth and breadth of details & scope capturing key aspects of portfolio management in practice (i.e. completeness)?
  - Using the framework, are you able to generate useful insights or pointers for designing or improving portfolio management in your organisation (i.e. quality)?
  - What level of clarity (or coherence of content) did this framework have in depicting portfolio management in your organisation (i.e. consistency)?
  - Can this framework be adapted or configured according to context of portfolio management in your organisation (i.e. adaptability)?
  - Any general comments on: what problems you could encounter in implementing this framework, what could be improved to make it more practical and useful? what is missing in this framework?

- The context of the questions was adapted for the academic informants

Request to fill the scores in the feedback questionnaire

- Using the same questions in previous step, a questionnaire was developed to give scores on the scale of 1 to 5. The questionnaire is provided in Appendix 5C

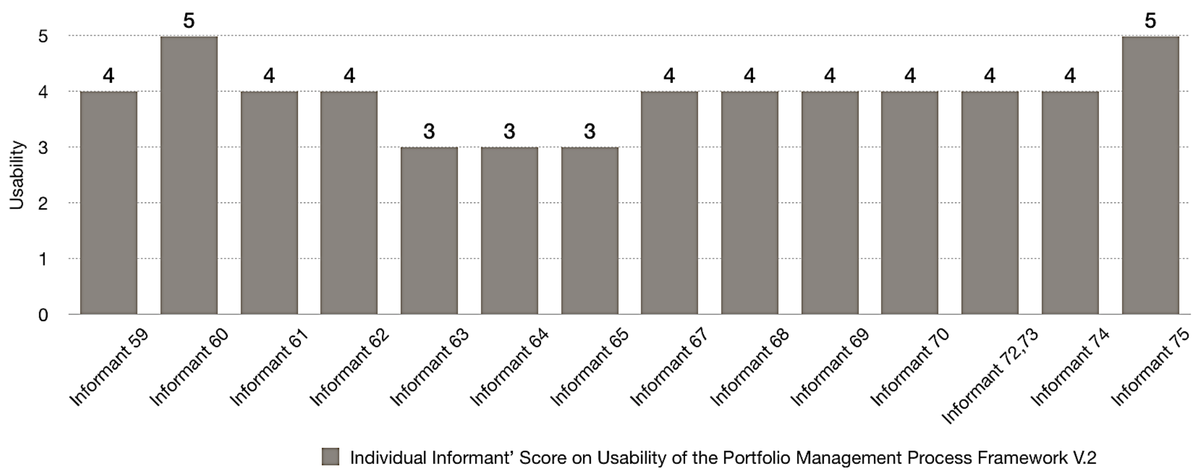
Figure 5.17: Interview Protocol for Refinement Interviews

E. Findings of the refinement interviews

As mentioned in Step D, the findings are structured according to the five criteria: usability, completeness, quality, consistency and adaptability of the framework V.2. For each of the criteria, feedback scores given by the informants for framework V.2 and associated remarks are provided. Finally, a list of opportunities for improvement (*and implications for this research*) of the framework V.2 are presented.

<u>Usability of Portfolio Management Process Framework V.2</u>

The average score (rounded to one decimal point) of usability of the framework V.2 was 3.9/5, which indicated that most of the informants found it self-explanatory and intuitive. The researcher also observed that during the refinement interviews, the industrial informants were able to recognise portfolio management processes, sub-processes and their components in the framework V.2.



Average Score: 3.9

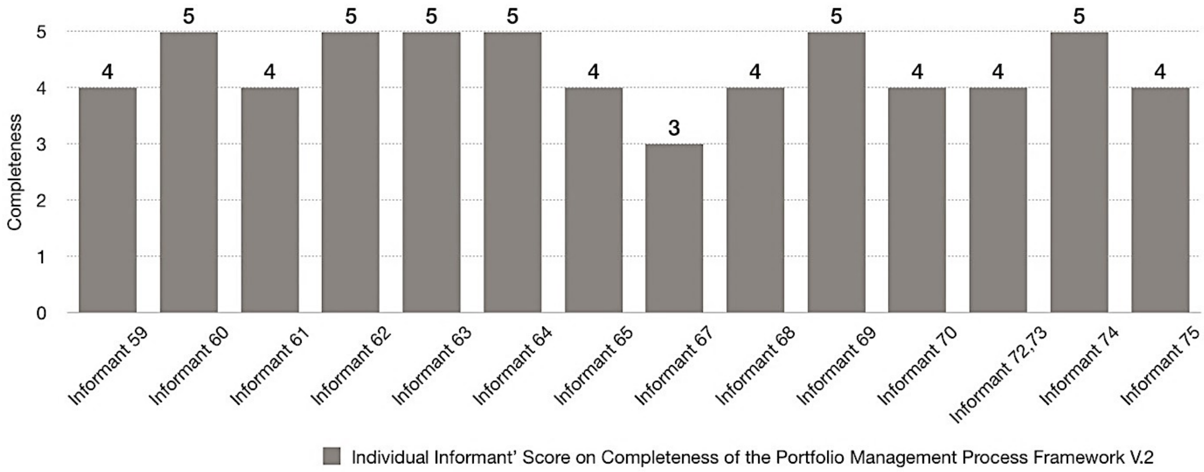
Figure 5.18: Usability of Framework V.2

For example, Informant 57 considered Ecosystem Surveillance to be the most important part of portfolio management for generating customer and market insights based on which the new projects would be defined. Similarly, Informants 58 and 74 recognised and confirmed that business cases in their companies are reviewed on the monthly basis. The following remarks made by informants during the discussion are illustrative of the usability scores:

- "*The framework is systematic and very understandable*" (Informant 59)
- "*The framework is clear and captures a lot information*" (Informant 75)

Completeness of Portfolio Management Process Framework V.2

The average score of completeness of the framework V.2 was 4.3/5, which indicated that most of the informants found that the framework captures an appropriate level of depth and breadth of detail and scope of portfolio management processes.



Average Score: 4.3

Figure 5.19: Completeness of Framework V.2

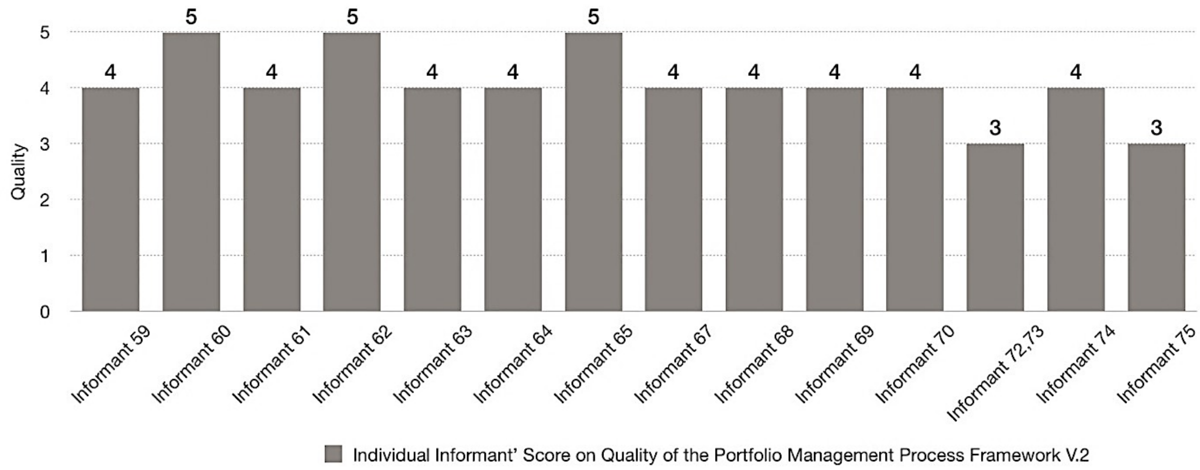
Informants confirmed many of the aspects of the framework V.3, such as its components. For example, Informant 58 confirmed that roadmaps, which are created annually, form an important part of Portfolio Strategy Development. Similarly, Informant 59 confirmed that top management support the process of Portfolio Strategy Development and provide annual budget for portfolio implementation.

The following remarks made by informants during the discussion are illustrative of the completeness scores:

- "*The framework does cover all aspects of [Informant's 61 Company]*" (Informant 61)
- "*This model could be ideal for portfolio management – all companies should follow*" (Informant 62).

<u>**Quality of Portfolio Management Process Framework V.2**</u>

The average score of quality of the framework V.2 was 4.0/5, which indicated that most of the informants found it useful. The researcher also observed that during the refinement interviews, industrial informants were able to reflect on the portfolio management processes in their companies and generate insights about their strengths and weaknesses.



Average Score: 4.0

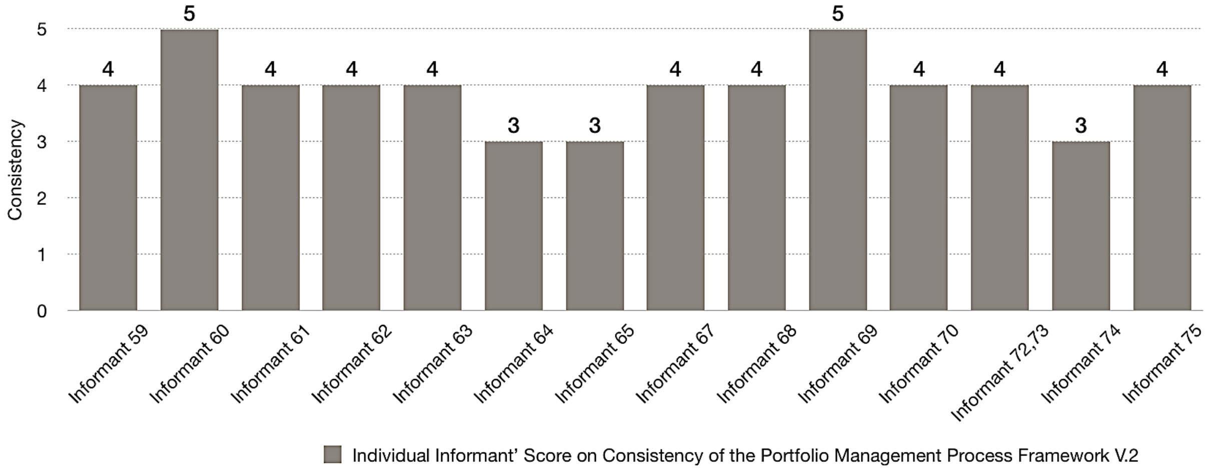
Figure 5.20: Quality of Framework V.2

For example, Informant 58 mentioned that Ecosystem Surveillance in his company is not strong, and the portfolio management focus is more on current business and less towards the future. Another example is the recognition by Informant 67 of a lack of quality in business case management in his company. The following remarks made by informants during the discussion are illustrative of quality scores:

- "*Your study makes so much sense – 'a stepping stone to small or immature companies how to effectively bridge between their strategy/demands and projects*" (Informant 68)
- "*I think it is very useful from intuition*" (Informant 62)
- "*Most of the building blocks we have, the value added is only in the structure*" (Informant 72 and 73, both scored jointly)

Consistency of Portfolio Management Process Framework V.2

The average score of consistency of the framework V.2 was 3.9/5, which indicated that most of the informants found that the framework has appropriate degree of coherency in depicting portfolio management processes in practice.



Average Score: 3.9

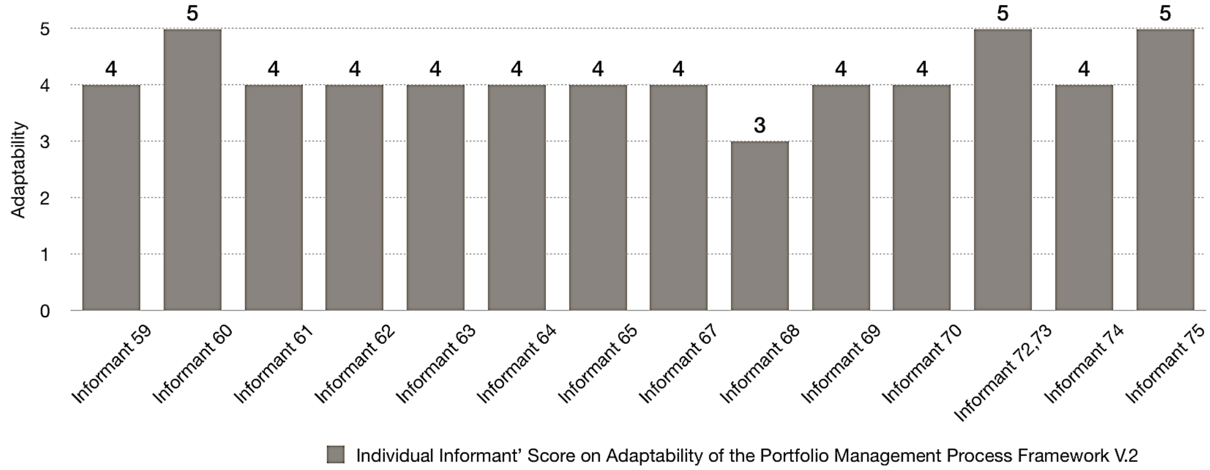
Figure 5.21: Consistency of Framework V.2

The following remarks made by informants during the discussion are illustrative of consistency scores:

- "*Practical, it almost same as [Informant's Company]*" (Informant 61)
- "*The framework does cover all aspects of portfolio management in [Informant's Company]*" (Informant 75)
- "*It is consistent, but the order of the building blocks is different*" (Informant 72 and 73)

Adaptability of Portfolio Management Process Framework V.2

The average score of adaptability of the framework V.2 was 4.1/5, which indicated that most of the informants considered that the framework could be easily adapted or configured according to the context of their organisational context and portfolio management practices.



Average Score: 4.1

Figure 5.22: Adaptability of Framework V.2

The following remarks made by the informants during the discussion are illustrative of the scores on adaptability of the framework v3:

- *"For every organisation the framework needs to be adapted based on their needs and strategy creation*" (Informants 72 and 73, both scored jointly)
- "*It is consistent, but the order of the building blocks is different*" (Informant 72 and 73)

Opportunities of improvement of Portfolio Management Process Framework V.2

Even though the framework V.2 was scored well in terms of usability, completeness, quality, consistency and adaptability, as described above, the following opportunities (*with implications for this research*) for refinement of the framework were identified:

- The Project Management Function was not sufficiently clear (Informants 59 and 69). Both of the informants mentioned that information regarding this function was quite limited and further work would be beneficial to explore this function in more detail. *A subsequent in-depth case study (10th) on portfolio management processes was undertaken to explore this function further***.**

- It would be useful to create a timeline of deliverables from different portfolio management stakeholders for different portfolio management processes (Informants 72 and 73). *Deliverable timelines are very specific to organisational structures, processes and might have less utility if developed generically, so developing such timeline was considered as future work opportunity.*

- It would be useful to explore how the framework V.2 could be used for public sector organisations or funding agencies such as the EPSRC[27](Informants 65 and 75). *Exploring the applicability of the framework in public sector companies or such agencies would need different research methodology and case studies, so it was considered as future work opportunity***.**

- It would be useful to explore how digital techniques could be used for improving efficiency of portfolio management processes (Informant 57). *Exploring the digital techniques for portfolio management would entail separate research efforts, so it was considered as future work opportunity.*

Overall, the 17 refinement interviews with both academic and industrial informants have revealed that the framework V.2 is quite self-explanatory, covers appropriate depth and breadth of portfolio management, could be used for generating insights for improving portfolio management, depicts portfolio management in practice, and could be configured according to portfolio management context. Also, these interviews led to identification of number of opportunities for improving the framework V.2. As a result, the 10th in-depth case study exploring portfolio management was planned.

F. Planning for the 10th Case Study

The 10th case study on portfolio management processes was planned to achieve three objectives (see Section 5.3 for other nine case studies). Firstly, as mentioned in Step E, informants in the refinement interviews indicated the need to gather more information about the project-

[27] EPSRC (Engineering and Physical Sciences Research Council), is the main UK government agency for funding research and training in engineering and physical sciences, investing more than 800m GBP a year in broad range of subjects. More information can be found on https://www.epsrc.ac.uk (accessed between 2015 & 2018)

-management function. Secondly, to overcome the limitation of data on which the framework V.1 and V.2 were based as both were derived from the narrative experiences of the informants. These experiences could be subjected to risk of individual informant biases (in some cases) and uncovering tacit (and unarticulated) knowledge about portfolio management processes. Thirdly, to explore applicability and practical utility of the framework V.2, i.e. how can this framework be used as an intervention to understand & improve portfolio management in a company? Addressing these objectives would entail that the researcher should gain much deeper and wider data access (as compared to just relying and gathering the narrative experiences in Phase I and Phase II's Stage I). Therefore, the 10th case study was needed and planned, in which the researcher could gain required level of data access by becoming a part of portfolio management processes in a firm.

G. Selecting 10th case study firm

The researcher undertook a four-month long internship in the portfolio management office of a large European pharmaceutical company, termed 'EUPHA', was selected as a 10th case study partner for two main reasons:

(1) It satisfied all four case study selection criteria used for Stage I (see Section 5.3), so that the 'boundary conditions' of the overall case study methodology did not change, reinforcing the reliability of this research. EUPHA is a technology-intensive firm (as a pharmaceutical company), with 20-50k employees, used formal portfolio management processes which were also continuously improved (as confirmed during internship planning discussions with the Informant 78), and the company had global operations.

(2) During case study partnership discussion, EUPHA agreed to an internship, during which the researcher would become part of portfolio management system and could gain the required level of data access to achieve the three objectives set out in Step F.

Brief overview of EUPHA case

EUPHA is a leading pharmaceutical company based in Europe. The researcher secured an internship with the biological drugs sector business unit (one of four), which develops the drugs to treat cancer, cardiovascular and metabolic diseases. This sector is further split into units called franchises, such as Oncology, Endocrinology. The portfolio of this sector has a multi-billion Euro budget, typically with 20-50 new drug development projects in different phases of the drug development process, as shown in Figure 5.23 below.

Figure 5.23: General Drug Development Process (Source: Author, based on EUPHA's documents and is similar to Stage-Gate process)

The researcher became part of portfolio management team (as shown in Figure 5.24) which supports portfolio decision-making on these drug development projects by collecting and analysing portfolio data. Overall portfolio management in the EUPHA can be divided into four levels as shown in Figure 5.24.

- The first level relates to projects, at which different drug development projects in different phases are executed.

- The second level corresponds to the portfolio, which includes portfolio management team supporting three processes: project level evaluation by providing relevant information, guidance and documentation to project teams for assessing their projects, collecting and analysing the project evaluation data and generating portfolio insights, and monitoring portfolio performance financial and non-financial indicators.

- After analysis of portfolio data, the third level relates to the business sector for which the decisions on these projects are taken, including resource allocation and prioritisation. At this level portfolio strategy is also developed.

- The fourth level is the company's executive board, at which the overall drug development portfolio is strategically and operationally steered.

H. Collecting 10th case study data

The researcher used three methods for collecting data related to portfolio management processes in EUPHA: documentation, direct and participatory observations and interviews.

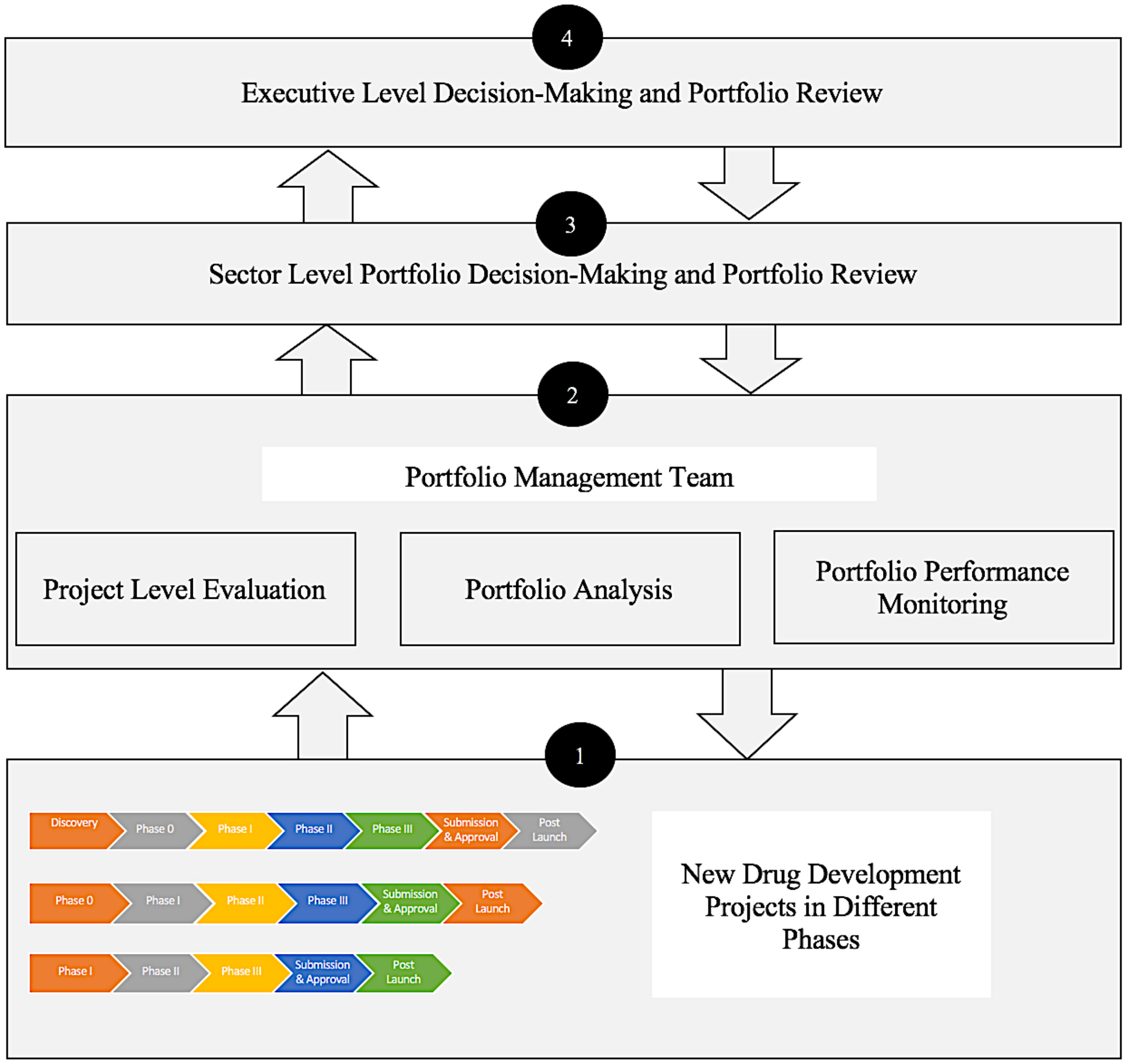


Figure 5.24: Levels of Portfolio Management in EUPHA (Source: Author's own depiction)

Relevant documents such as EUPHA's formal guide for portfolio management processes, presentation materials related to portfolio decision-making and team structures, business case templates for projects, project and portfolio reports were also collected by gaining relevant access to the portfolio management IT system of the company. The researcher also attended training related to portfolio management processes and tools in the company. During the four-months, the researcher was able to directly observe and participate in the portfolio management processes and collaborate with other portfolio management team members. A total of seven interviews with relevant portfolio management stakeholders were conducted (see Appendix 3B). The interviews were exploratory in nature, either seeking detailed explanation and/or description of portfolio management aspects found in documents or confirming the insights gained from the observations made by the researcher. Extensive notes were taken during these interviews and observations.

I. Analysis of the 10th case study data

The data collected on portfolio management processes in EUPHA was analysed using the framework V.2 as a lens. The data collected was coded against the framework V.2 and used to elucidate key portfolio management processes, their sub-processes and components, and stakeholder functions of the framework V.2. In this way, it reveals, the data which corresponded well and have not corresponded well with the framework. The data which did not conform with the framework V.2 was further discussed with the EUPHA informants and if needed, more data was collected. Furthermore, the findings were shared with the informants and the feedback was collected. The findings of the data analysis are presented in the next step.

J. Findings of the 10th case study

Using the framework V.2, the researcher was able to elucidate an overall portfolio management processes in EUPHA (see Step K). This addressed one of the objectives set in Step F, to test the applicability and utility of the framework. The data analysis of EUPHA's case revealed four key findings (with these refinements leading to the development of framework V.3):

- A new component labelled '*Functional Strategic Alignment*' was added to Corporate Functions of the framework V.2.

- Two new components labelled '*Project Management Support*' and '*Inter-Project Collaboration Facilitation*' were added to Project Management Functions to the framework V.2, addressing one of the objectives set in Step F.

- A new component labelled '*Expansion-Deletion'* was added to Post-Launch Tracking of the process of New Product Management to the framework V.2.

- A new portfolio management function labelled '**Portfolio Management Governance Functions**' with three components was added to the framework V.2.

K. Development of Portfolio Management Process Framework V.3

As indicated in Figure 5.25, the framework V.3 was developed as a result of four modifications made in the framework V.2 (see Step J). Before discussing these modifications in detail, it would be useful to discuss how the framework V.2 helped in elucidating the portfolio management processes in this case. The purpose here is to briefly outline examples of several *components* of sub-processes of the key portfolio management processes, rather than explaining each part of the framework with respect to EUPHA. Overall, the components of key portfolio management processes and stakeholder functions were observed in the EUPHA's case.

Ecosystem Surveillance: for example, the component *Information Type* included practices related to gathering competitive and market insights. As Informants 76 and 77 mentioned that they derived competitive insights by attending medical conferences, searching websites, talking to key opinion leaders and patients, after which a report was prepared for the dissemination of the insights to different stakeholders. Another component *Responsibility* indicated that there was a dedicated global forecasting and new product planning team (e.g. Informants 76 and 77) which was responsible for deriving these types of insights.

Portfolio Strategy Development: this process aims at answering the questions relating to the strategic and financial focus of portfolios. The strategic focus was concerned about developing franchise strategy and priorities, and the financial focus was about updating key assumptions underpinning existing business (i.e. products which are already launched into the market) and projects in a portfolio. This process was carried out in different stages starting with gathering project data to presentation of portfolio strategy to the executive board of EUPHA. Among its components, *Priorities* were operationalised by dividing the overall strategy into three parts: strategic initiatives (projects beyond normal course of business), drug development pipeline (new and existing drug development projects) and existing business (for products launched into the market) for which the contribution from of each of the four franchises was sought. The component *Product Strategy* for one of the franchises included recognition as an emerging leader in the therapeutic area(s) targeted by that franchise. The instances of *Roadmaps* included development of franchise roadmaps and R&D roadmaps. The component *Visualisations* included a number of portfolio visuals; for example, one of the visuals was a horizontal bar chart depicting the ranges of expected Net Present Value for the projects (low, mean, high).

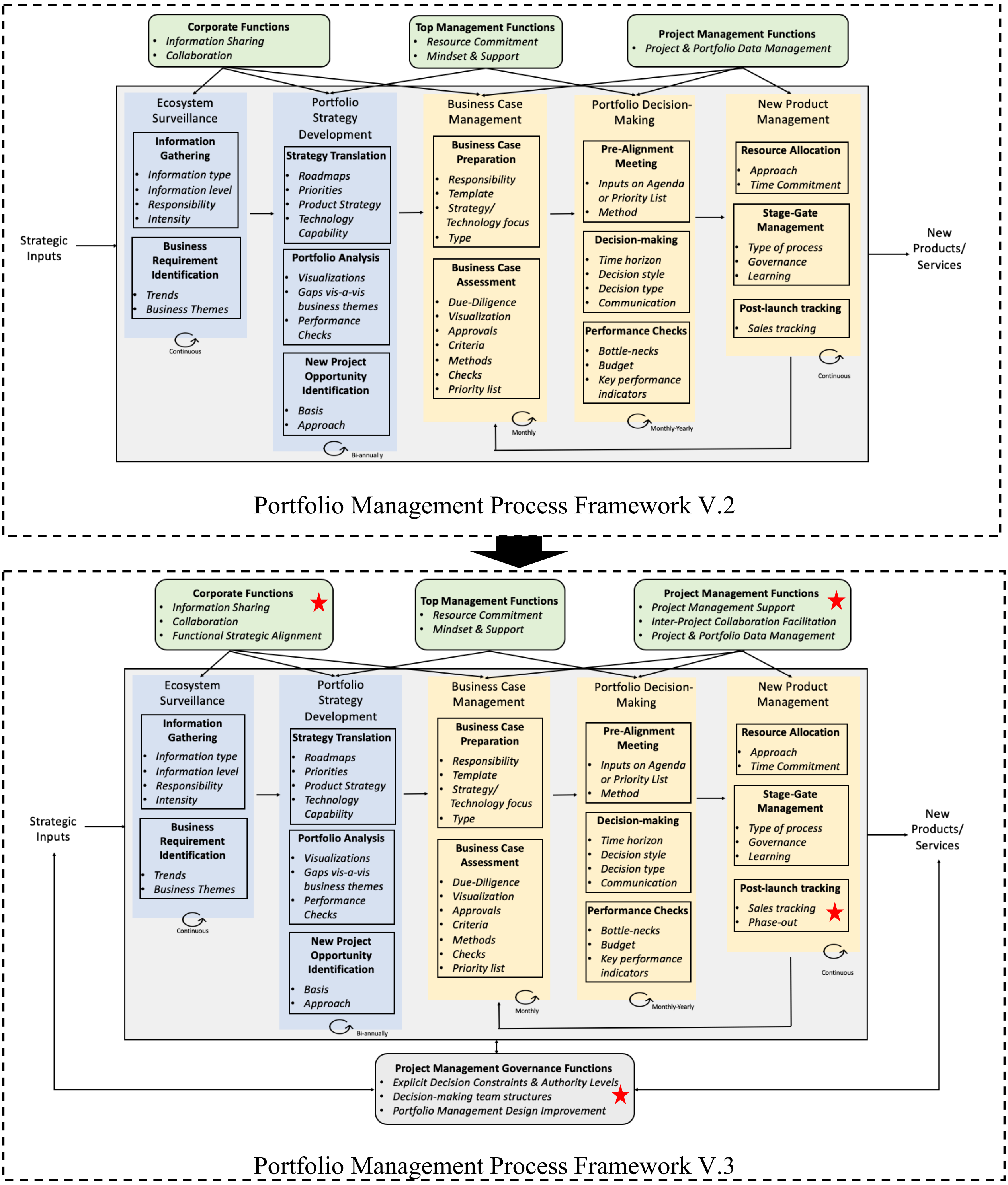


Figure 5.25: Portfolio Management Process Framework V.2 and V.3

(★ represents the pointer to the differences between the above frameworks)

Another visual was a vertical bar chart depicting overall expected sales and cost of projects in a portfolio.

Business Case Management: for example, the component *Due-Diligence* included calibration of project assumptions and financial and non-financial figures in the business cases of the projects in the pipeline, which was carried out at different portfolio management levels (see Figure 5.24). The *Criteria* used for assessing business cases include financial (e.g. NPV, discount rate, IRR, Sales forecasts, marketing cost), non-financial (e.g. novelty, differentiation), commercial (e.g. launch date, unmet needs, time to market) and technical (e.g. Probability of Technical Success or PoTS) aspects. Similarly, the *Method* included using a scoring technique to assess projects in their early-stages based on the above non-financial criteria. The component *Template* included both financial and non-financial templates, with the non-financial template including information according to the above commercial criteria, and the financial template incorporating details according to the above financial and technical criteria.

The *Priority List* includes three categories: projects with a high priority have high levels of scientific confidence and feasibility; projects with medium priority has moderate scientific confidence; and projects with low priority. The component *Visualisation* included a two-dimensional risk matrix: risk impact and its probability. The *Type* component included eight different projects classes: research, development, clinical study, infrastructure and life cycle management projects, with a different business case template used for each type in EUPHA. The *Responsibility* for a business case (non-financial) for early phase-project was attributed to project and programme leaders. Whereas for the financial business case, the manager, commercial lead and controller of a project were responsible.

Portfolio Decision-Making: once the project data was analysed by the portfolio management team, a pre-reading booklet was prepared as per the needs of the sector level decision-making team. The process of portfolio decision-making differs for early- and late-stage projects, for which different decision-making cadences were followed. Various decisions such as resource allocation, setting project priorities, and adjustment of project assumptions and financial numbers were carried out during this process. For example, the component *Key Performance Indicators* included risk assessment and mitigation of projects in the pipeline. A risk mitigation tool was used for each project in which the type different functional risks (such as may be associated with manufacturing) were lodged with their impact and their status monitored. The risk profile eventually impacted the process of prioritisation of projects in a portfolio. The resulting information was communicated to project leaders and made 'public' on the company's intranet.

New Product Management: The process of new product (or drug) development followed the stage gates as described in Figure 5.24. The resources are allocated to these projects by the 'resource controlling unit', which manage and control both financial and non-financial resources. For example, the component *Learning* included the capture of learnings from both terminated and ongoing projects at different phases. One full day workshop was conducted between a facilitator, project team and programme leader of a terminated project, after which insights were communicated to both decision-makers and other project teams.

Stakeholder Functions: the portfolio management in EUPHA was driven on a cross-functional basis. For example, during Portfolio Strategy Development, different functions such as manufacturing, finance, marketing were involved. The component *Information Sharing* included sharing competitive and market insights with franchise and new drug development program leaders through reports and conducting workshops. The Top Management Functions were split between early- and late-stage decision making. For example, the instances of *Mindset & Support* included that the portfolio decision-makers of early-phase projects aim to support project leaders in achieving project goals, defining milestones for projects, and providing guidance on relevant project activities to be carried out in the next phase. The Project Management Function involved collecting and analysing portfolio data to facilitate portfolio decision-making.

The following sections will discuss the four modifications mentioned in Step J:

- **A new component labelled '*Functional Strategic Alignment*' was added to Corporate Functions of the framework V.2.**

This component involves developing and aligning functional strategy such as manufacturing strategy, financial strategy with portfolio strategy. Associated practices include development of R&D roadmaps, aligning franchise strategy with functional strategies, and developing regional strategy such as addressing the strategic questions such as how to introduce a particular drug in a particular geographical region.

- **Two new components labelled '*Project Management Support*' and '*Inter-Project Collaboration Facilitation*' were added to Project Management Functions to framework V.2, addressing one of the objectives set in Step F.**

This component refers to the set of practices related to the project level support such as in its planning, execution and reporting. Associated practices include using an IT system to manage project, providing training and guidance on filling different project documents such as timelines, cost and budget and providing mandates to project managers as to how to execute projects. This component also includes using different documents and guidance for different types of projects and identifying constraints related to resources, budget and time in projects. The component of '*Inter-Project Collaboration Facilitation*' includes practices associated with fostering learning and collaboration between different types of projects. Associated practices include facilitating meetings between different project managers to share project learnings and discussing key issues faced by them.

- **A new component labelled '*Expansion-Deletion'* was added to Post-Launch Tracking of New Product Management to the framework V.2.**

This component of '*Expansion-Deletion*' refers to the life-cycle management of products in market. Associated practices include expanding market of existing products by entering into new markets or countries, updating product compositions according to market changes or regulations, and deleting or taking out the products from the market.

- **A new portfolio management function labelled *'Portfolio Management Governance Functions'* with three components was added to the framework V.2.**

This function refer to the formal governance guidance for portfolio decision-makers which includes scope and mandates for making portfolio decisions. This includes three components: *Explicit Decision Constraints and Authority Levels, Decision-making team structures* and *Portfolio Management Design Improvement*. The component of *Explicit Decision Constraints* *and Authority Levels* includes the description of project constraints such as overbudget or delay for which a particular decision or action would be warranted by specified stakeholder. For example, as found in this case, the decision-making team has to make a decision on a project (in addition to phase-gate based decision) if the cost of a project (with a particular priority) deviated (increased) by €150-250,000 in a fiscal year, if a project is delayed by 2-4 months for the next planned phase, or if there is a significant change in project strategy.

Decision-Making Team Structures refers to controlling of the scope of participation and information in portfolio decision-making events by different stakeholders. This gives clarity on roles to the decision-making team members and reduces coordination efforts. For example, as found in this case, their decision-making team for late-phase project was divided into four types of stakeholders: chair (who chairs the portfolio decision-making meeting), core (for whom the meeting was mandatory), large (for whom the meeting is optional) and extended (for whom the invitation is needed to attend the meeting). The component *Portfolio Management Design Improvement* refers to the identification of opportunities and needs for improving portfolio management processes by the portfolio decision-makers. For example, as found in this case, the sector level decision-making team recognised that the process of determining the PoTS of a project need more transparency and structure. As a result, a need for a management tool overcoming this limitation was recognised and the portfolio management team was instructed to develop such a tool. This component also includes incorporating learnings and suggestions recommended by the project and program leaders in overall decision-making.

Overall, Stage II which included 17 refinement interviews and 10th case study led to the development of the framework V.3. The basis of the framework V.3 was the framework V.2 (see Section 5.4), which itself was based V.1 (see Section 4.3) and V.0 (see Section 2.6). A further empirical work was needed for verification of the framework V.3.

5.5 Stage III: Portfolio Management Process Framework V.4

This section presents Stage III (framework verification), which builds upon the framework V.3 (i.e. Stage II) as shown in Figure 5.26 and **leads to the development of the Portfolio**

Management Process Framework V.4, which is Result II. This section has three sub-sections: 5.5.1 and 5.5.2 introduce the basis and methodology (a focus group with STIM companies, see Section 3.4) used for deriving the framework V.4 respectively; and 5.5.3 describes the findings of the focus group and framework V.4.

5.5.1 Basis used for derivation of the Portfolio Management Process Framework V.4

The basis used was framework V.3 as shown in Figure 5.26. The rationale is that the purpose of Stage III is to review and verify to what extent framework V.3 captures relevant portfolio management processes, sub-processes, practices and stakeholder functions that are useful for supporting portfolio management formalisation.

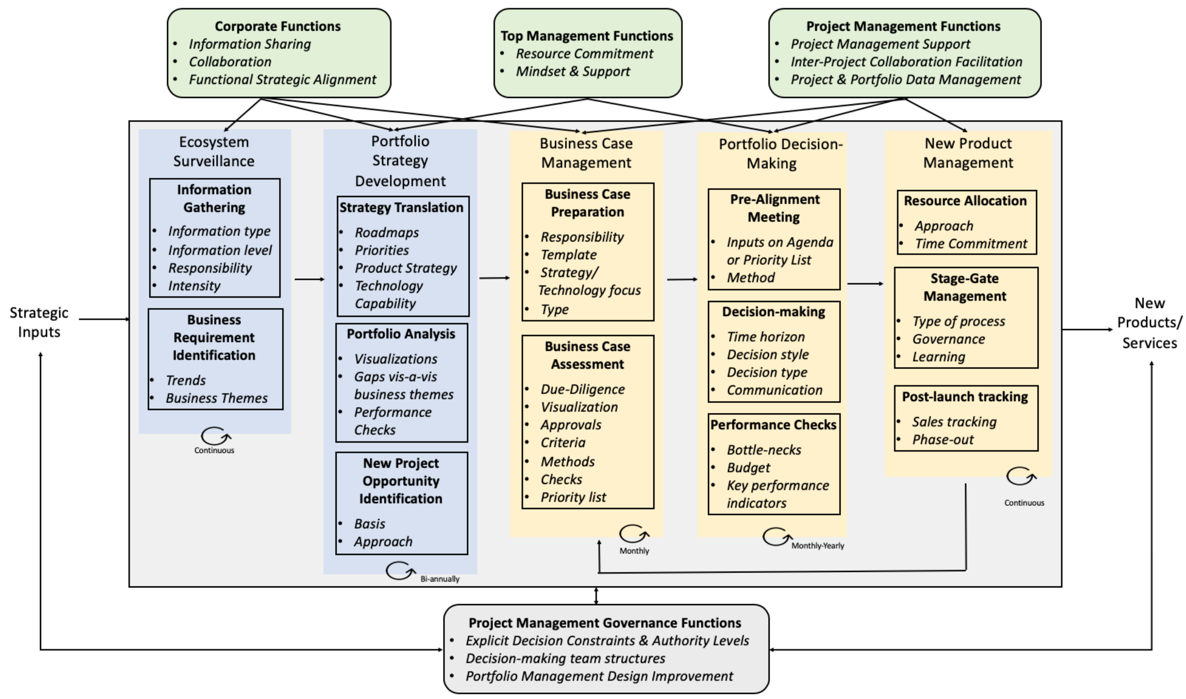


Figure 5.26: Portfolio Management Process Framework V.3 (adapted from Figure 5.25)

5.5.2 Methodology for developing Portfolio Management Process Framework V.4

A 90-minutes focus group with industrial informants from the STIM companies (see Section 3.4) was planned and conducted to verify the framework V.3 at the Institute for Manufacturing at the University of Cambridge.

The focus group method was chosen primarily because it is more efficient than conducting individual interviews, and because of the benefits of participant interaction that is enabled by the format. The selection of participants for the focus group was made on an opportunistic basis rather than purposive, constrained by the format of the STIM event and those participating in it. However, participation of non-case companies[28] was encouraged, to enable critical review of the framework by clarifying any ambiguous terminology and identifying improvement opportunities associated with it. This is because informants from non-case companies could potentially identify new meanings, interpretations or components of the framework while reflecting on portfolio management in their companies. Having non-case informants in the focus group also enabled implications about the generalisability of the framework to be explored. A total of five industrial practitioners from four non-case companies participated in the focus group discussion (see Appendix 3B for more details on the informant roles and company descriptions). The overall structure of the focus group discussion is shown in Figure 5.27.

5.5.3 Findings of the focus group discussion

In general, informants considered that the framework V.3 could be used as an intervention for portfolio management formalisation. The key processes, sub-processes and their components and stakeholder functions were recognised by the informants, implying that the framework is quite stable (see note at end of this section) and has appropriate depth and breadth of information about portfolio management processes, with little improvement needed in its visual aspects. The following sections will discuss the scores for each of the five criteria against which the framework was evaluated (usability, completeness, quality, consistency and adaptability), and then whether the scores have increased/decreases/remained constant with respect to framework V.2. Also, the remarks from informants associated with these criteria are also outlined.

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[28] Non-case companies here refer to the companies which did not participate in any of the 10 case studies conducted in Stage I (see Section 5.2) and Stage II (see Section 5.3).

Introduce the background to PhD research to the informant

- The researcher introduces the background of the research and describe research objectives. It was then followed by summary of the framework V.0, V.1, V.2 and V.3. The researcher then introduced the objective of focus group.

⬇

Introduce & describe Portfolio Management Process Framework V.3

- The researcher then introduced and describe each of the constructs of the framework V.3 (as shown in Figure 5.38). This discussion included brief overview of sub-processes, components and practices of five key portfolio management processes and the stakeholder functions.

⬇

Discussion between focus group informants moderated by the researcher

- The framework V.3 was printed on A1 size sheet and put on the wall in the discussion room.

- The informants were briefed about the basis for review and evaluation of the framework V.3, which was the five criteria mentioned in Sept C of the Stage II.

- Participants were asked to provide feedback using two different colored post-it notes, yellow for positive feedback and pink for improvement opportunities

- The researcher moderated the discussion and provided more explanation about the parts of the framework V.3 where needed by the focus group informants.

⬇

Fill the evaluation scores in the feedback questionnaire

- The informants were asked to fill the feedback questionnaire which involved scoring of the framework V.3 on five different criteria: usability, completeness, quality, consistency and adaptability. See Appendix 5C for the questionnaire.

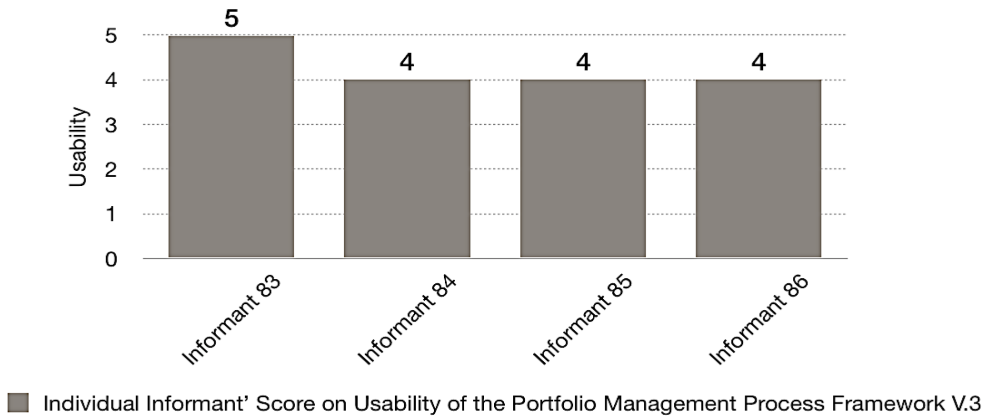
Note: One of the five informants (the Informant 87) was not able to fill the feedback questionnaire due to his prior commitments.

Figure 5.27: Structure of Focus Group Discussion

Usability of Portfolio Management Process Framework V.3

The average score (rounded to one decimal point) of usability for framework V.3 was 4.3/5, which indicated that the informants found it self-explanatory and intuitive. Usability for framework V.3 (average = 4.3) is higher than for framework V.2 (average = 4.1), indicating an improvement. The following informant remarks are illustrative of the scores on usability for framework V.3:

- '*It is self-explanatory'* (Informant 84)
- *'Clear and comprehensive framework*' (Informant 86)
- *'Like the process/elements'* (Informant 83)



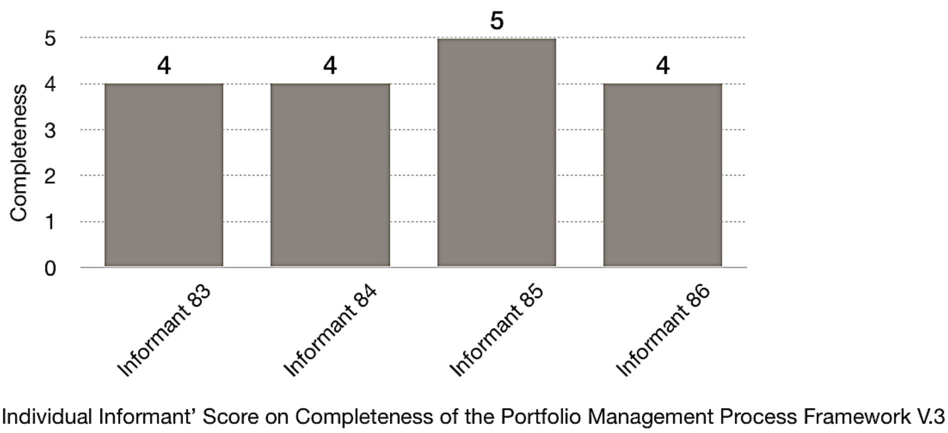
Average Score: 4.3

Figure 5.28: Usability of Framework V.3

Completeness of Portfolio Management Process Framework V.3

The average score for completeness of framework V.3 was 4.3/5, which indicated that the informants found that the framework captures an appropriate level of depth and breadth of detail and scope of portfolio management processes. The completeness of framework V.3 (average = 4.3) is the same as that of framework V.2 (average = 4.3), indicating that framework v4 can be considered as being stable in terms of scope and detail. The following informant remarks are illustrative of the scores on completeness for framework V.3:

- '*All core elements covered*' (Informant 83)
- '*It covers the critical element with the proper level of detail*' (Informant 84)

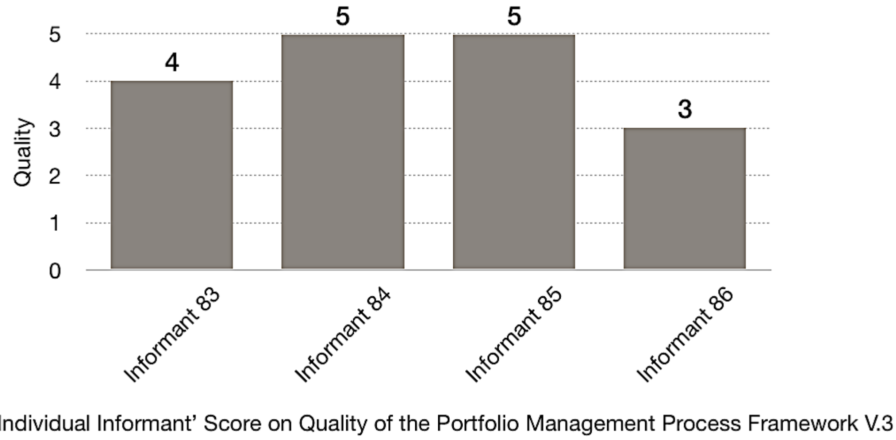


Average Score: 4.3

Figure 5.29: Completeness of Framework V.3

<u>**Quality of Portfolio Management Process Framework V.3**</u>

The average score of quality for framework V.3 was 4.3/5, which indicated that most of the informants found it useful. The quality of the framework V.3 (average = 4.3) is higher than the framework V.2 (average = 4.0), indicating that framework V.3 provides more insights or pointers than the framework V.2 to improve portfolio management processes in a company.



Average Score: 4.3

Figure 5.30: Quality of Framework V.3

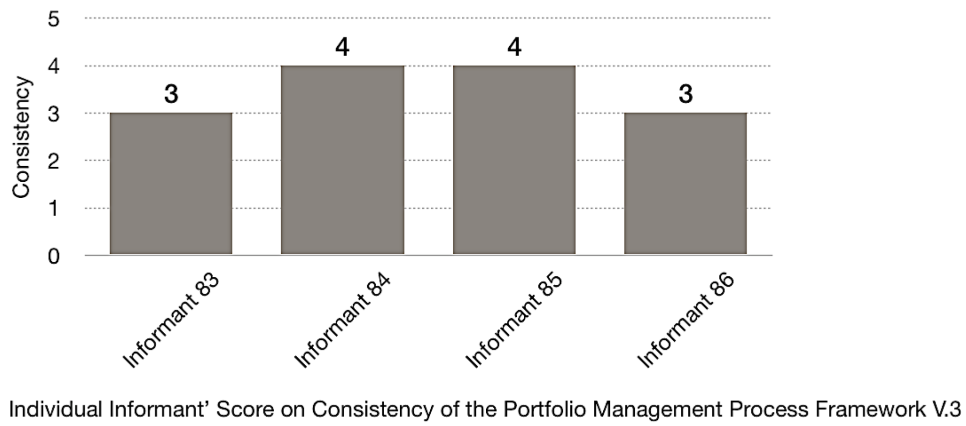
The following informant remarks are illustrative of the scores on quality for framework V.3:

- *'Very good as checklist or action plan for future projects'* (Informant 87)
- *'It provides the pillar to start generating the maturity in [the Informant's company]'* (Informant 84)

<u>**Consistency of Portfolio Management Process Framework V.3**</u>

The average score of consistency for framework V.3 was 3.5/5, which indicated that the informants found that framework depicts portfolio management processes in practice in a coherent manner. However, consistency of the framework V.3 (average = 3.5) is lower than the framework V.2 (average = 3.9).

This is because the framework V.3 does not fully capture the other aspects, for example, the case of dependency of project decision (e.g. approval) on public funding grants allocated by the public funding bodies such as the government agencies (as explained by the Informant 86). This means that the framework needs to be adapted according to portfolio management context.



Average Score: 3.5

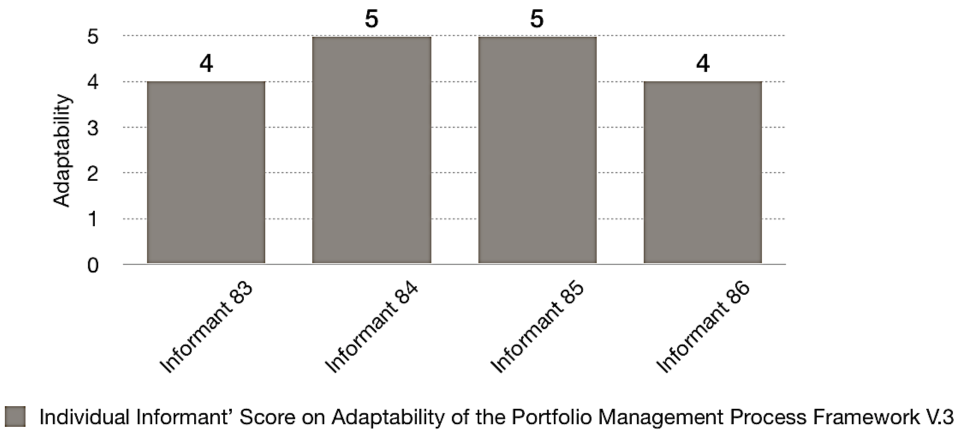
Figure 5.31: Consistency of the Framework V.3

Another reason is small size of focus group and included non-case firms. Consequently, this research does not claim that the framework V.3 is a 'one fit for all' solution for different types of portfolio and for different organisational contexts, but rather the claim is that the framework could be used as a stepping stone or intervention for initiating discussions and planning actions regarding portfolio management formalisation. The following informant remarks or point are illustrative of or explain the scores on quality of the framework V.3:

- '*Decisions may be outside control of business, e.g. govt. research*' (Informant 86)
- The arrangement of the portfolio management process blocks is quite different compared to the Informant 85' company

Adaptability of Portfolio Management Process Framework V.3

The average score for adaptability of the framework V.3 was 4.5/5, which indicated that the informants found that the framework can be easily adapted or configured according to the context of portfolio management. Adaptability of the framework V.3 (average = 4.5) is higher than for framework V.2 (average = 4.1), indicating that framework V.3 can be considered more flexible than framework V.2 in general.



Average Score: 4.5

Figure 5.32: Adaptability of the framework V.3

Opportunities for improvement Portfolio Management Process Framework V.3

Even though the framework V.3 scored higher on most of the five criteria, the following opportunities (*with implications for this research*) for refinement of the framework were identified:

- Suggesting the frequency of each key portfolio management process could make the framework V.3 quite inflexible. It would be useful to indicate that frequency of the sub-processes of these key processes could also be varied (Informants 83 and 86). *The visual representation of the framework V.4 was improved by indicating frequencies of the sub-processes of the key processes*.

- It would be useful to clarify the structure of stakeholders responsible for identifying business requirement identification in Ecosystem Surveillance (Informants 84 and 85). *The stakeholder structure of Ecosystem Surveillance is very specific to organisational structures and processes, and would have less utility if developed generically, so identifying such related structures was considered as future work opportunity*.

- It would be useful to describe the tools and techniques used for carrying out key portfolio management processes and their sub-processes (Informants 83, 85 and

86). *The researcher acknowledges that the industrial practitioners have a keen interest in management tools and techniques and future work is suggested in this regard.*

All in all, the scores for framework V.3 also reinforced its generalisability as the informants were non-case partners and they were able to agree and recognise that framework V.4 consists of relevant portfolio management processes, sub-processes and components, and stakeholder functions. Incorporating the relevant improvement suggestions in the framework V.3 during focus group discussion led to the development of the framework V.4, which is Result II as shown in Figure 5.33 below.

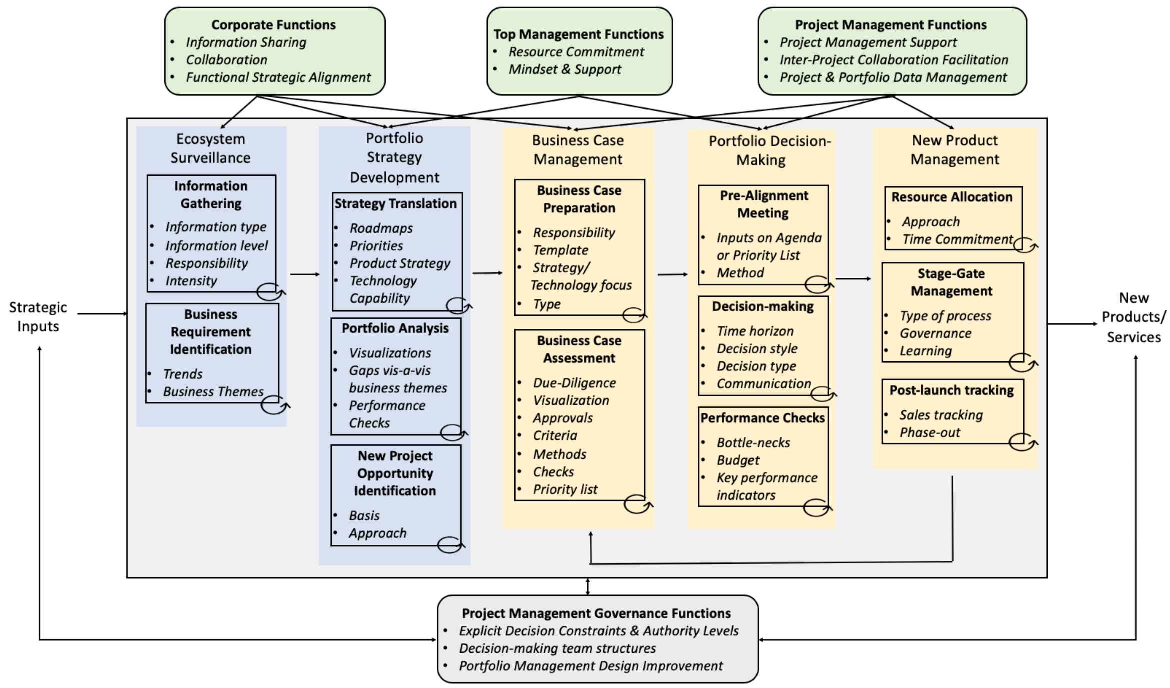


Figure 5.33: Portfolio Management Process Framework V.4 (Result II)

To recap, Stage I included 9 in-depth case studies on portfolio management using the framework V.1, which led to the development of framework V.2. Then 17 refinement academic and industrial interviews and a 10th in-depth case study were conducted to refine the framework V.2, leading to the development of framework V.3. Finally, in Stage III a focus group with non-case companies was conducted, which suggested that framework V.3 is quite stable. The framework V.4 (Result II) was developed following the recommendations from the group discussion.

Note on stability of Result II

To gauge stability of research outputs, the order and number of changes that have been introduced were tracked through the research process, from framework V.1 (Result I) to framework V.4 (Result II). The order of changes can be defined as:

Ist order: Number of new key portfolio management processes and stakeholder functions

IInd order: Number of new sub-processes of key portfolio management processes

IIIrd order: Number of new components of these sub-processes and stakeholder functions

Figure 5.34 depicts the number of changes from the framework V.1 to V.2, V.2 to V.3 and V.3 and V.4 in terms of three order of changes mentioned above.

Figure 5.34: Stability of Result II

Using the above figure, it can be argued that Result II is reasonably stable within the given contextual boundaries of its underpinning empirical studies, as all number of changes with respect to order of changes reached 0 from V.3 to V.4. Therefore, no Ist order and IInd order changes are expected with further empirical studies. However, IIIrd order changes may be expected with portfolio management processes observed with relaxed contextual boundaries.

5.6 Discussion of Result II

This section discusses theoretical and managerial implications of Result II, followed by its limitations. This section is organised into three sub-sections: 5.6.1 presents the theoretical implications of the constructs of Result II, 5.6.2 discusses managerial implications, and 5.6.3 outlines the limitations of Result II.

5.6.1 Theoretical Implications of Result II

There are three primary theoretical implications of Result II, discussed in more detail in the paragraphs below.

- *Result II expands the process construct, one of the central constructs of portfolio management formalisation, by adding sub-process of the five key portfolio management processes (which have implications for portfolio management performance) – see Figure 5.35. An example is the addition of Strategy Translation as a sub-process of Portfolio Strategy Development (which is one of the five key portfolio management processes).*

As mentioned in Sections 2.5 and 4.4, the portfolio management formalisation has implications for the portfolio management performance (e.g. Jugend & da Silva, 2014; Spieth & Lerch, 2014; Kock et al., 2014). As indicated in Figure 4.9, methods and process are the two central constructs of portfolio management formalisation. Result I expanded the process construct by adding five key portfolio management processes and argued that these processes have potential implications for the performance.

Result II further expands Result I by revealing the sub-processes of those five key portfolio management processes that could be formalised to reap benefits of process formalisation-performance relationship (as shown in Figure 5.35).

Similar to Result I, Result II could also explain the source of difference between the firms having formal overall portfolio management (55%) and the firms having formal NPD process

(69%) as indicated in the benchmarking survey by Barczak et al. (2009). Based on Result II, it can be argued that such a difference exists because formalising the NPD process (particularly the Stage-Gate Management sub-process – see Figure 5.35) is not a sufficient condition for formalised portfolio management, and other sub-processes such as Information Gathering, Strategy Translation, Business Case Preparation & Assessment, Decision-Making and Resource Allocation of key portfolio management processes also need to be formalised in parallel. Each sub-process construct of key portfolio management processes will now be discussed with respect to the extant literature.

Ecosystem Surveillance: refers to the series of tasks associated with collection and analysis of information about the business ecosystem of an organisation. Result II splits this process into two sub-processes: *Information Gathering* and *Business Requirement Identification*.

Result I argued that this key process of Ecosystem Surveillance is linked with the Absorptive Capacity (ACAP) of a firm (e.g. Cohen & Levinthal, 1990; Zahra & George, 2002), which has implications for firm performance (Lane et al., 2006; Tsai, 2001) and portfolio management performance (Biedenbach & Muller, 2012).

The literature has offered multiple conceptualisations of ACAP. For example, Zahra & George (2002) postulated two components of ACAP: Potential Absorptive Capacity (PACAP) and Realised Absorptive Capacity (RACAP). PACAP refers to the firm's ability to acquire and assimilate the external knowledge and RACAP refers to the firm's ability to transform and exploit that external knowledge for commercial ends.

Result II is closely linked with PACAP as *Information Gathering* involves acquiring ecosystem information and *Business Requirement Identification* involves assimilating that information to understand trends such as market or technology drivers, and to identify business requirements.

A number of studies argue that PACAP is a necessary condition for sustaining competitive advantage, influencing innovation performance i.e. new product success, which is one of the

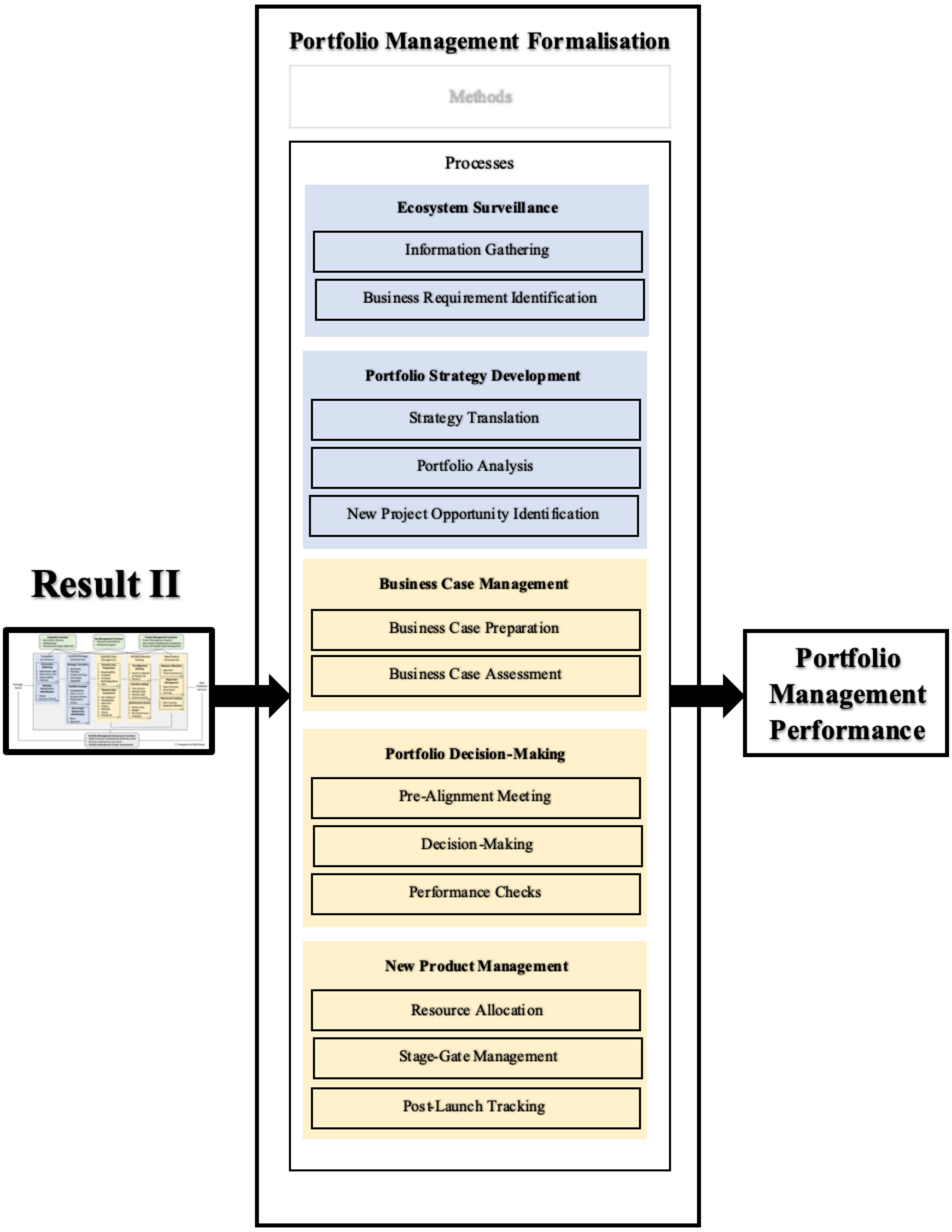


Figure 5.35: Implications of Result II for Portfolio Management Formalisation & Performance

dimensions of portfolio management performance (e.g. Zahra & George, 2002; Fosfuri & Tribo, 2008). The rationale behind this is that firms could take time and cost advantages by developing up-to-date products aligned with market and customer needs if they continuously scan their external environment and update their knowledge and skills base, which manifests the PACAP of a firm.

Along the above lines of argument, *Result II strengthens Result I by positing that formalisation of Ecosystem Surveillance will have an impact on portfolio management performance, and it further conceptualises that the formalisation of Ecosystem Surveillance consists of two sub-processes, Information Gathering and Business Requirement Identification.*

Portfolio Strategy Development: refers to the series of tasks associated with setting strategic goals and directions for portfolio decisions, determining gaps in portfolio and identifying new project opportunities that could be pursued to implement the strategy or to fix portfolio gaps. Result II splits this process into three sub-processes: *Strategy Translation, Portfolio Analysis and New Project Opportunity Identification*. Result I argued that this key process of Portfolio Strategy Development is closely linked with the concept of formal strategic planning, which has implications for firm performance (e.g. Thune and House, 1970; Ansoff et al., 1970) and portfolio management performance (e.g. Cooper et al., 2001; Kang & Montoya, 2014; Klingebiel & Rammer, 2013; Klingebiel & Joseph, 2015).

- The *Strategy Translation* process can be linked to the construct of portfolio strategy proposed by Kang & Montoya (2014), as both of these constructs involves the component of product strategy, which in turn focuses on deciding product development and market entry strategies. Kang & Montoya (2014) argued that firms opting to be first to market and pioneering new products in their portfolio will have a major financial advantage leading to new product success.

- The *Portfolio Analysis* process combines the constructs of analytical posture (Meskendahl, 2010) and portfolio visualisation (Killen & Kjaer, 2012; Killen, 2013). Meskendahl (2010) argued that strategic orientation of a portfolio involves systematic analysis of internal information such as project portfolio and deriving substantial management implications, which could influence decision-making and firm performance (Goll & Rasheed, 1997). On the other hand, Killen & Kjaer (2012) and Killen (2013) argued that portfolio visualisation, such as showing project interdependencies using project maps, could lead to better portfolio decisions and performance.

- The *New Project Opportunity Identification* process combines the constructs of ideation strategy and process formalisation proposed by Kock et al (2014). They argued that a formalised and explicit idea generation activity aligned with organisational strategy will improve portfolio management performance.

Along the above lines of argument, *Result II strengthens Result I by positing that formalisation of Portfolio Strategy Development will have an impact on portfolio management performance, and it further conceptualises that the formalisation of Portfolio Strategy Development consists of three sub-processes, Strategy Translation, Portfolio Analysis and New Project Opportunity Identification.*

Business Case Management: refers to the series of tasks associated with preparation and assessment of business cases to enable portfolio decision-making. Result II splits this process into two sub-processes: *Business Case Preparation* and *Business Case Assessment*. Result I argued that this key process of Business Case Management is closely linked with 'investment initiatives' in the resource allocation literature (e.g. Bower, 1970; Burgelman, 1983; Maritan & Lee, 2017) and business case control (Kopmann et al., 2015) in portfolio management literature, which have implications for the portfolio management performance.

- The *Business Case Preparation* process can be linked to the construct called business case existence proposed and empirically tested by Kopmann et al. (2015), as both of these constructs tends to imply that to improve business case quality, firms should establish common methods, forms or documentation and guidance for designing business cases. Using a cross-industry survey of 184 informants, Kopmann et al. (2015) concluded that business case existence has a positive impact on the performance.

- The *Business Case Assessment* process combines various constructs such as business case existence & business case monitoring (Kopmann et al., 2015); methods and criteria (Jugend & da Silva, 2014; Spieth & Lerch, 2014) and due-diligence (Meskendahl, 2010), as all of these constructs tend to imply that business cases should be accurate, valid and must undergo a comprehensive assessment for their financial and non-financial value before decision-making. As a result, these constructs have been corelated with the performance(Kopmann et al., 2015; Jugend & da Silva, 2014; Spieth &Lerch, 2014; Meskendahl, 2010). The rationale behind this is that formal, valid and comparable business cases lead to informed portfolio decisions and ensures that resources are allocated to projects aligned with strategic priorities, eventually contributing to the goals of value maximisation and strategic alignment of portfolio management.

Along the above lines of argument, *Result II strengthen Result I by positing that formalisation of Business Case Management will have impact on portfolio management performance, and it further conceptualises that the formalisation of Business Case Management consists of two sub-processes, Business Case Preparation and Business Case Assessment.*

Portfolio Decision-Making: refers to the series of tasks associated with taking selection, termination or hold decisions on projects in the context their assessed values, portfolio priorities and performance. Result II splits this process into three sub-processes: *Pre-Alignment Meeting, Decision-Making* and *Performance Checks*. Result I argued that the key process of Portfolio Decision-Making is closely related to the concept of formal strategy decision-making, which has implications for firm performance (e.g. Thune and House, 1970; Ansoff et al., 1970; Eisenhardt & Bourgeois II, 1988) and portfolio management performance (Kester et al., 2014).

- The essence of *Pre-Alignment Meeting* is that decision-makers tend to form common opinions about the portfolio decision issues and discuss their views before decision-making. It can be linked to decision-specific characteristics such as decision familiarity, magnitude of impact, opportunity or crisis, as proposed by Papadakis et al. (1998) and strategic issues (Dutton & Duncan, 1987), where decision-makers understand the characteristics of portfolio decisions to be taken. A number of studies have highlighted the influence of decision characteristics on decision-making performance (e.g. Papadakis et al. 1998; Dutton & Duncan, 1987; Hickson, 1986). The rationale behind this is that the way decision-makers perceive portfolio decisions impacts the decision-making rationality, which in turn has been found to impact firm performance. For example, Fredrickson (1985) suggests that if a decision is perceived as threat, the decision-making process tends become more comprehensive and rational.

- The *Decision-Making* process builds upon various constructs discussed in the extant literature such as evidence-based decision-making (Kester et al., 2011, 2014) and decision transparency (Urhahn & Spieth, 2014). These constructs tend to imply that *Decision-Making* components such as portfolio decision-making style and transparency influence the portfolio management performance. For example, transparent portfolio decisions enhance commitment of project teams to their projects and increases the likelihood of project success (e.g. Pinto & Slevin, 1987), which is one of the dimensions of the performance.

- The essence of the *Performance Checks* process is to ensure that portfolio performance is monitored, and corrective actions such portfolio risk mitigation are taken. The extant literature argues that having formal portfolio control is linked with positive portfolio management performance (e.g. Schultz et al., 2013; Teller & Kock, 2013).

Along the above lines of argument, *Result II strengthens Result I by positing that formalisation of Portfolio Decision-Making has an impact on portfolio management performance, and it further conceptualises that formalisation of Portfolio Decision-Making consists of three sub-processes, Pre-Alignment Meeting, Decision-Making and Performance Checks.*

New Product Management: refers to the series of tasks associated with allocating resources to selected projects and implementing those projects while performing pre- and post-launch stage-gate activities. Result II splits this process into three sub-processes: *Resource Allocation, Stage-Gate Management* and *Post-Launch Tracking*. Result I argued that this key process of New Product Management has implications for firm performance and portfolio management performance (e.g. Cooper et al., 2001; Griffin, 1997).

- The essence of the *Resource Allocation* process is that limited resources are effectively and efficiently allocated between the projects in line with strategic priorities. In this way, it can be closely linked with the construct of allocation quality investigated by Jonas et al. (2013) and Rank et al. (2015), which influences portfolio management performance. The rationale behind this is that if resources are allocated effectively and efficiently, the likelihood of negative impacts from 'fire-fighting' on NPD performance can be reduced (Repenning, 2001).

- The *Stage-Gate Management* process has been extensively associated with NPD performance in the extant literature (Schultz et al., 2013; Cooper et al., 2001; Barczak et al., 2009), which is one of the dimensions of the portfolio management performance. For example, firms employing formal Stage-Gate processes can easily separate out the non-valuable projects in early phases, eventually impacting portfolio value by making resources available to more valuable projects. Moreover, one of the best practices is to configure Stage-Gate according to project type (e.g. MacCormack et al., 2012).

- The essence of the *Post-Launch Tracking* process is to monitor the success ratio of sales in business cases and to take corrective actions to improve product sales, for example by market expansion or product maintenance efforts. It is related with the empirically tested construct called business case tracking (Kopmann et al., 2015), which contributes to overall portfolio success. The rationale behind this is that it facilitates and increases learning from project completion, leading to improved business case management capabilities, which has been positively linked with portfolio management performance (Kopmann et al., 2015; Jugend & da Silva, 2014; Spieth &Lerch, 2014; Meskendahl, 2010).

Along the above lines of argument, *Result II strengthens Result I by positing that formalisation of New Product Management will have impact on portfolio management performance, and it further conceptualises that the formalisation of New Product Management consists of three sub-processes, Resource Allocation, Stage-Gate Management and Post-Launch Tracking.*

The following paragraphs will discuss the second key implication of Result II:

- *Result II adds stakeholder function as another central construct of portfolio management formalisation and expands it further by revealing three stakeholder functions that could be formalised to reap benefits of stakeholder function formalisation and performance relationship* (as shown in Figure 5.36).

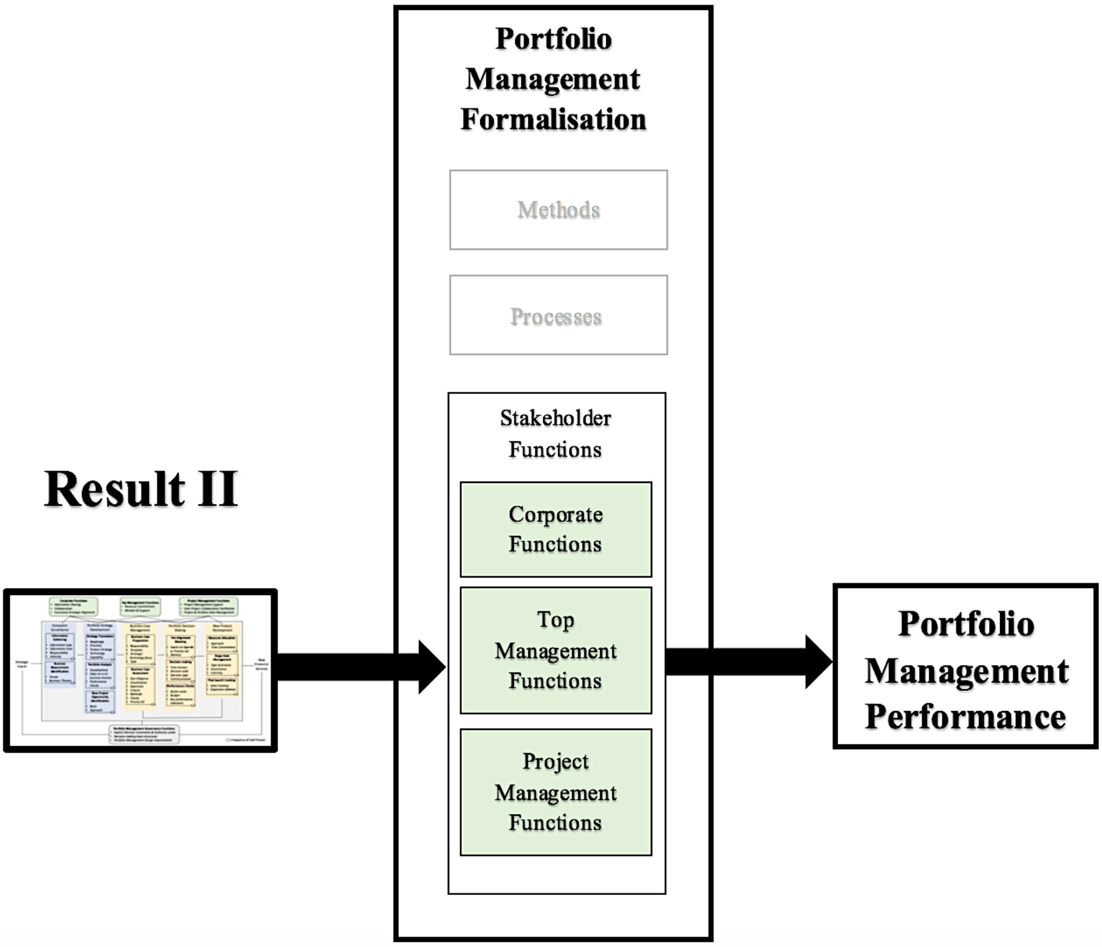


Figure 5.36: Implications of Result II for Portfolio Management Stakeholder Functions Formalisation & Performance (Source: Author)

Three relevant Stakeholder Functions have been revealed: Corporate, Top Management and Project Management Functions. Result I identified the first two Stakeholder Functions, while Result II not only confirmed and explored these two functions, but also added the third function. The extant literature has already argued that the involvement of relevant portfolio stakeholder can influence portfolio management performance (e.g. Beringer et al., 2013; Jonas 2010). Each of the three functions are discussed below with respect to the extant literature.

Corporate Functions: refers to the involvement of the various functional stakeholders, such as marketing, finance and operations in portfolio management processes. The components of this function include sharing of project and portfolio data between functions; collaborating cross-functionally, for example to assess projects; and aligning functional strategy with portfolio strategy. This function is linked to the constructs of cross-functional collaboration

(Kester et al., 2011), inter-functional integration (Perks, 2007) and cooperation quality (Jonas et al., 2013), as these constructs tend imply that cooperation and collaboration between different corporate functional stakeholders have implications for portfolio decision-making and resource allocation.

The rationale behind this is that cross-functional assessment improves business case quality by doing due-diligence on their numbers and assumptions (Kester et al., 2011) and validating business case feasibility, which in turn improves portfolio management performance (Kopmann et al., 2015). Further, Criscuolo et al. (2017) argues that cross-functional decision-making teams prefer more radical to incremental projects, and that this contributes to maintaining Portfolio Balance in terms of radical vs incremental projects. Moreover, cross-functional integration has been argued as an antecedent for new product success, which is one of the dimensions of the performance (e.g. Griffin & Hauser, 1996). Along the above lines of argument, *Result II posits that formalisation of Corporate Functions in portfolio management will have impact on portfolio management performance.*

Top Management Functions: refers to attention and involvement of senior management in portfolio management processes such as Portfolio Decision-Making. The components of this function include resource commitment for portfolio implementation and portfolio management processes and providing support to project and portfolio managers and empowering them. This function is grounded in the Strategy & Decision-Making literature, which argues that involving top management in decision-making improves firm performance (e.g. Papadakis et al., 1998). Particular to the portfolio management domain, a number of studies have argued that top management support and involvement is a factor of portfolio management performance (e.g. Criscuolo et al., 2017; Talke et al., 2010; Hermano & Martin-Cruz, 2016).

The rationale behind this is that the risk profile of top management determines the balance between incremental and radical projects in a portfolio, which is one of the dimensions of portfolio management performance. Moreover, top management has been identified as a critical success factor for project success (Fortune & White, 2006), because of their capacity to allocate adequate resources to projects and promoting conditions for project success (e.g. Staehr, 2010). Along the above lines of argument, *Result II posits that formalisation of Top Management Functions in portfolio management will have impact on portfolio management performance.*

Project Management Functions: refers to the stakeholders who are responsible for facilitating portfolio decisions by providing enabling information about projects and the portfolio. This function includes components such as providing project management support to project teams, managing project and portfolio data and facilitating cross-project collaboration and learning. This function can be linked to constructs such as project management formalisation (e.g. Cooper et al., 2001; Teller et al., 2012) and portfolio management office (e.g. Unger et al., 2012) which have implications for portfolio management performance.

The rationale behind this is that formal project management mechanisms enables systematic portfolio decision-making by providing comparable information to make informed decisions, which influences project and portfolio success. Further, coordination between different projects by a centralised unit such as project or portfolio management office improves resource allocation quality (Jonas et al., 2013) by diffusing tensions, power struggles and bottlenecks in resource allocation, which could eventually influence project performance. Along the above lines of argument, *Result II posits that formalisation of Project Management Functions in portfolio management will have impact on portfolio management performance.*

The third key implication of Result II is discussed below:

- *Result II explicates the linkages between portfolio management processes and with the stakeholder functions. However, these linkages are indicative only.*

Linkages between portfolio management processes: Result I suggested that there is a linear sequence between the portfolio management processes, starting from Ecosystem Surveillance to New Product Management. Result II not only found further evidence supporting this linear sequence but also revealed the link from New Product Management to Business Case Management, as indicated in Figure 5.15.

The essence of this link is that as project execution advances with time or enters different Stage-Gate phases, the project assumptions and numbers in the business case need to be updated. This link supports other portfolio management models proposed in the extant literature (see Section 2.2). For example, in Cooper's PITS model (see Table 2.4), this link exemplifies a constant interaction between Portfolio Management and New Product Process. Similarly, it also exemplified the link between project development and individual project analysis phases in the portfolio management process model developed by Archer & Ghasemzadeh (1999) – see Table 2.4. However, it should be noted that this research does not claim that this overall sequential linkage will be universal across portfolio management in different firms across industries. The sequential linkage in Result II is indicative only as the portfolio management processes have to be adapted to the context of organisational aspects such as its structures and other business processes and may include feedback loops and iterations.

Linkages between portfolio management processes and stakeholder functions: Result II also indicated the linkages between stakeholder functions and portfolio management processes. Corporate Functions are primarily involved in Ecosystem Surveillance (e.g. joint customer visit by Marketing and R&D to gather customer pain points), Portfolio Strategy Development (e.g. to align functional strategy such as manufacturing strategy with portfolio strategy) and Business Case Management (e.g. for cross-functional assessment of business case as the assessment involves cross-functional criteria). Top Management Functions are involved in Portfolio Strategy Development and Portfolio Decision-Making (as senior management is responsible for defining strategy gaols and making strategy decision). Project Management Functions are involved in Business Case Management (e.g. for coordinating with project managers to collect business cases), Portfolio Decision-Making (e.g. for filtering project and portfolio data and providing pre-read for decision-making, highlighting project issues) and New Product Management (e.g. providing support in project planning and execution).

These findings of Result II fill the gap of the disconnect between relevant stakeholders and portfolio management processes in other portfolio management models proposed in the extant literature. For example, the Strategy Development phase in Archer & Ghasemzadeh framework (1990) and Portfolio Planning phase in the Patterson's framework (2005) could be driven by the Corporate Functions and Top Management Functions. Similarly, the phases from Pre-Screening to Project Development in Archer and Ghasemzadeh's framework could be driven by the Corporate Functions and Project Management Functions.
Overall, Result II led to the three key theoretical implications as discussed above. The next section will discuss the managerial implications of Result II

5.6.2 Managerial Implications of Result II

Result II has two key managerial implications in addition to Result I.

- Firstly, managers can use Result II as a diagnostic intervention or aid (e.g. as a checklist) to improve overall portfolio management performance in their companies. The portfolio management processes, their sub-processes and components and stakeholder functions provide and appropriate level of information to diagnose an existing portfolio management system in a company, to identify areas for improvement and associated actions. The scores on the completeness and quality of the framework V.4 (Result II) clearly suggest that a large number of industrial practitioners found that it useful to derive insights for improving portfolio management processes in their companies (see Section 5.4 and 5.5). Moreover, managers could use Result II to narrow down their attention or focus only on particular portfolio management processes which have implications for portfolio management performance.

- Secondly, the managers can use the comprehensive set of portfolio management practices presented in Section 5.3 to operationalise or formalise portfolio management processes and stakeholder functions in their companies.

Overall, managers should understand that formalising an NPD process is not a sufficient condition for superior firm performance, a number of portfolio management processes and stakeholder functions have to be formalised in parallel.

5.6.3 Limitations of Result II

Result II has some limitations, as follows:

- The insights from developing Result II were derived from a large number of companies operating in wide range of industrial sectors (see methodology of Stage I, II and III in Sections 5.3, 5.4 and 5.5). Although, Result II has a certain degree of generalisation in terms of portfolio management processes and their practices, it does not reveal industry specific nuances of portfolio management processes and their underpinning practices (as compared to a few studies in the extant literature, e.g. Wheelwright & Clark, 1992).

- Second limitation is the boundary conditions of Result II in terms of its applicability and consistency, as Result II is primarily developed based on portfolio management practices in private sector companies, and there is a possibility that some of the aspects of Result II might not be valid for public sector and other non-commercial organisations (as indicated in Sections 5.3 and 5.4).

- Result II does not reveal contingency factors of degree of portfolio management formalisation, as it might not be necessary to fully formalise each part of Result II to build a viable or optimal portfolio management system for a company. This is because the portfolio management system must be adapted or configured according to the context of company's structure and other business processes.

- Although Result II does reveal sequential dependency between portfolio management processes, but it does not reveal variable inter- dependencies between them (which is covered in Chapter 6). Moreover, the practical utility of Result II is indicated in 5.6.2 but it still lacks proper process and structure to be effectively deployed as diagnostic aid for improving portfolio management in a company. This limitation is addressed in Chapter 7.

Overall, Section 5.6 has discussed theoretical and managerial implications and limitations of Result II. The next section will present a summary of this chapter.

5.7 Summary of Result II

This chapter addressed one of the research sub-questions of this research (see Section 3.1), *how may key portfolio management be formalised*. Result I (i.e. the framework V.1) was used as a basis for the development of Result II (i.e. framework V.4). The overall derivation of Result II was divided into three stages. Using framework V.1 for conducting nine in-depth case studies on portfolio management in technology-intensive firms, Stage I resulted in the development of framework V.2. With an objective to refine framework V.2, a total of 17 stand-alone interviews with academic and industrial practitioners and a 10^{th} in-depth case study was carried out in Stage II, which resulted into the development of framework V.3. Additionally, a focus group with industrial practitioners was conducted to verify framework V.3. As a result, Stage III resulted in the development of framework V.4 (i.e. Result II), which is considered to be reasonably stable based on feedback in all three Stages (see Figure 5.34).

The Portfolio Management Process Framework V.4 reveals sub-processes, components and their practices for five key portfolio management processes and three stakeholder functions.

- The Ecosystem Surveillance process was divided into two sub-process: Information Gathering and Business Requirement Identification.
- The Portfolio Strategy Development process was divided into three sub-processes: Strategy Translation, Portfolio Analysis and New Project Opportunity Identification.
- The Business Case Management process was divided into two sub-processes: Business Case Preparation and Business Case Assessment.
- The Portfolio Decision-Making process was divided into three sub-processes: Pre-Alignment Meeting, Decision-Making and Performance Checks.
- The New Product Management process was divided into three sub-processes: Resource Allocation, Stage-Gate Management and Post-Launch Tracking.
- Three relevant portfolio management stakeholder functions have been identified: Corporate functions, Top Management Functions and Project Management Functions.

The theoretical implication of Result I is that it expands the process construct by revealing the above sub-processes of the key processes and introduces three portfolio management stakeholder functions to the construct of portfolio management formalisation, which has implications for portfolio management performance (see Section 5.6.1). Moreover, Result II also suggests sequential linkages between portfolio management processes and stakeholder functions, therefore filling the gap of a disconnect between portfolio management processes and stakeholders in other frameworks in the literature. The managerial implication of Result II is that it can be used as a diagnostic aid to improve portfolio management processes and the management practices underpinning Result II could be used to formalise portfolio management processes.

The limitations of Result II include a lack of insights about industry specific portfolio management practices and potentially limited consistency with portfolio management in the public sector companies. However, other limitations such as a lack of understanding about variable dependencies between portfolio management processes and a lack of process and structure to effectively deploy Result II as a diagnostic aid in a company are addressed in Chapters 6 and 7 respectively.

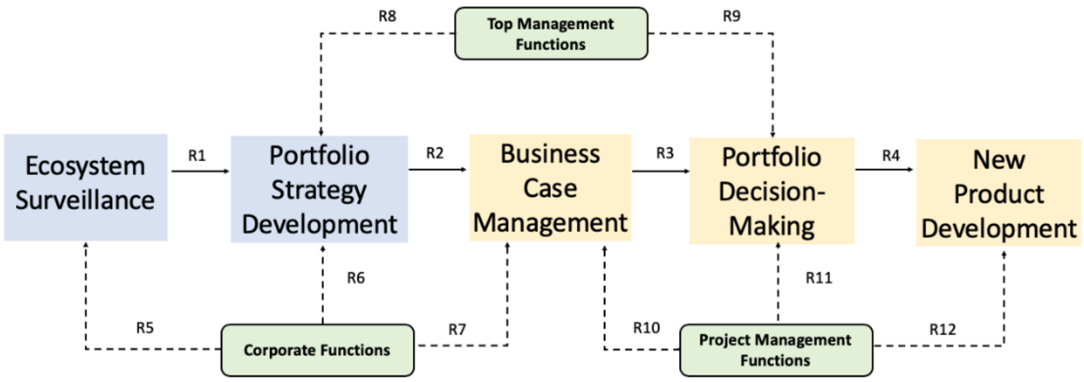
CHAPTER 6 RESULT III: INTEGRATION OF PORTFOLIO MANAGEMENT PROCESSES

This chapter introduces the background to Result III in terms of relevant knowledge gap addressed, basis and methodology associated with its derivation. It then presents Result III, which is the framework integrating key portfolio management processes and stakeholders. Then the theoretical and managerial implications of Result III are discussed, followed by a summary of the chapter.

Contents

6.1 Introduction to Result III

The purpose of this chapter is to present and discuss Result III, which is the framework exploring and describing interrelationships (as R1-R12) between key portfolio management processes and their stakeholders (see Figure 6.1). The primary relationships (R1-R4) here are referred to the relationships between portfolio management processes only whereas the secondary relationships (R5-R12) are the relationships between portfolio management processes and stakeholder functions. Section 6.2 outlines the background to Result III, with the framework and its components presented in more detail in Section 6.3.



R1	*Ecosystem Surveillance positively impacts Portfolio Strategy Development*	Primary Relationships
R2	*Portfolio Strategy Development positively impacts Business Case Management*	
R3	*Business Case Management positively impacts Portfolio Decision-Making*	
R4	*Portfolio Decision-Making positively impacts New Product Management*	
R5	*Corporate Functions positively impacts Ecosystem Surveillance*	Secondary Relationships
R6	*Corporate Functions positively impacts Portfolio Strategy Development*	
R7	*Corporate Functions positively impacts Business Case Management*	
R8	*Top Management Functions positively impacts Portfolio Strategy Development*	
R9	*Top Management Functions positively impacts Portfolio Decision-Making*	
R10	*Project Management Functions positively impacts Business Case Management*	
R11	*Project Management Functions positively impacts Portfolio Decision-Making*	
R12	*Project Management Functions positively impacts New Product Management*	

Figure 6.1: Result III (Portfolio Management Process Framework V.5)

Then theoretical and managerial implications of Result III are provided in Section 6.4, followed by a summary in Section 6.5. As mentioned in Result I, there could be two types of relationships between the key portfolio management processes and stakeholder functions: sequential or variable (see Section 4.4). Result II indicates the sequential relationships between these processes and functions (see Sections 5.2 and 5.6). Whereas, building upon Result II, Result III describes the variable dependencies between these process and functions. Particularly, Result III explores how the variability (in terms of strength) in one of the constructs of Result II could impact its other construct(s). In other words, for example, what might the impact of increasing the strength of Ecosystem Surveillance be on other processes such as Portfolio Strategy Development. To answer these types of questions, Result III explores 12 relationships as outlined in Figure 6.1. R1-R4 are emphasised more as compared to R5-R12 as they explore inter-relationships between portfolio management processes, which is the prime focus of this PhD.

6.2 Background to Result III

The section provides the background to Result III in three parts: (1) relevant knowledge gap addressed by Result III; (2) basis used for the derivation of Result III; and (3) methodology, which includes data collection and analysis methods used, leading to Result III.

6.2.1 Knowledge gap addressed by Result III

As discussed in Section 2.5, there exist three knowledge gaps with respect to process design for portfolio management (i.e. formalisation, integration and evolution of portfolio management processes). Among these three gaps (as mentioned in Section 3.2), this chapter is concerned with the second, which is the *lack of understanding about interrelationships between portfolio management processes.*

Before further discussion, a brief recap of the need to fix this gap is provided. The extant literature has suggested that integration of portfolio management processes and stakeholders has a positive impact on portfolio management performance (e.g. Meskendahl, 2010; Jonas et al., 2013; Floricel & Ibanescu, 2008), however failed to investigate how these processes and stakeholders could be integrated, with a lack of associated practical guidance. To address this gap, Result II has already indicated one way to enable integration, in terms of connecting the key portfolio management processes in a sequence, with linkages between these processes and relevant stakeholder functions.

However, another way to support integration could be to exploit variable dependencies between these processes and stakeholder functions. Exploring such dependencies could potentially reveal guidance or insights on how these processes could be synergised. Therefore, providing a practical aid to integrate portfolio management processes and stakeholders could be useful to firms striving to improve their portfolio management performance. Therefore, the research sub-question (as mentioned in Section 3.2) addressed here is:

How may key portfolio management processes be integrated?

6.2.2 Basis used for derivation of Result III

The basis used for answering the above research sub-question is Result II. This is because Result II has already revealed the key portfolio management processes and stakeholders (see Chapter-5) that could be integrated. Moreover, these processes and stakeholders have implications for portfolio management performance as well (see Section 5.6). This means that using Result II will imply that the focus of the integration will remain on the relevant and critical (in terms of performance) parts of the overall portfolio management system rather than its non-critical parts.

6.2.3 Methodology of Result III

Since Result III is based on Result II, the methodological derivation of the constructs of Result III remain same as those of Result II. As can be observed in Figure 6.1, Result III extends Result II by conceptually developing and exploring relationships describing dependencies between the key portfolio management processes and stakeholder functions. The following section will discuss the relationships underpinning Result III in more detail.

6.3 Result III: Portfolio Management Process Framework V.5

This section presents exploratory relationships describing variable dependencies between the above-mentioned constructs of Result III, which are portfolio management processes and stakeholder functions. The inter-relationships are explored by connecting the sub-processes and components of these processes and functions (see Chapter-5). Firstly, the primary relationships are described, followed by the secondary relationships (see Figure 6.1)

R1: Ecosystem Surveillance positively impacts Portfolio Strategy Development

- The essence of *Strategy Translation* is to determine portfolio strategy by developing roadmaps, identifying strategic priorities and product strategy; and is related with *Information Gathering and Business Requirement Identification* processes. This is because the information needed to develop roadmaps and product strategy plans makes use of information about the ecosystem of an organisation, such as market and technology information. For example, the layers of roadmapping architecture suggested by Phaal et al. (2001) for strategic planning includes a 'Market' layer, and the quality of inputs for that layer depends on the quality of market awareness and insights.

- The essence of *Portfolio Analysis* is to critically analyse a portfolio (often using visuals such as bubble charts and roadmaps) to derive strategic insights or identify strategic gaps in a portfolio; and is related with the sub-processes of Ecosystem Surveillance. This is because, portfolio information represented in visuals could be better interpreted if managers have better knowledge of the ecosystem associated with their company. For example, for the risk vs reward bubble matrix (Cooper et al., 2001), the interpretation of risk and reward corresponds to market risk and potential sales, which in turn depends on the quality of their estimates derived on the basis of market insights.

- The essence of *New Project Opportunity Identification* is to identify new project opportunities to implement strategy or fix strategic gaps and is related with the Ecosystem Surveillance. This is because, if firms proactively identify the micro or macro trends (e.g. digitalisation) in its ecosystem, they could be able to proactively and deliberately pursue new product development projects to gain time and cost advantages or decide the orientation of their ideation strategy. Moreover, in that case, new project ideas would be improved if firm is better aware of market trends, customer needs and the nature of the competition.

Building on the above points, *Result III strengthens the argument for the relationship between Ecosystem Surveillance and Portfolio Strategy Development, and posits that Ecosystem Surveillance positively impacts Portfolio Strategy Development.*

R2: Portfolio Strategy Development positively impacts Business Case Management

- The essence of *Business Case Preparation* is to design business cases for both new and existing projects as clearly, consistently and robustly as possible; and is related with the sub-processes of Portfolio Strategy Development. This is because, for example, if employees are better aware of portfolio strategy and priorities, it is more likely that they will propose projects which are aligned with the portfolio strategy and feel more committed and motivated to develop business cases, eventually leading to better quality business cases.

- The essence of *Business Case Assessment* is to evaluate merits and disadvantages of individual business cases, and as a portfolio; and is related with the sub-processes of the Portfolio Strategy Development. This is because, for example, if managers are better aware of strategic plans and priorities, the strategic fit of business cases can be determined in a more rational and transparent manner. This can be achieved by mapping business cases on roadmaps or categorising them according to strategic priorities.

Building on the above points, *Result III strengthens the argument for the relationship between Portfolio Strategy Development and Business Case Management, and posits that Portfolio Strategy Development positively impacts Business Case Management.*

R3: Business Case Management positively impacts Portfolio Decision-Making

- The essence of *Pre-Alignment Meeting* is to frame and understand portfolio decisions and their characteristics such as decision familiarity, magnitude of impact, opportunity or crisis; and is related with the sub-processes of Business Case Management. This is because, for example, if business cases are better understood in terms of their merits and disadvantages, the portfolio decision can be more rationally and transparently framed and understood, eventually impacting the quality of overall portfolio decision-making process.

- The essence of *Decision-Making* is to undertake and communicate portfolio decisions such as project selection or termination or hibernation; and is related with the sub-processes of Business Case Management. This is because, for example, portfolio decisions consider information provided in business cases. If business cases are properly designed and assessed, it would be easier to differentiate between 'good' and 'bad' projects, which would increase the quality of selection or termination decisions by being more rational, objective and traceable. For instance, it would be rational to select a project with high strategic fit and high financial impact or terminate a project with low strategic fit and low financial impact. This could be possible when business cases are properly designed, presented and assessed on the basis of strategic and financial criteria.

- The essence of *Portfolio Checks* is to ensure that project and portfolio performance is monitored, and corrective actions such as portfolio risk mitigation are taken; and is related with the sub-processes of Business Case Management. This is because, for example, for monitoring project and portfolio performance, the information provided in the business cases are used and if that information is not defined, available, up-to-date or poorly assessed, the quality of *Performance Checks* will decrease, leading to poor project and portfolio performance. For example, if the risks in a highly complex and innovative new product project are not defined and monitored, the likelihood of that project going over budget or being delayed would increase.

Building on the above points, *Result III strengthens the argument for the relationship between Business Case Management and Portfolio Decision-Making, and posits that Business Case Management positively impacts Portfolio Decision-Making.*

R4: Portfolio Decision-Making positively impacts New Product Management

- The essence of *Resource Allocation* is to effectively and efficiently allocate resources between projects in line with strategic priorities; and is related with the sub-processes of Portfolio Decision-Making. This is because, for example, project priorities which are determined in *Decision-Making* serve as one of the bases for resource allocation. This means, if priorities are clearly determined and communicated, the resource allocation process would become more transparent and objective.

- The essence of *Stage-Gate Management* is to execute projects in a Stage-Gate process according to their type or characteristics; and is related with the sub-processes of Portfolio Decision-Making. This is because, for example, the quality of project execution depends on the quality of resource allocated to that project, which in turn depends on its priority as determined in *Decision-Making.* Moreover, the quality of Stage-Gate governance could be improved if project performance is properly monitored.

- The essence of *Post-Launch Tracking* is to monitor the success ratio of sales in business cases and take corrective actions such as by improving sales of existing products; and is related with the sub-processes of Portfolio Decision-Making. This is because, for example, framing decisions on an existing product as an opportunity or crisis in the *Pre-Alignment Meeting* has implications in terms of whether product sales should be expanded (e.g. by expanding the product into new market or changing its features), or if the product should be removed from a market. Moreover, if project performance is monitored properly (e.g. in timely manner) in the *Performance Checks,* the likelihood to achieve the objectives of *Post-Launch Tracking* could be increased.

Building on the above points, *Result III* strengthens *the argument for the relationship between Portfolio Decision-Making and New Product Management, and posits that Portfolio Decision-Making positively impacts New Product Management*

R5: Corporate Functions positively impacts Ecosystem Surveillance

Result II posits that there is a relationship between Corporate Functions and Ecosystem Surveillance. The quality of *Information Gathering and Business Requirement Identification* could be related with the degree of integration of different Corporate Functions (such as Finance, Marketing). For example, more types and better information (e.g. customer needs) could be gathered effectively and efficiently if R&D and Marketing experts jointly visit customer sites. Similarly, the trends in an ecosystem of a company can be spotted early on if these functions jointly share and analyse their respective functional information. Therefore, Result III posits that *Corporate Functions positively impacts Ecosystem Surveillance.*

R6: Corporate Functions positively impacts Portfolio Strategy Development

Result II posits that there is a relationship between Corporate Functions and Portfolio Strategy Development. The quality of *Strategy Translation, Portfolio Analysis and New Project Opportunity Identification* can be related with the degree of inter-functional integration. For example, co-development of strategy and technology roadmaps facilitates better alignment of individual functional strategies (e.g. manufacturing strategy) because of the inputs of functional leaders. Similarly, portfolio information embedded into portfolio visuals could be more critically analysed in cross-functional team. Moreover, the number and quality of new project ideas could be improved with inter-functional integration. Therefore, Result III posits that *Corporate Functions positively impacts Portfolio Strategy Development.*

R7: Corporate Functions positively impacts Business Case Management

Result II posits that there is a relationship between Corporate Functions and Business Case Management. The quality of *Business Case Preparation and Business Case Assessment* is related with degree of inter-functional integration. For example, the quality of business case design could be improved with cross-functional responsibilities, as better collaboration between these functions would lead to more accurate and up-to-date information in business cases. Similarly, estimation of a project's merits and disadvantages could be made more transparent and objective if inter-functional teams assess the business cases. This is because, project business cases are assessed on the basis of multi-functional criteria, and if the assessment of the business cases is carried out in inter-functional teams, better validation of the functional fit (e.g. market fit, technical fit) of the business cases could be achieved. Therefore, Result III posits that *Corporate Functions positively impacts Business Case Management.*

R8: Top Management Functions positively impacts Portfolio Strategy Development

Result II posits that there is a relationship between Top Management Functions and Portfolio Strategy Development. The quality of Portfolio Strategy Development is related with the degree of involvement of top management (e.g. in terms of their attention, time and diversity). For example, according to Talke et al. (2010), more diverse top management teams lead to clearer portfolio strategies. This is because diversity in top management teams facilitates the development of clear portfolio strategy priorities by specifying and establishing innovation priorities. Moreover, better quality of strategic insights could be derived from portfolio visuals with the involvement of top management, as they have more understanding of the overall company strategy and commitments. Similarly, top management involvement would lead to more strategically aligned new project ideas. Therefore, Result III posits that *Top Management Functions positively impacts Portfolio Strategy Development.*

R9: Top Management Functions positively impacts Portfolio Decision-Making

Result II posits that there is a relationship between Top Management Functions and Portfolio Decision-Making. The quality of Portfolio Decision-Making is related with degree of involvement of top management. For example, top management team characteristics such as their risk propensity and need for achievement influences the framing of portfolio decisions and the decision-making processes (e.g. Papadakis et al., 1998). Moreover, portfolio performance, such as its strategic alignment, could be improved with top management involvement, given their level of understanding of the overall company strategy and commitments, enabling strategic alignment. Therefore, Result III posits that *Top Management Functions positively impacts Portfolio Decision-Making.*

R10: Project Management Functions positively impacts Business Case Management

Result II posits that there is a relationship between Project Management Functions and Business Case Management. The quality of Business Case Management can be related with Project Management Functions. For example, if project managers are given proper guidance and support in terms how to plan projects, how and what information needs to be filled in the business cases, the overall quality of business cases can be improved. Moreover, the better the coordination between project managers and project management functional units, the more timely and reliable information will be in business cases. As a result, the assessment quality of business cases would improve, as quality information in business cases would reduce the time and effort spent in assessing them. Therefore, Result III posits that *Project Management Functions positively impacts Business Case Management.*

R11: Project Management Functions positively impacts Portfolio Decision-Making

Result II posits that there is a relationship between Project Management Functions and Portfolio Decision-Making. The quality of Portfolio Decision-Making is related with the degree of support provided by the Project Management Functional unit. For example, top management attention and time could be optimally used in *Pre-Alignment Meeting* if the background work of business case assessment is carried out well by this unit. Similarly, decision-quality is positively associated with the quality of portfolio visuals (Killen et al., 2012), which are developed by this unit as well. Moreover, project management functions facilitate portfolio decisions by highlighting key issues in project and portfolio and pointing to learning from previous projects during decision-making. As a result, more informed portfolio decisions could be taken. Therefore, Result III posits that *Project Management Functions positively impacts Portfolio Decision-Making.*

R12: Project Management Functions positively impacts New Product Management

Result II posits that there is a relationship between Project Management Functions and New Product Management. The quality of New Product Management is related with the degree of support provided by the Project Management Functions. This is because, for example, the quality of resource allocation is impacted by how resource allocation requests and conflicts are managed by this unit in general. Moreover, project management functions promote transparency in resource allocation by tracking the different types of resources, and also prevent the projects suffering from non-availability of resources, which eventually impacts its overall execution. Therefore, Result III posits that *Project Management Functions positively impacts New Product Management.*

6.4 Discussion of Result III

This section discusses theoretical and managerial implications of Result III, followed by its limitations.

6.4.1 Theoretical Implications of Result III

Result III has five key theoretical implications:

- Result III proposes the integration of portfolio management stakeholders and processes, corroborating and expanding on the findings of Meskendahl (2010), which indicated that integration of portfolio management stakeholders and processes can improve overall portfolio management performance. Result III elucidates this finding by revealing how three stakeholder functions are variably related with five key portfolio management processes, while both functions and processes having implications for the performance as well (see Result II in Section 5.6). For instance, Result III proposes the integration of Corporate Functions (as one of the stakeholder functions) with Ecosystem Surveillance, Portfolio Strategy Development and Business Case Management as key portfolio management processes.

- Result III proposes the integration of portfolio management processes, extending the findings of Archer and Ghasemzadeh (1999), which made the case for integration of the portfolio management processes, but only exploring variable correspondence (referring to the integration of data structures underpinning the different processes) rather than dependencies. Result III explores and identifies dependencies between the processes, by explaining how variability (in terms of strength) in one process influences the other process(s). For example, Ecosystem Surveillance can be positively correlated with Portfolio Strategy Development, which means, if the quality of ecosystem surveillance is improved, the quality of Portfolio Strategy Development would be improved. The extant literature has consistently ignored this dependency aspect of process integration in overall portfolio management.

- Result III expands on the finding of Biedenbach and Muller (2012), which stated that a firm's ACAP (Input) has a positive relationship with its portfolio management performance (Output). Result II has already corroborated this relationship by indicating that the process of Ecosystem Surveillance (which is related with the ACAP of a firm) have implications for the performance (see Section 5.6). However, this relationship is based on 'Input-Output' logic and ignores the entities (e.g. processes) mediating this relationship. Using an 'Input-Process-Output' logic, Result III further extends this relationship by revealing the processes that mediate the relationship between a firm's ACAP and portfolio management performance (Biedenbach and Muller, 2012). This indicates that the other four key portfolio management processes mediate this relationship: Portfolio Strategy Development, Business Case Management, Portfolio Decision-Making and New Product Management.

- Similarly, Result III expands on the finding of Kang and Montoya (2014), which stated that a firm's Portfolio Strategy (Input) has a positive relationship with portfolio management performance (Output). Result II has already corroborated this relationship as well (see Section 5.7). Result III further extends this relationship by revealing the processes mediating the relationship between a firm's portfolio strategy and portfolio management performance (Kang and Montoya, 2014). This indicates that the other three key portfolio management processes mediate this relationship: Business Case Management, Portfolio Decision-Making and New Product Management.

- Result III expands on the finding of Kopmann et al. (2015), which stated that Business Case Control (Input) has a positive relationship with portfolio management performance (Output). Result II has already corroborated this relationship (see Section 5.7). Result III further extends this relationship by revealing the processes mediating the relationship between business case control and portfolio management performance (Kopmann et al., 2015). This indicates that the other two key portfolio management processes mediate this relationship: Portfolio Decision-Making and New Product Development.

- Result III expands on the findings of Kester et al. (2011, 2014), which stated that Portfolio Decision-Making (Input) has a relationship with portfolio management performance (Output). Result II has already corroborated this relationship by indicating that the process of Portfolio Decision-Making has implications for portfolio performance as well (see Section 5.7). Result III further extends this relationship by revealing the process mediating the relationship between Portfolio Decision-Making and the performance (Kester et al., 2011, 2014). This indicates that the New Product Management process mediates this relationship.

6.4.2 Managerial Implications of Result III

Result III has two key managerial implications:

- Managers can use Result III as a meta-level diagnostic for portfolio management performance. They should understand that merely following task-performance relationships (e.g. Portfolio Strategy Development leads to portfolio management performance) is not sufficient enough to improve the overall portfolio management. They should also pay attention to the processes (e.g. Business Case Management) that are mediating these types of relationships to improve the portfolio management holistically and exploit synergies by integrating the portfolio management processes.

- Managers should understand that integration of portfolio management stakeholders and processes could result in better design and implementation of the overall portfolio management. They could exploit and operationalise the relationships underpinning Result III, for example, to improve Portfolio Strategy Development, the quality of inputs from Corporate Functions and Top Management Functions needs to be improved.

6.4.3 Limitations of Result III

Result III have two key limitations:

- Although the constructs of Result III are based on comprehensive empirical data (see Sections 5.3,5.4 and 5.5), the exploratory relationships linking these constructs are more conceptual and exploratory in nature and lack quantitative empirical evidence. This research suggests future research to explore and test these relationships using large scale, cross-industry quantitative surveys with relevant portfolio management stakeholders.

- Since Result III is based on Result II (including its constructs and their relationships), Result III has a similar limitation to Result II, of a lack of a structured process to deploy it as a diagnostic aid in practice. This means testing the practical utility of Result II would have implications for the utility of Result III as well. This limitation is addressed in Chapter-7.

6.5 Summary of Result III

This chapter addressed one of the research sub-questions of this research (see Section 3.1), which is *How may key portfolio management processes be integrated*. Result II was used as a basis for the development of Result III (i.e. Portfolio Management Process Framework V.5). The overall derivation of Result III can be divided into two parts. The first part is the development of constructs of Result III, which is based on empirical data underpinning Result II (see Sections 5.3,5.4 and 5.5). The second part is the exploratory relationships establishing the dependencies between these constructs, which have been developed conceptually. Result III and underpinning relationships are is shown in Figure 6.1.

The theoretical implication of Result III is that it corroborates and expands on previous research findings related to the integration of portfolio management processes and stakeholders (e.g. Meskendahl, 2010; Archer and Ghasemzadeh, 1999). It also expanded on the portfolio management task-performance relationships identified in the extant literature (e.g. Kopmann et al., 2015) by revealing the processes that mediates these relationships. The managerial implication of Result III is that managers could use it as meta-level diagnostic while keeping their attention and focus on the aspects which are critical for portfolio management performance. The limitations of Result III include a lack of quantitative empirical evidences supporting the underpinning exploratory relationships linking its constructs. Result III is based on Result II, which lacks a structured process to deploy it as a diagnostic aid in practice. This limitation is addressed in the following Chapter 7, which describes the development of a structured process to test the practical utility of Result II, which has implications for Result III as well.

CHAPTER 7 RESULT IV: ASSESSMENT OF PORTFOLIO MANAGEMENT PROCESSES

This chapter describes Result IV, which is the diagnostic tool for assessment of portfolio management processes and underpinning management practices. It first introduces the background to Result IV in terms of relevant knowledge gap addressed, basis and methodology associated with its development and application. It then presents findings from the pilot studies of Result IV. Then the theoretical and managerial implications of Result IV are discussed, followed by a summary of the chapter.

Contents

7.1 Introduction to Result IV

The purpose of this chapter is to present and discuss Result IV (see Figure 7.1), which is the diagnostic tool (and its deployment processes shown in Table 7.2) for assessing portfolio management processes and underpinning management practices. Section 7.2 outlines the background and methodology of Result IV, with findings from pilot studies presented in Section 7.3. Then theoretical and managerial implications of Result IV are provided in Section 7.4, followed by a summary in Section 7.5.

As described in Section 5.6, Result II sets out a framework describing key portfolio management processes and associated stakeholder functions that can be used as a diagnostic aid to improve formalisation of portfolio management processes. This led to the need to further explore how it can be deployed in practice. Such demonstration of practical utility of Result II strengthens the validity of the constructs of Result III, as Result III was based on Result II (see Sections 6.2 and 6.4).

Considering these aims, Result IV developed a diagnostic tool for assessing portfolio management practices as well as a structured process to deploy that tool in practice. As shown in Figure 7.1, Result IV is a template-based diagnostic tool, which involves scoring portfolio management practices (underpinning Result II) against a certain criterion by relevant portfolio management stakeholders. A three-stage structured process to facilitate the deployment of this tool in practice was developed (as shown in Table 7.2).

7.2 Background to Result IV

The section provides the background to Result IV in three parts: (1) relevant knowledge gap addressed by Result IV; (2) basis used for the derivation of Result IV; and (3) methodology, which includes development and application steps of Result IV.

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Assessment of Portfolio Management Practices

A. Ecosystem Awareness
A1. Invest resources for market and customer investigations (e.g. funds, personnel)
A2. Identify market and social trends across different geographical regions
A3. Investigate new technologies and review Intellectual Property (internally and externally)
A4. Scan for opportunities for Merger & Acquisition (e.g. set-up incubators)
A5. Gather competition insights from commercial ends (e.g. from sales, suppliers, distributors)
A6. Monitor existing products in market and identify life cycle management needs
A7. Analyze & prioritize micro/macro trends to identify business requirements

B. Inter-functional Collaboration
B1. Govern portfolio(s) from different functional perspectives– R&D, Finance, Marketing etc.
B2. Functional and regional experts together conduct business reviews
B3. Corporate functions share project and portfolio level information with each other
B4. Corporate functions together create, maintain, and own technology and business roadmaps

C. Strategic Clarity
C1. Use strategic buckets to guide overall resource allocation
C2. Identify strategic targets based on long term roadmaps (e.g. new product introduction rate, revenue growth)
C3. Set direction and priorities for developing technology platforms and capabilities
C4. Translate business strategy into new product ideas and plans
C5. Use strategy and roadmaps to define new product assessment criteria
C6. Fill strategic gaps in portfolio(s) by identifying new project opportunities across different organizational levels

D. Customer Orientation
D1. Understand customer roadmaps and identify value addition opportunities or unmet needs
D2. Maintain dialogues with customers from early stages of product/technology development
D3. Gather customer feedback on short-long term product plans by doing prototyping or trials using new technologies (e.g. Virtual Reality)

E. Business Case Management Quality
E1. Do due-diligence to gather evidence behind assumptions and numbers in business cases
E2. Ensure accountability & feasibility of business cases from functional perspectives (e.g. by creating functional approvals points in the cases)
E3. Get the information from the business cases that is required for portfolio decision-making (e.g. NPV, strategic impact)
E4. Generate visuals & insights/recommendations based on business case assessment as needed by top management for decision-making
E5. Identify issues while monitoring progress of business cases(e.g. unmet objectives, low sales)

F. Resource Allocation Quality
F1. Get operational clarity (e.g. resource availability) at project as well as portfolio levels
F2. Manage resource allocation requests and conflicts (e.g. by using a resource management process)
F3. Use explicit basis to prioritize or negotiate resource allocations (e.g. roadmaps/criteria)
F4. Create resource allocation plans and assess implications of resource commitments

G. Preparedness for Risk
G1. Identify and manage project level risks (e.g. market, technology, delivery)
G2. Identify and manage portfolio level risks (e.g. over-budget, balance between products' time to market)
G3. Leave slack resources or capacity to handle contingencies

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Assessment of Portfolio Management Practices

H. Project Selection Quality
H1. Assess individual projects from multi-functional perspectives (e.g. technical, strategic criteria etc.)
H2. Use assessment methods and visuals which reveal merits/de-merits of individual projects and portfolio compositions
H3. Perform portfolio checks by categorizing projects from different perspectives (e.g. related to budget, balance, resources)
H4. Understand opportunity cost of projects that are not selected and discuss alternatives (if needed)
H5. Get inputs from top management for final prioritization of projects and resource authorization
H6. Use stage-gate reviews to ensure validity of business cases over time
H7. Identify warning signals for 'pet' projects
H8. Communicate portfolio decisions with further guidance to project applicants

I. Project Termination Quality
I1. Identify internal and external warning signals leading to project termination
I2. Use measures to avoid escalation of commitment in projects (e.g. forward-looking attitude, back-up projects in case of termination)
I3. Involve top management team in termination decisions and communicate the grounds of project termination
I4. Use a set of criteria for project termination (e.g. fundamental limits of technology, strategically irrelevant)
I5. Put projects on hold when warranted and assess implications of termination
I6. Terminate 'bad' projects in early phases of execution (e.g. by using a robust stage-gate process)

J. Learning Orientation
J1. Enact and improve portfolio management process with support from top management team
J2. Audit portfolio management process and introduce changes while considering organizational readiness levels
J3. Capture learnings at stage-gates & create formal learning reports for future references

K. Portfolio Management Structure & Design
K1. Portfolio management team or unit (if exists) provide support to business lines and project managers
K2. Portfolio management process performs the function of balancing demand vs supply of resources
K3. Portfolio management process performs the function of change management (e.g. resource changes)
K4. Portfolio management process manage transition of ideas to businesses holistically
K5. Take portfolio decisions that reflect desired leadership in market and innovation
K6. Use different stage-gate processes according to projects types
K7. Formally manage portfolio data using IT tools and applications
K8. Use learning from previous projects during portfolio decision-making events
K9. Use a guide that describes portfolio management activities, roles and responsibilities, project templates etc.
K10. Synchronize portfolio decision-making or reviews with product & industry characteristics (e.g. high-tech product need frequent reviews)

L. Agility
L1. Update portfolio strategy, roadmaps, business cases
L2. Reprioritize projects and resource allocations with changes in internal and external environment (e.g. change in strategic focus)
L3. Communicate project and portfolio updates to top management team
L4. Handle urgencies or new opportunities at project and portfolio levels (e.g. by having extraordinary portfolio decision-making meetings)
L5. Assess sensitivities or implications of changes in portfolio, resource allocations etc.

Figure 7.1: Template-based Portfolio Management Diagnostic Tool

7.2.1 Knowledge gap addressed by Result IV

As discussed in Section 2.5, there exist three knowledge gaps with respect to process design for portfolio management (i.e. formalisation, integration and evolution (i.e. assessment) of portfolio management processes). Among these (as mentioned in Section 3.2), this chapter is concerned with the third knowledge gap, which is the *lack of comprehensive assessment approach for portfolio management processes.*

Before further discussion, a brief recap of the need to fix this gap is provided. The extant literature has suggested that evolution (leading to maturity) of portfolio management processes is associated with portfolio management performance (e.g. Killen et al., 2013; Meskendahl, 2010; Petit, 2010; Floricel & Ibanescu, 2008). However, as described in the Section 2.5, the few existing portfolio diagnostic aids as found in the extant literature (e.g. Kahn et al., 2006) do not comprehensively covers all aspects of portfolio management processes.

To address this gap, either Result II could be directly used to diagnose the portfolio management processes in its current form as an overall process framework (as demonstrated in Section 5.5) or in a form of a diagnostic tool, which involves comprehensive assessment of portfolio management practices underpinning Result II. Result IV is concerned with the latter as the tool would not only lead to the assessment of the processes in a company but also provide a basis for comparison of the portfolio management practices between companies. This is because the tool involves scoring of the practices against certain criteria, and these scores can be further analysed at company, inter-company and industry levels. In this way, Result IV and its findings could be used to provide benefits of benchmarking of overall portfolio management. So, the research sub-question (as mentioned in Section 3.2) addressed here is:

How may key portfolio management processes be assessed?

7.2.2 Basis used for derivation of Result IV

The basis used for answering the above research sub-question is Result II. This is because Result II has already revealed the key portfolio management processes and associated stakeholder functions that could be assessed. Moreover, these processes and stakeholders have implications for portfolio management performance as well (see Section 5.6). This means that using Result II will imply that the focus of the assessment will remain on the relevant and critical (in terms of performance) parts of the overall portfolio management rather than its non-critical parts.

7.2.3 Methodology of Result IV

The methodology of Result IV was divided into two parts: development and application. The development methodology describes how Result IV (i.e. the diagnostic tool) was developed. The application methodology describes how the tool was deployed in practice (in 7 pilot studies), which involved a process with three stages: pre-assessment, assessment and post-assessment.

1. ***Development Methodology of Result IV***

The development methodology included two further steps:

I. Identification of portfolio management practices to be assessed

As mentioned in Section 7.1, Result IV was based on Result II. The management practices underpinning portfolio management processes as outlined in Result II (including Stage I, II and III as described in Sections 5.2, 5.3 and 5.4) were further analysed. Using the grounded analysis method, total of 64 portfolio management practices (categorised into 12 portfolio management factors from A-L and are linked to portfolio management processes and stakeholder functions, see Figure 7.1 and Table 7.1) were identified which could be assessed. The purpose of Table 7.1 is to outline which portfolio management factors are linked to which portfolio management processes and stakeholder functions. E.g. in case a company finds out that Preparedness for Risk factor is a key issue in their overall portfolio management as a result of using the diagnostic tool, this would indicate Portfolio Decision-Making and New Product Management processes and associated practices would warrant further review for improvement.

Table 7.1: Portfolio Management Factors and Link with Portfolio Management Processes and Stakeholder Functions

Portfolio Management Factors	**Description**	**Link with Portfolio Management Processes and Stakeholder Functions**

A. Ecosystem Awareness	set of practices related to collection and analysis of information about a firm's ecosystem entities such as market and competitors.	Ecosystem Surveillance
B. Inter-Functional Collaboration	set of practices related to mutual collaboration and coordination between different corporate functions such as Marketing and R&D to drive portfolio management processes.	Corporate Functions
C. Strategic Clarity	set of practices associated with development, communication and steering of portfolio strategy.	Portfolio Strategy Development
D. Customer Orientation	set of practices regarding alignment of projects and portfolio with customer needs.	New Product Management
E. Business Case Management Quality	set of practices related to business case management for supporting portfolio decision-making.	Business Case Management
F. Resource Allocation Quality	set of practices associated with resource allocation to new and existing projects.	New Product Management
G. Preparedness for Risk	set of practices related to management of project and portfolio level risks.	Portfolio Decision-Making, New Product Management
H. Project Selection Quality	set of practices related to project selection or in other words, how well underpinned a project selection procedure are.	Business Case Management, Portfolio Decision-Making
I. Project Termination Quality	set of practices related to project termination or in other words, how well underpinned a project termination procedure is.	Business Case Management, Portfolio Decision-Making
J. Learning Orientation	set of practices related to learning capabilities of a firm at project and portfolio levels.	Top Management Functions, New Product Management

K. Portfolio Management Structure and Design	set of practices related to documentation of portfolio management processes and the mindset with which portfolio management is carried out.	Top Management Functions, Project Management Functions, Portfolio Management Governance Functions
L. Agility	set of practices related to documentation of portfolio management processes and the mindset with which portfolio management is carried out.	Portfolio Strategy Development, Business Case Management and Portfolio Decision-Making

These factors are:

A. ***Ecosystem Awareness*****:** refers to set of practices related to collection and analysis of information about a firm's ecosystem entities such as market and competitors. This factor is related to the process of Ecosystem Surveillance in Result II.

B. ***Inter-functional Collaboration*****:** refers to the set of practices related to mutual collaboration and coordination between different corporate functions such as Marketing and R&D to drive portfolio management processes. This factor is related to Corporate Functions in Result II.

C. ***Strategic Clarity*****:** refers to the set of practices associated with development, communication and steering of portfolio strategy. This factor is related to the process of Portfolio Strategy Development in Result II.

D. ***Customer Orientation*****:** refers to the set of practices regarding alignment of projects and portfolio with customer needs. The factor is related to processes of Portfolio Strategy Development and New Product Management in Result II.

E. ***Business Case Management Quality:*** refers to the set of practices related to business case management for supporting portfolio decision-making. This factor is related to the process of Business Case Management in Result II.

F. ***Resource Allocation Quality:*** refers to the set of practices associated with resource allocation to new and existing projects. This factor is related to the process of New Product Management in Result II.

G. Preparedness for Risk: refers to the set of practices related to management of project and portfolio level risks. This factor is related to the processes of Portfolio Decision-Making and New Product Management in Result II.

H. Project Selection Quality: refers to the set of practices related to project selection or in other words, how well underpinned a project selection procedure are. This factor is related to the processes of Business Case Management and Portfolio Decision-Making in Result II.

I. Project Termination Quality: refers to the set of practices related to project termination or in other words, how well underpinned a project termination procedure is. This factor is related to the process of Business Case Management and Portfolio Decision-Making in Result II.

J. Learning Orientation: refers to the set of practices related to learning capabilities of a firm at project and portfolio levels. This factor is related to the processes of Top Management Functions and New Product Management of Result II.

K. Portfolio Management Structure and Design: refers the set of practices related to documentation of portfolio management processes and the mindset with which portfolio management is carried out. This factor is related to the processes of Top Management Functions, Project Management Functions and Portfolio Management Governance Functions in Result II.

L. Agility: refers to the set of practices related to adaptation of projects and portfolio with respect to changes in internal and external environment. This factor is related to the processes of Portfolio Strategy Development, Business Case Management and Portfolio Decision-Making in Result II.

The following step describes the selection of scoring criteria against which the above portfolio management practices can be assessed.

II. Selection of scoring criteria for assessing portfolio management practices

Note, this research does not aim to use measures for assessing statistical significance and methods regarding the assessment of the above practices with performance, but rather involved descriptive analysis approach as adopted from the scoring method used by Menke (2013). This is because, the scoring technique (as used by Menke, 2013) was already proven to be useful for assessing and generating quality diagnostic insights for portfolio management practices. Therefore, the scoring technique used in this research involved four criteria, with key questions and answer formats:

- **Relevance**: Is this practice relevant for achieving portfolio management objectives? To answer this question, the option is YES or NO.
- **Importance**: How important is this practice for achieving portfolio management objectives? To answer this question, a scale from 0 (low importance) to 100 (high importance) with intervals of 10 points was used.
- **Consistency**: How consistent is this practice in your company? To answer this question, a scale from 0% (Don't use this practice) to 100% (Use this practice every time when appropriate) with intervals of 10 points was used.
- **Execution Quality**: How well does the company execute this practice relative to what is feasible? To answer this question, a scale from 0% (No quality) to 100% (High quality, as high as practically possible) with intervals of 10 points was used.

Following these two steps in the development methodology, a template-based diagnostic tool was developed, which is shown in Table 7.2

2. ***Application Methodology of Result IV***

The application methodology included a process which was used to facilitate the deployment of the diagnostic tool, divided into three stages:

I. **Pre-Assessment Stage**: refers to preparation work such as engaging with a company looking to improve their portfolio management processes, communicating process and anticipated benefits of the diagnostic tool to stakeholders, and determining the scope of portfolio management system to be assessed.

II. **Assessment Stage**: refers to the use of the diagnostic tool in practice, where relevant portfolio management stakeholders fill in their scores against the four assessment criteria while reflecting on state of the portfolio management practices in their companies.

III. **Post-Assessment Stage**: refers to a set of tasks such as analysis of the assessment scores, dissemination of findings at company and cross-company level to scoring participant(s) and identification of improvement actions.

To make the deployment of tool more flexible depending on the level of time commitment and scale of assessment preferred by firms, the three stages of the application methodology were designed to be applied using either a workshop-based or non-workshop-based approach (see Table 7.2).

Table 7:2: Steps in Application Methodology of Result IV

<table>
<tr><th></th><th>WORKSHOP-BASED APPROACH</th><th>NON-WORKSHOP-BASED APPROACH</th></tr>
<tr><td>STAGE I: PRE-ASSESSMENT</td><td colspan="2">

Identify a technology-intensive firm interested in using the diagnostic tool
Discuss the objectives and benefits of using the tool, which are:
1. Reveals which portfolio management are perceived to be performed well
2. Develops a common perception about state of portfolio among different portfolio management stakeholders
3. Comparison of portfolio management practices with other companies
Identify a portfolio and its scope (in terms of corporate or business unit level) of which the management practices would be assessed using the tool
Identify the relevant portfolio management stakeholders (portfolio decision-makers and/or portfolio management coordinators) of the selected portfolio
Discuss the structure of the tool in terms portfolio management practices and criteria and provide scoring guidance (with examples) to the selected stakeholders.

</td></tr>
<tr><td>STAGE II: ASSESSMENT</td><td colspan="2">

Participants do the scoring for each of the portfolio management practice against all four criteria (could be done in group or individually)
Participants send their scores back to the researcher

</td></tr>
<tr><td rowspan="2">STAGE III: POST-ASSESSMENT</td><td colspan="2">

Researcher analyse the scores from all participants by averaging the scores for each practice against importance, consistency and execution quality, and followed by color coding as given follow:

<table>
<tr><th>Average Scores</th><th>Low</th><th>Medium</th><th>High</th></tr>
<tr><td>Importance</td><td>1-4</td><td>5-7</td><td>8-10</td></tr>
<tr><td>Consistency</td><td>0%-40%</td><td>50%-70%</td><td>80%-100%</td></tr>
<tr><td>Execution Quality</td><td>0%-40%</td><td>50%-70%</td><td>80%-100%</td></tr>
</table>
</td></tr>
<tr><td>

A half-day workshop with scoring participants was organised to share the findings and their implications.
The added value of the workshop was the collective identification of actions for improving portfolio management practices with consensus among the stakeholders.
Additionally, it provided an opportunity for the stakeholders to develop a common perception about portfolio management in the company by discussing similarities and differences between each other.

</td><td>

The researcher shared the findings of the assessment score through e-mail to the participant(s).
Further remote support was offered by the researcher if the company was interested in defining improvement actions.

</td></tr>
</table>

After developing the diagnostic tool and the process of its application, 7 pilot studies of the tool were carried out with case firms (which participated in development of Result II) and non-case firms (which did not participate in development of Result II) using both the approaches (see Table 7.2). As mentioned in Section 3.4, the purposive sampling technique was used to identify the firms for pilot studies.

- Pilot studies with case companies were sought and responding case company participants reviewed against the *Relevance* criteria in the assessment template, in order to further test and strengthen the construct validity of Result II (with implications for Result III as well).

- Pilot study with non-case companies was sought to strengthen the external validity of Result II. This is because if non-case companies found the portfolio management practices *relevant,* it would imply that Result II can be generalised outside the context in which it was derived (e.g. industrial sector and company size).

The pilot study using a workshop-based approach was carried out with two non-case and two case companies, with the pilot study using the non-workshop-based approach carried out with one non-case and three case companies. The next section discusses the findings of the pilot studies.

7.3 Result IV: Pilot Studies of Portfolio Management Diagnostic Tool

This section presents findings from the pilot studies aimed at deploying the diagnostic tool in practice and is divided into two sub-sections: Average scores of portfolio management practices (Section 7.3.1) and reflections on the diagnostic tool and its deployment process (Section 7.3.2).

7.3.1 Average Scores of Portfolio Management Practices

This section presents the overall findings of 7 pilot studies (with 7 companies). Each portfolio management practice was considered relevant if more than 4 out of 7 companies responded 'Yes' for each practice against the *Relevance* criteria. Then the rounded off average scores (by all 7 companies) of *Importance, Consistency* and *Execution Quality* for each of the practices is reported in the Table 7.3. Following Menke's (2013) approach, an *actualisation score* was also calculated, which is a product of consistency and execution quality scores. The actualisation score is the measure of effective usage or performance of a portfolio management practice.

Table 7.3: Average Scores of Portfolio Management Practices

AVERAGE SCORES OF PORTFOLIO MANAGEMENT PRACTICES					
	RELEVANCE (Yes or No)	**IMPORTANCE (0-10)**	**CONSISTENCY (0-100%)**	**EXECUTION QUALITY (0-100%)**	**ACTUALISATION SCORE (0-100%)**
A. ECOSYSTEM AWARENESS					
A1	Yes	8.6	64	50	32
A2	Yes	6.9	51	36	18
A3	Yes	8.3	76	60	46
A4	Yes	6.4	51	54	28
A5	Yes	7.9	61	60	37
A6	Yes	6.6	54	63	34
A7	Yes	6.7	47	53	25
B. INTER-FUNCTIONAL COLLABORATION					
B1	Yes	6.9	51	47	24
B2	Yes	6.1	49	41	20
B3	Yes	8.1	64	60	38
B4	Yes	7	41	51	21
C. STRATEGIC CLARITY					
C1	Yes	8.4	70	69	48
C2	Yes	7	53	53	28
C3	Yes	8.9	71	74	53
C4	Yes	8.3	60	71	43
C5	Yes	7.9	60	47	28
C6	Yes	8	57	67	38
D. CUSTOMER ORIENTATION					

D1	Yes	8.6	60	66	40
D2	Yes	8	59	67	40
D3	Yes	8.3	57	63	36
E. BUSINESS CASE MANAGEMENT QUALITY					
E1	Yes	7.7	57	63	36
E2	Yes	7	51	51	26
E3	Yes	8.1	57	57	32
E4	Yes	7.4	66	67	44
E5	Yes	7.3	61	53	32
F. RESOURCE ALLOCATION QUALITY					
F1	Yes	8.3	66	61	40
F2	Yes	8.1	59	50	30
F3	Yes	8.4	64	63	40
F4	Yes	8.6	66	64	42
G. PREPAREDNESS FOR RISK					
G1	Yes	7.9	77	69	53
G2	Yes	7.7	63	59	37
G3	Yes	7.3	39	39	15
H. PROJECT SELECTION QUALITY					
H1	Yes	7.9	79	76	60
H2	Yes	7.7	51	46	23
H3	Yes	7.3	70	61	43
H4	Yes	7.9	54	43	23
H5	Yes	7	64	59	38
H6	Yes	8.7	70	69	48
H7	Yes	7.9	34	44	15
H8	Yes	8.1	79	71	56
I. PROJECT TERMINATION QUALITY					
I1	Yes	7.6	59	64	38
I2	Yes	7.4	59	60	35
I3	Yes	8.3	70	70	49
I4	Yes	7.7	50	61	31
I5	Yes	8.3	64	66	42
I6	Yes	7.7	70	70	49
J. LEARNING ORIENTATION					
J1	Yes	8.3	64	74	47
J2	Yes	7.9	60	64	38
J3	Yes	7.7	53	53	28

K. PORTFOLIO MANAGEMENT STRUCTURE AND DESIGN					
K1	Yes	8.4	67	74	50
K2	Yes	7.7	54	66	36
K3	Yes	7.7	51	61	31
K4	Yes	8.1	63	67	42
K5	Yes	8.3	63	76	48
K6	Yes	6.4	59	59	35
K7	Yes	4.3	33	31	10
K8	Yes	7	56	59	33
K9	Yes	6.1	53	53	28
K10	Yes	6.3	43	50	22
L. AGILITY					
L1	Yes	8.4	71	76	54
L2	Yes	8.4	70	69	48
L3	Yes	8.6	80	84	67
L4	Yes	8.3	71	71	50
L5	Yes	8	64	61	39
INDUSTRY AVERAGE (OF ALL 64 PRACTICES)		**7.7**	**60**	**60**	**37**

As it can be implied from the Table 7.3, all of the portfolio management practices were considered relevant for achieving portfolio management objectives.

Each of the portfolio management factor will be discussed below (as defined in Section 7.2), using a two-way bar graph in which the red coloured bar indicates the importance of the practice and the blue bar indicates the actualisation score.

For the purpose of this discussion, the scale of actualisation has been converted into the same scale as importance. **The black coloured bars imply industry average portfolio management practice score (i.e. average of all 64 practices) for comparison purposes**.

A. Ecosystem Awareness

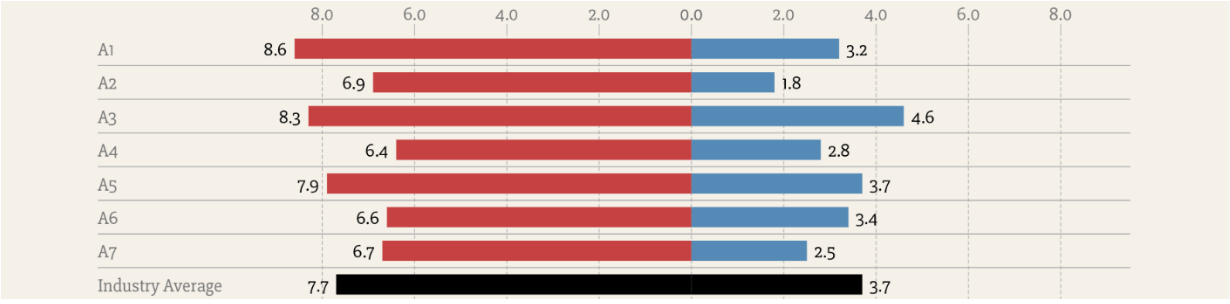

Figure 7.2: Importance vs Actualisation of Ecosystem Awareness

As seen in Figure 7.2, the practices related to ecosystem awareness were considered important (with each scoring more than 6) for achieving portfolio management objectives, with the highest score given to A1 (8.6) and lowest to A4 (6.4). Despite the importance of these practices, the actualisation scores of A1 (3.2), A2 (1.8), A4 (2.8), A6 (3.4) and A7 (2.5) were lower than the industry average. The practices A3 and A5 were perceived to be performed well, with both scoring above industry averages for importance and actualisation. Overall, this implies that ecosystem awareness is an important portfolio management factor and associated practices need to be performed well (given their actualisation scores).

B. Inter-Functional Collaboration

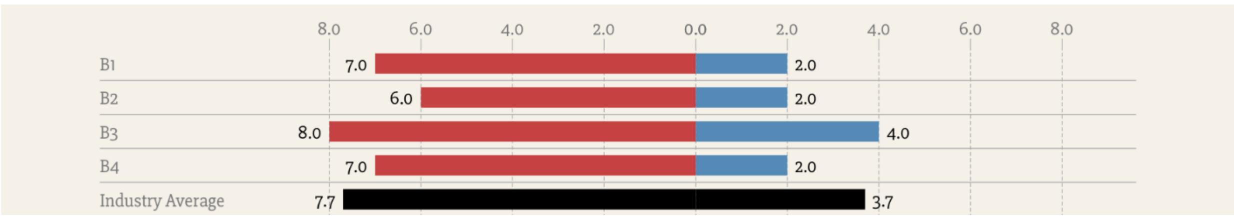

Figure 7.3: Importance vs Actualisation of Inter-Functional Collaboration

As seen in Figure 7.3, the practices related to inter-functional collaboration were considered important (with each scoring more than or equal to 6) for achieving portfolio management objectives, with highest score given to B2 (8.0) and lowest to B2 (6.0). The actualisation scores of B1, B2, B3 (each scoring 2.0) were lower than the industry average. Whereas, B3 was perceived to be performing well with both scores above industry averages for importance and actualisation. Overall, this implies that inter-functional collaboration is an important portfolio management factor and associated practices need to be performing well (given their actualisation scores).

C. Strategic Clarity

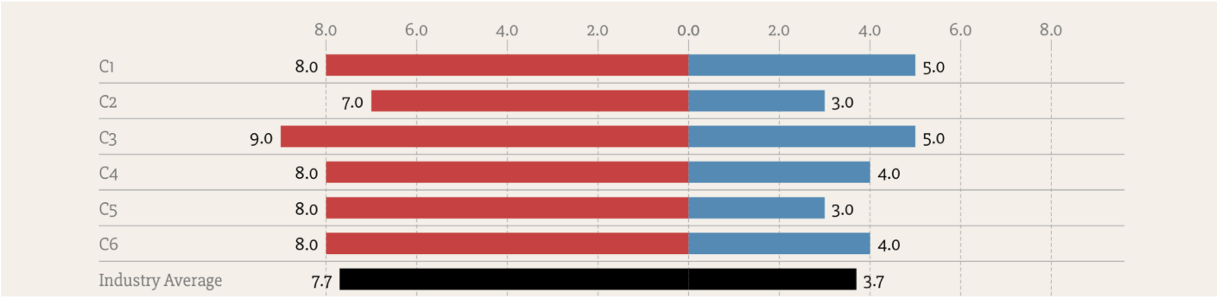

Figure 7.4: Importance vs Actualisation of Strategic Clarity

As seen in Figure 7.4, the practices related to strategic clarity were considered important (with each scoring more than 7) for achieving portfolio management objectives, with the highest score given to C3 (9.0) and lowest to C2 (7.0). The actualisation scores of C2 (3.0) and C5 (3.0) were lower than industry average. The practices C1, C3, C4 and C4 were perceived to be performing well with all scoring above industry averages for importance and actualisation. Overall, this implies that strategic clarity is an important portfolio management factor and most of the associated practices are perceived to be performing well (given their actualisation scores).

D. Customer Orientation

Figure 7.5: Importance vs Actualisation of Customer Orientation

As seen in Figure 7.5, the practices related to customer orientation were considered highly important (with each scoring more than or equal to 8) for achieving portfolio management objectives, with the highest score given to D1 (9.0). It is interesting to note that all of their actualisation scores were above the industry average with each scoring 4.0. Overall, this implies that customer orientation is an important portfolio management factor and associated practices are perceived to be performing well (given their actualisation scores).

E. Business Case Management Quality

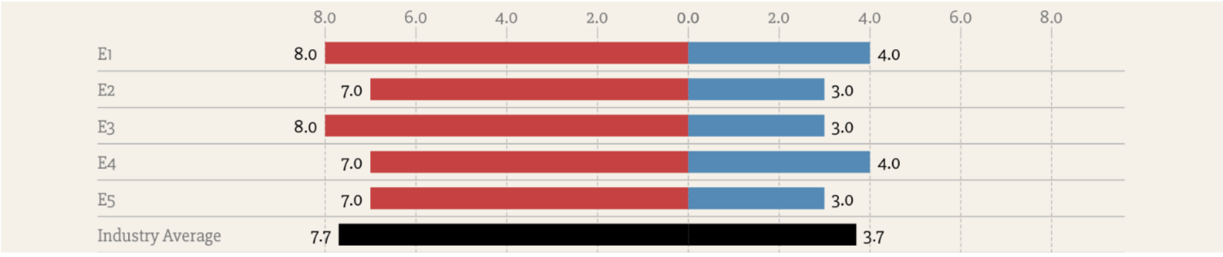

Figure 7.6: Importance vs Actualisation of Business Case Management Quality

As seen in Figure 7.6, the practices related to business case management were considered important (with each scoring more than or equal to 7) for achieving portfolio management objectives, with the highest score given to E1 (9.0) and E3 (9.0). Despite the importance of these practices, the actualisation scores of E2, E3 and E5 are lower than the industry average, with each of these scoring 3.0. Overall, E1 was perceived to be performed well with both scores above industry averages on importance and actualisation. This implies that business case management is an important portfolio management factor and associated practices need to be performed well (given their actualisation scores).

F. Resource Allocation Quality

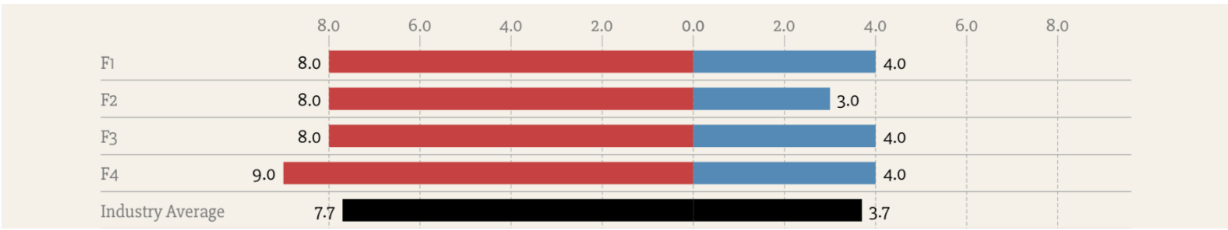

Figure 7.7: Importance vs Actualisation of Resource Allocation Quality

As seen in Figure 7.7, the practices related to resource allocation were considered important (with each scoring more than or equal to 8) for achieving portfolio management objectives, with the highest score given to F4 (9.0). The actualisation score for F2 (3.0) is lower than the industry average, with the rest of the practices above industry averages, each scoring 4.0. Overall, this implies that resource allocation quality is an important portfolio management factor and associated practices are perceived to be performing well (given their actualisation scores).

G. Preparedness for Risk

Figure 7.8: Importance vs Actualisation of Preparedness for Risk

As seen in Figure 7.8, the practices related to preparedness for risk were considered important (with each scoring more than or equal to 7) for achieving portfolio management objectives, with the highest score given to G1 (8.0) and G3 (8.0). The actualisation score of G2 (2.0) was lower than the industry average, whereas G1 (5.0) and G2 (4.0) were above industry average. Overall, this implies that preparedness for risk is an important portfolio management factor and associated practices are perceived to be performing well (given their actualisation scores).

H. Project Selection Quality

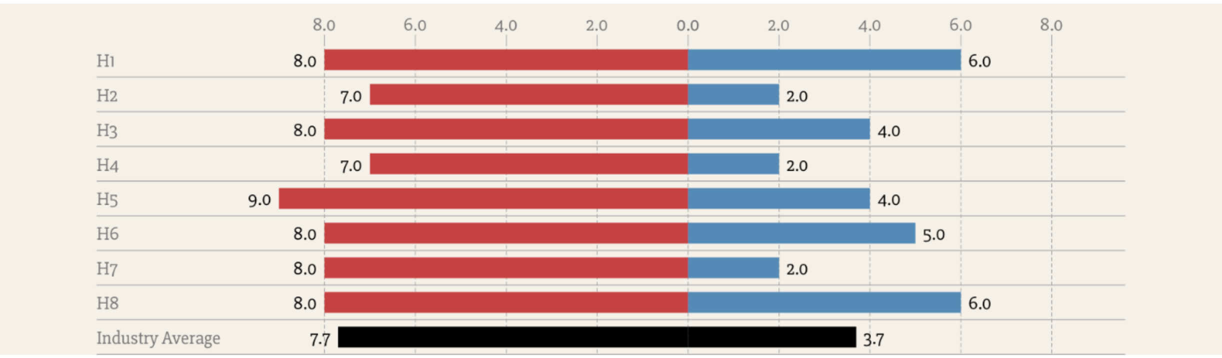

Figure 7.9: Importance vs Actualisation of Project Selection Quality

As seen in Figure 7.9, the practices related to project selection quality were considered important (with each scoring more than or equal to 7) for achieving portfolio management objectives, with highest score given to H5 (9.0). The actualisation scores of H2 (2.0), H4 (2.0), and H7 (2.0) were lower than the industry average, whereas H1 (5.0), H2 (4.0), H5 (4.0), H6 (5.0) and H8 (6.0) scored above industry average. Overall, this implies that project selection quality is an important portfolio management factor and some of associated practices need to be performed well (given their actualisation scores).

I. Project Termination Quality

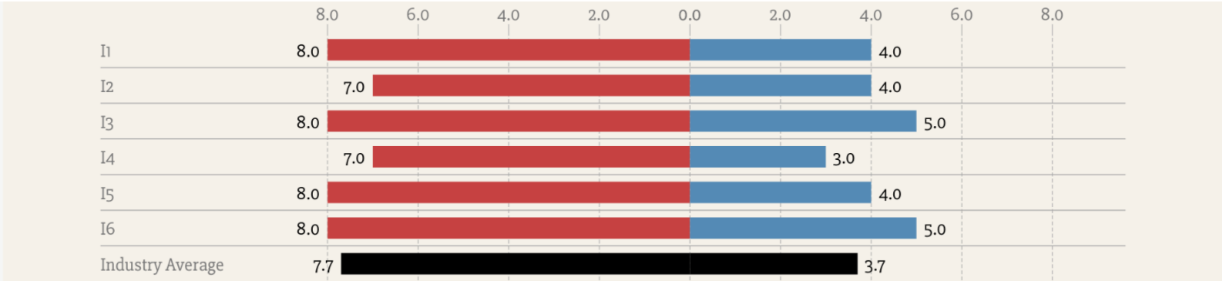

Figure 7.10: Importance vs Actualisation of Project Termination Quality

As seen in Figure 7.10, the practices related to project termination quality were considered important (with each scoring more than or equal to 7) for achieving portfolio management objectives, with the highest scores given to I1, I3, I5 and I6, all scoring 8.0. It is interesting to note that the actualisation score of I4 only (3.0) was lower than the industry average, with rest of the practices scoring above industry average. Overall, this implies that project termination quality is an important portfolio management factor and associated practices are perceived to be performing well (given their actualisation scores).

J. Learning Orientation

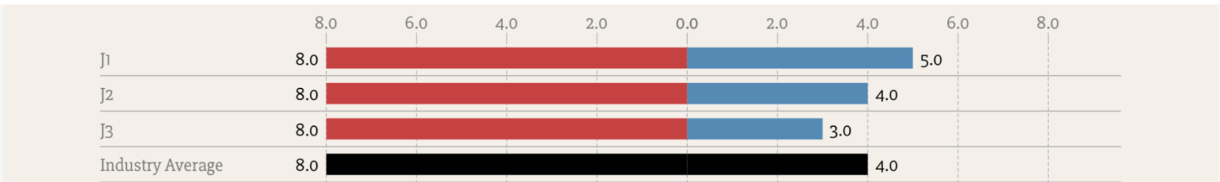

Figure 7.11: Importance vs Actualisation of Learning Orientation

As seen in Figure 7.11, the practices related to learning orientation were considered important (with each scoring 8.0) for achieving portfolio management objectives. The actualisation scores for J2 (3.0) was lower than the industry average, whereas J1 (5.0) and J2 (4.0) scored above industry average. Overall, this implies that learning orientation is an important portfolio management factor and most of associated practices are perceived to be performing well (given their actualisation scores).

K. Portfolio Management Structure and Design

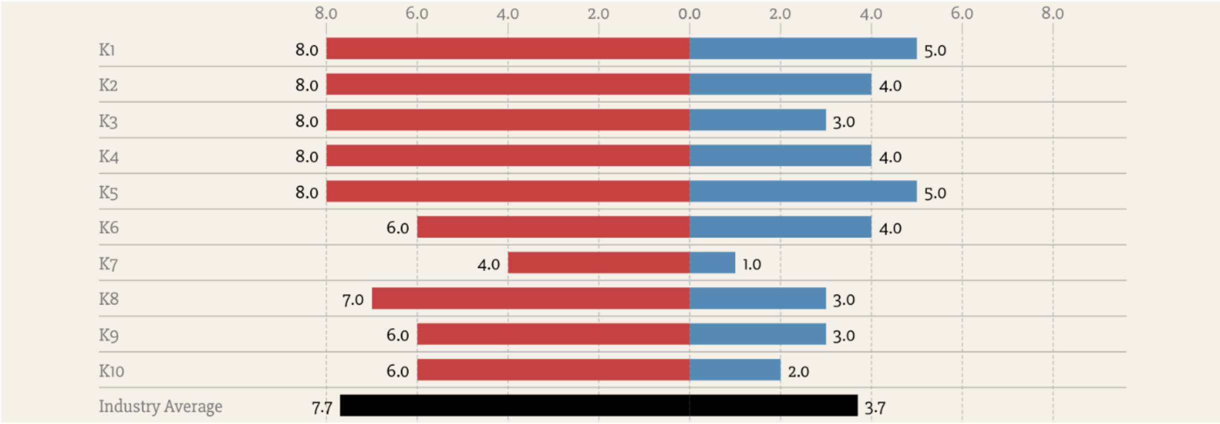

Figure 7.12: Importance vs Actualisation of Portfolio Management Structure and Design

As seen in Figure 7.12, the practices related to portfolio management structure and design were considered important (with each scoring more than or equal to 6) for achieving portfolio management objectives, with the exception of K7 (4.0). The actualisation scores of K3 (3.0), K7 (1.0), K8 (3.0), K9 (3.0), K10 (2.0) were lower than the industry average, whereas K1 (5.0), K2 (4.0), K4 (4.0), K5 (5.0) scored above industry average. Overall, this implies that portfolio management structure and design is an important portfolio management factor and associated practices need to be performed well (given their actualisation scores).

L. Agility

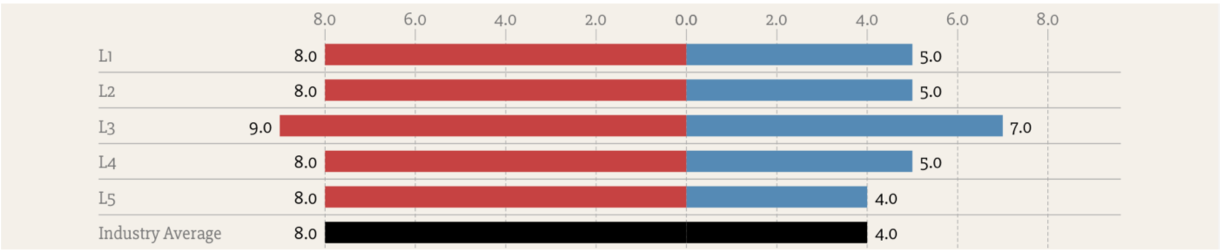

Figure 7.13: Importance vs Actualisation of Agility

As seen in Figure 7.13, the practices related to agility were considered important (with each scoring more than or equal to 8) for achieving portfolio management objectives, with the highest score given to L3 (9.0). The actualisation scores for all these practices were above industry averages, with each scoring more than or equal to 4.0. Overall, this implies that agility is an important portfolio management factor and associated practices are perceived to be performing well (given their actualisation scores).

7.3.2 Reflections on Portfolio Management Diagnostic Tool's Structure and Deployment Process

This section presents the key learnings (including improvement suggestions) gained from the pilot studies of the portfolio management diagnostic tool and is divided into two parts: tool structure (as discussed in development methodology in Section 7.2) and deployment process (as discussed in application methodology in Section 7.2).

Portfolio Management Diagnostic Tool's Structure

- All of the portfolio management practices used in the diagnostic tool were found to be relevant and important for achieving portfolio management objectives, and most of the scoring participants found the set of practices quite comprehensive. Also, the tool was considered as flexible if a participating firm might want to adapt or add its specific portfolio management or related practices to it for assessment. It must be noted that adding more practices to the tool might increase the time commitment and cognitive burden on the scoring participants.

- With regards to the scoring criteria and technique, most of the participants were able to understand the criteria and technique. This means that the tool's structure in its current form provides useful diagnostic insights. However, for conducting quantitative studies using this tool would imply revisiting the scoring scales, criteria and techniques used in this research.

Portfolio Management Diagnostic Tool's Deployment Process

- Since the deployment process employed workshop and non-workshop-based approaches, divided into three stages of pre-assessment, assessment and post-assessment, most of the participating firms found the overall process appropriate given the amount of the effort they wanted to invest in the overall assessment (half-day workshop).

- However, quite a number of participants requested to digitalise the assessment tool for the purpose of ease in scoring. This research acknowledges this suggestion for digitalising the assessment tool using an online application and considers it as future work.

- It could be useful to 'dry-run' the diagnostic tool with one of the scoring participants from the company in advance (before rolling out to others) to ensure appropriate understanding of the practices and to reveal any differences in the interpretation of portfolio management practices due to context of a firm. This would help in configuring the tool according to the needs of the participating firm.

7.4 Discussion of Result IV

This section discusses theoretical and managerial implications of Result IV, followed by its limitations.

7.4.1 Theoretical Implications of Result IV

This chapter demonstrates the utility of Result IV, which is the portfolio management diagnostic tool developed based on Result II. The findings from the pilot studies validated the Result II as the management practices underpinning its constructs has been found relevant and important by case as well as non-case firms (see Table 7.3). These findings also support the external validity of Result II as non-case firms confirmed use of these portfolio management practices. Furthermore, Result III is partially validated as its constructs are the same as Result II. Other key theoretical implications of Result IV are:

- Ecosystem Awareness (Result IV) is related to the process of Ecosystem Surveillance (Result II) and has been found important and relevant for portfolio management objectives. This supports the findings of Biedenbach and Muller (2012), which suggests that the ACAP of a firm contributes to portfolio management performance as the information collected about ecosystem entities helps in developing up-to-date products aligned with customer needs.

- Similarly, Inter-Functional Collaboration (Result IV) is related to Corporate Functions of Result II and supports the findings of Kester et al., (2011), Perks (2007) and Jonas et al., (2013). For example, sharing of project and portfolio information between various functions such as Marketing, Finance would improve the information quality which eventually contributes to portfolio management performance.

- Strategic Clarity (Result IV) is related to the process of Portfolio Strategy Development of Result II and supports the findings of Cooper et al. (1999) and Meskendahl (2010). These studies suggest that portfolio strategy contributes to portfolio management performance. For example, developing strategic roadmaps and buckets could facilitate the strategic alignment of a portfolio.

- Customer orientation (Result IV) is related to the process of Portfolio Strategy Development and New Product Management of Result II and supports the findings of Cooper et al. (2001). For example, better the understanding of customer needs at project and portfolio level, better will be portfolio strategic alignment with customer needs, which eventually contributes to the NPD and portfolio management performance.

- Business Case Management Quality (Result IV) is related to the process of Business Case Management of Result II and supports the findings of Kopmann et al. (2015). For example, better design of business cases results into better quality of information, which supports rationality and transparency in portfolio decision-making.

- Resource Allocation Quality (Result IV) is related to the process of New Product Management of Result II and supports the findings of Jonas et al. (2013) and Rank et al. (2015). For example, if resources are allocated effectively and efficiently, the likelihood of negative impacts from 'fire-fighting' on NPD performance can be reduced (Repenning, 2001).

- Preparedness for Risk (Result IV) is related to the process of Portfolio Decision-Making and New Product Management of Result II and supports the findings of Teller & Kock

(2013). For example, formalising project and portfolio level risk management procedures contributes project and portfolio management performance.

- Project Selection Quality (Result IV) is related to the process of Portfolio Decision-Making of Result II and supports the findings of Kester et al. (2011), Urhahn & Spieth (2014) and Pinto & Slevin (1987). For example, rationality in project selection decisions increases the likelihood of project success and commitment for its successful execution.

- Project Termination Quality (Result IV) is related to the process of Portfolio Decision-Making of Result II and supports the findings of Unger et al. (2012) and Lechler & Thomas (2015). For example, terminating ‘bad’ project early contributes to the overall portfolio value and its strategic alignment.

- Learning Orientation (Result IV) is related to the process of New Product Managementand Top Management Functions of Result II and supports the findings of Killen & Kjaer (2012) and Talke et al., (2010). For example, top management support in portfolio decision-making and improvement of portfolio management processes improves the quality of portfolio decisions.

- Portfolio Management Structure and Design (Result IV) is related to Top Management Functions, Project Management Functions and Portfolio Management Governance Functions of Result II and supports the findings of Unger et al. (2012) and Klingebiel & Rammer (2013) and Klingebiel & Joseph (2015). For example, formalisation of project management functions increases the likelihood of project success and taking portfolio decisions in line with strategy of a firm ensures strategic alignment of portfolio

- Agility (Result IV) is related to the process of Portfolio Strategy Development, Business Case Management and Portfolio Decision-Making of Result II and supports the findings of Kester et al. (2013) and Kopmann et al. (2015). For example, monitoring business cases ensures that portfolio decisions are taken on up-to-date and relevant information.

7.4.2 Managerial Implications of Result IV

Result IV has two key managerial implications:

- Managers can use Result IV to diagnose the strengths and weaknesses of portfolio management processes and their underpinning management practices in their companies. The pilot studies demonstrate the practical utility of Result IV. Moreover, the tool and its deployment process can be configured according to firm needs.

- Managers can compare their assessment scores with other companies' scores as shown in the Table 7.2, which provides industry averages for each portfolio management practices in terms of their importance, consistency, execution quality and actualisation (or performance). This type of comparison would provide the benchmarking insights.

7.4.3 Limitations of Result IV

Result IV has two key limitations:

- The scoring of portfolio management practices involves subjective assessment, a function of respondent's knowledge and objectivity, and which could be biased, leading to biased findings. To address this issue, scoring should be carried out with different portfolio management stakeholders to ensure triangulation of scores to a reasonable extent, along with other good practices (e.g. Mitchell et al., 2018).

- It does not reveal which portfolio management practices are statistically significant for portfolio management performance as it does not use quantitative methodology and related instruments. However, this research suggests that a wider quantitative study could be carried out using Result IV as the basis for future work.

7.5 Summary of Result IV

This chapter addressed the final research sub-question of this research (see Section 3.1), which is *'How may key portfolio management processes be assessed?'*. The management practices underpinning Result II were used as a basis for the development of Result IV (i.e. the portfolio management diagnostic tool as shown in Figure 7.1). Then the process for deploying this tool in practice was developed which included workshop and non-workshop-based approaches (as shown in Table 7.1). A total of 7 pilot studies with case and non-case firms were carried using both the deployment approaches.

As shown in Table 7.2, the results from pilot studies were derived by averaging out the scores of all 64 portfolio management practices against the criteria of importance, relevance and execution quality. Furthermore, the actualisation score was calculated which is considered as a proxy of performance of each portfolio management practice. Overall, the findings suggest that all portfolio management practices were considered relevant and important for achieving portfolio management objectives, with some practices were perceived to be performed well on average at industry level while others were not.

The theoretical implication of Result IV is that it corroborates and expands on previous research findings related to the portfolio management processes and stakeholders (e.g. Meskendahl, 2010; Kopmann et al., 2015; Unger et al., 2012). The managerial implication of Result IV is that managers could use it as a diagnostic aid to assess the portfolio management practices in their firms and derive benchmarking insights by comparing their scores with other companies.

The limitations of Result IV that the assessment is quite subjective in nature and could be subjected to biases, to be addressed. Also, Result IV does not reveal which portfolio management practices are statistically significant for portfolio management performance, which could be considered as future research work.

With Results I to Result IV described in Chapters 4 to 7 respectively, all four sub-research questions set out in this research has been addressed. The next chapter presents the conclusion of this PhD research.

CHAPTER 8 CONCLUSION

This chapter first revisits the background to this research and key knowledge gaps in portfolio management as identified in both theory and practice. It then provides a brief overview of answers to the research questions designed to address these knowledge gaps. It closes with a summary of the knowledge contributions made by this research, future research work in light of its limitations and final conclusion.

Contents

8.1 Research Background and Knowledge Gaps

As technology-intensive environments can be characterised by high levels of market and technical uncertainties, rapidly changing customer needs, and shrinking product-lifecycles (Hauser et al. 2006; Eisenhardt, 1989), firms operating in such environment must continuously innovate in order to survive in the short and long term. The NPD capability, i.e. ability to successfully develop and introduce new products or services into new and existing markets, can enable firms to generate cash flows to continue funding existing operations while investing part of the revenue in future innovation efforts (e.g. Chao & Kavadias, 2013).

Despite the positive association between the NPD capability and firm performance, there are research studies which also indicate the high rate of failure of new products, eventually leading to lower firm performance (Cooper et al. 2001; Repenning, 2001; Barczak et al. 2009). The various reasons investigated for poor firm performance in the context of NPD include inadequate resource allocation, unmet customer needs, lack of clear strategy, poor NPD selection and termination quality. Formalising and adapting NPD capabilities is one way to avoid such scenarios (Cooper et al. 2001; Griffin, 1997), but the risk of such failures can also be reduced when NPD projects are collectively managed to ensure organisational success, i.e. focusing on the portfolio management capability (Urhahn & Spieth, 2014; Kester et al. 2014).

Portfolio Management is understood as a complex, dynamic decision-making process for selecting new NPD projects, terminating irrelevant NPD projects, (re)prioritising and (re)allocating resources to projects in order to achieve strategic alignment, balance and value maximisation (Cooper et al. 2001). However, the context in which portfolio decisions are taken amplifies the complexity of portfolio management tasks (i.e. limited resource availability, highly uncertain environment (Petit, 2012; Floricel et al. 2008), ambiguous and poor information quality (Kopmann et al. 2015; Jonas et al. 2013), and unclear strategy (Beringer et al. 2013), and high interdependencies among NPD projects (Teller et al. 2012). Such complexities and uncertainties can render portfolio management ineffective. There are at least three prime knowledge gaps to which ineffectiveness in portfolio management from both theoretical and practical aspects can be attributed (as discussed in Section Chapter 1 and 2):

- Lack of guidance on how and what to formalise in portfolio management processes

- Limited understanding of inter-relationships between portfolio management processes
- Lack of a comprehensive assessment approach for portfolio management processes

Considering these knowledge gaps, the overall research question and sub-questions were set, which are described along with their answers in the next section.

8.2 Research Questions and Answers

As described in Section 3.1, three knowledge gaps lead to four research objectives (as the first gap is split into two research objectives) as follows:

- Identification of key portfolio management processes, to enable portfolio decision-making
- Formalisation of portfolio management processes, to define underlying sub-process, components and practices
- Integration of portfolio management processes, to synergise these processes by understanding their inter-relationships
- Assessment of portfolio management processes, to provide a diagnostic aid which can be deployed to enhance maturity levels of portfolio management processes

Consequently, these four research objectives lead to four sub-research questions (RQ1-4) respectively (with the overall research question synthesised subsequently):

RQ1: What are the key portfolio management processes that can be formalised?
RQ2: How may key portfolio management processes be formalised?
RQ3: How may key portfolio management processes be integrated?
RQ4: How may key portfolio management processes be assessed?

The overall research question designed to address the above three knowledge gaps is:

How may key portfolio management processes be formalised, integrated and assessed in order to improve portfolio management performance in technology-intensive firms?

The following sections will revisit answers to each of the four research sub-questions.

RQ1: What are the key portfolio management processes that can be formalised?

To answer this research sub-question, 2 focus groups and 9 exploratory interviews with portfolio decision-makers and coordinators were conducted (with details shown in Appendix 3A). This led to the development of Result I (see Figure 4.1), which is the framework outlining five key portfolio management processes (see Chapter-4 for more details):

- **Ecosystem Surveillance:** refers to the series of tasks which involves collection of information about the business ecosystem of an organisation such as market trends, technology opportunities and customer complaints.

- **Portfolio Strategy Development:** includes a set of tasks such as setting strategic direction(s) for a portfolio and its decisions, identifying new project opportunities to fill any portfolio gaps and allocating budget for portfolio implementation.

- **Business Case Management:** refers to series of tasks such as preparation and assessment of project business cases to be considered during portfolio decision-making. It can be considered as a pre-decision-making process.

- **Portfolio Decision-Making:** refers to the set of tasks undertaken to decide whether to invest/continue to invest/terminate projects, labelled as project selection and termination decisions.

- **New Product Management:** refers to the tasks which are undertaken to allocate resources to the prioritised projects and implement those projects while performing relevant pre and post launch NPD Stage-Gate activities.

As mentioned in Section 4.4, these five portfolio management processes have implications for portfolio management performance as well. The next research sub-question further explores sub-processes and their components, stakeholders of these portfolio management processes.

RQ2: How may key portfolio management processes be formalised?

To answer this research sub-question, 10 in-depth case studies, 17 exploratory interviews and 1 focus group with portfolio decision-makers or coordinators were conducted (details in Appendix 3B). This led to the development of Result II (see Figure 5.33), which is the framework outlining sub-processes (and *components*) and stakeholders driving these five key portfolio management processes (see Chapter-5 for more details):

Ecosystem Surveillance: its sub-processes and *components* (described in Table 5.4) are:

- Information Gathering: involves collection of information about the business ecosystem of an organisation. Its components are *Information Type, Information Level, Responsibility and Intensity.*
- Business Requirement Identification: involves analysis of the collected information and identifying its implications for a business. Its components are *Trends and Business Themes.*

Portfolio Strategy Development: its sub-processes and *components* (described in Table 5.5) are:

- Strategy Translation: involves breaking down high-level strategy into portfolio goals and setting directions for portfolio decisions. Its components are *Roadmaps, Priorities, Product Strategy and Technology Capability.*
- Portfolio Analysis: involves analysis of portfolio to spot gaps with respect to strategy or business themes. Its components are *Visualisations, Gaps vis-à-vis business themes and Performance Checks.*
- New Project Opportunity Identification: involves determining new project opportunities or generating ideas that could be needed to achieve strategic goals or fix portfolio gaps. Its components are *Basis and Approach.*

Business Case Management: its sub-processes and *components* (described in Table 5.6) are:

- Business Case Preparation: involves developing new business cases and updating existing business cases related to different project types. Its components are *Responsibility, Template, Strategy/Technology Focus and Type.*
- Business Case Assessment: involves analysis of a value of individual business case and identification of its merits and demerits when compared to other business cases. Its components are *Due-Diligence, Visualisation, Approvals, Criteria, Methods, Check and Priority List*

Portfolio Decision-Making: its sub-processes and *components* (described in Table 5.7) are:

- Pre-Alignment Meeting: refers to the meeting between portfolio decision-makers to discuss their respective inputs on pre-read, understand and frame required decisions before actual decision-making. Its components are *Inputs on Agenda/Priority List and Method.*
- Decision-Making: refers to the actual decision-making event that involves making portfolio decisions such as project selection, termination or hibernation. Its components are *Time Horizon, Decision-Style, Decision Type and Communication.*
- Performance Checks: involves monitoring and optimising project and portfolio performance. Its components are *Bottle-Necks, Budget and Key Performance Indicators.*

New Product Management: its sub-processes and *components* (described in Table 5.8) are:

- Resource Allocation: refers to allocation of resources to project selected during portfolio decision-making. Its components are: *Approach and Time Commitment.*
- Stage-Gate Management: refers to execution of the selected projects according to relevant Stage-Gate processes. Its components are *Type of Process, Governance and Learning.*
- Post-Launch Tracking: refers to the monitoring of the products' performance which are already launched into the market. Its components are *Sales Tracking and Expansion-Deletion.*

In addition to these key processes, three stakeholder functions (and their *components*) associated with these processes were also identified and have been formalised (see Table 5.9):

- **Corporate Functions:** refers to functional stakeholders such as marketing, finance and operations personnel driving processes such as Ecosystem Surveillance, Portfolio Strategy Development and Business Case Management. Its components are *Information Sharing and Collaboration.*

- **Top Management Functions:** refers to stakeholders in a company who are responsible for making portfolio strategy and decisions and drives processes such as Portfolio Strategy Development and Portfolio Decision-Making. Its components are *Resource Commitment and Mindset & Support.*

- **Project Management Functions:** refers to stakeholders responsible for facilitating portfolio decisions by providing enabling information about project and portfolio. Its components are *Project & Portfolio Data Management, Inter Project Collaboration Facilitation and Project Management Support*.

Finally, a portfolio management governance function was identified which described overall governance of portfolio management processes:

- **Portfolio Management Governance Functions:** refers to the formal governance guidance for portfolio decision-makers which includes scope and mandates for making portfolio decisions. Its components are *Explicit Decision Constraints and Authority Levels, Decision-Making Team Structures and Portfolio Design Improvement*.

As mentioned in Section 5.5, these five portfolio management processes as well as three stakeholder functions have implications for portfolio management performance. The next research sub-question further explores interrelationships between these processes and stakeholder functions.

RQ3: How may key portfolio management processes be integrated?

Result II was used as a basis for answering this research sub-question. Using both the extant literature and findings from Result II, Result III (see Figure 6.1) was developed. Result III is a framework describing inter-relationships between key portfolio management processes and stakeholder functions (see Chapter-6 for more details).

As mentioned in Section 6.4, integrating portfolio management processes as well as portfolio management stakeholders has implications for portfolio management performance. The next research sub-question develops and deploys a portfolio management diagnostic tool in practice.

RQ4: How may key portfolio management processes be assessed?

Result II was used as the basis for answering this research sub-question. The management practices underpinning Result II were further analysed into 64 portfolio management practices, categorised into 12 portfolio management factors (A-L as outlined in Table 7.1). The criteria for scoring these practices was adapted from Menke (2013).

This led to the development of Result IV (see Figure 7.1), which is the template-based diagnostic tool (as shown in Figure 7.1) for portfolio management processes and its practical deployment approach (as shown in Table 7.1). Seven pilot studies were conducted for the deployment of this tool in practice (see Chapter-7 for more details).

As a result of the pilot studies, average scores (importance, consistency, execution quality and actualisation scores) for each portfolio management practice were calculated for benchmarking purposes, as shown in Table 7.3.

The overall research question set above has been answered by developing a portfolio management formalisation framework describing its portfolio management processes and stakeholder functions (Result I and II), a portfolio management integration framework establishing relationships between these processes and functions (Result III), and a diagnostic tool for assessing these processes and functions in form of 12 portfolio management factors (Result IV). The next section outlines the contributions to knowledge made by this research.

8.3 Contributions to Knowledge

Result I to IV has already been compared with the extant literature in Sections 4.5, 5.5, 6.5 and 7.5, respectively. This section provides a summary of the contribution to knowledge that this research had made, in terms of theory and practice.

8.3.1. Contributions to Theory

First of all, new concepts relating to portfolio management have been proposed and contributed to the innovation management domain. This research makes one primary and two secondary contributions. The primary contribution is:

A framework for formalising portfolio management processes and stakeholder functions

As shown in Figure 5.33, five key portfolio management processes and three stakeholder functions along with their sub-processes and components have been revealed as a framework. The novelty of the framework lies in comprehensively capturing and connecting different aspects of portfolio management and stakeholders that could be formalised, which has been unaddressed in the extant literature (e.g. Archer & Ghasemzadeh, 1999; Patterson, 2005).

This framework extends the construct of formalisation of portfolio management proposed by Spieth & Lerch (2014), Teller et al. (2012) and Kock et al. (2014) by positing that not only portfolio management methods need to be formalised for better portfolio management processes, but also formalisation of its processes and stakeholder functions have implications for portfolio management performance as well. As a result, the framework also highlights critical factors that have potential for driving portfolio management performance.

The strength of this framework lies into its configurability according to the context of portfolio management and firm, which has been demonstrated in a form of feedback from industrial practitioners. Overall, this framework argues that merely formalising NPD processes will not lead to better firm performance, and that formalisation of portfolio management processes and stakeholder functions is important as well.

The secondary contributions of this research are:

A framework for integrating portfolio management processes and stakeholder functions

As shown in Figure 6.1, a framework establishing inter-relationships between portfolio management processes and stakeholder functions has been developed. The exploratory relationships underpinning the framework shed light on impact of one portfolio management process on others and the impact of stakeholder functions on portfolio management processes. The novelty of the framework lies in expanding the construct of integration in portfolio management proposed in the extend literature (e.g. Meskendahl, 2010; Floricel & Ibanescu, 2008; Jonas et al., 2013).

Using the 'Input-Process-Output' logic, this framework reveals the intermediate processes which might impact the causal relationships between portfolio management inputs (e.g. strategy and business cases) and outputs (performance) as argued in the extant literature (e.g. Biedenbach and Muller, 2012; Kang & Montoya, 2010; Kopmann et al., 2015; Kester et al., 2011, 2014). Overall, this framework argues that integrating portfolio management processes and stakeholders could potentially result into better implementation of overall portfolio management in firms.

A tool for assessing portfolio management processes and stakeholder functions

As shown in Figure 7.1 and Table 7.3, a template-based diagnostic tool for assessing portfolio management processes has been developed. The tool involves assessing a set of portfolio management practices against their relevance, importance, consistency and execution quality. The novelty of the tool lies in proposing a tool for comprehensively assessing management practices underpinning portfolio management processes and stakeholder functions, which has been unaddressed in the literature (e.g. Kahn et al., 2006). The pilot studies deploying this tool results into the set of scores of these practices which offers benchmarking benefits. Moreover, the tool already has been and can be practically deployed using both workshop and non-workshop-based approaches depending on the level of efforts a firm is willing to put in assessing its portfolio management processes.

Overall, this research contributes to the Resource-Based View (RBV) by positing that portfolio management process is one of the such intangible resources which contributes to firm performance and reveals how to formalise portfolio management process by describing its key processes (e.g. Ecosystem Surveillance, Portfolio Strategy Development, Business Case Management, Portfolio Decision-Making, and New Product Management), sub-processes (e.g. Portfolio Analysis, Business Case Preparation and Assessment) and components (e.g. Roadmaps, Criteria, Decision Type) . This research extends the exploratory relationship between portfolio management process design and firm performance (e.g. Spieth & Lerch, 2014; Jonas et al., 2013) by developing portfolio management formalisation framework, which is considered as one of the intangible resources to make decisions and allocate and de-allocate resources to NPD projects and as the result, the firm performance is impacted by success or failure of the NPD projects.

8.3.2. Contributions to Practice

The overall practical contribution of this research can be described as follows:

- Managers can use the portfolio management formalisation framework (shown in Figure 5.33) as a diagnostic intervention or aid (e.g. as a checklist) to improve overall maturity and performance of portfolio management in their companies. The portfolio management processes, their sub-processes and components and stakeholder functions provide an appropriate level of information to diagnose existing portfolio management systems in companies, to identify areas for improvement and associated actions. Moreover, using this framework managers can narrow down their attention or focus only on particular portfolio management processes which have implications for portfolio management performance.

- Managers can use the portfolio management integration framework (as shown in Figure 6.1) as a meta-level diagnostic for Portfolio Management Performance. They should understand that merely following task-performance relationships (e.g. Portfolio Strategy Development leads to Portfolio Management Performance) is not sufficient enough to improve the overall portfolio management system. They should also pay attention to the processes (e.g. Business Case Management) that are mediating these types of relationships to improve the portfolio management system holistically and exploit synergies by integrating the portfolio management processes. Managers should understand that integration of portfolio management stakeholders and processes could result in better design and implementation of the overall portfolio management system. They could exploit and operationalise the relationships underpinning the framework, for example, to improve Portfolio Strategy Development, the quality of inputs from Corporate Functions and Top Management Functions needs to be improved.

- Managers can use the portfolio management diagnostic tool to identify the strengths and weaknesses of portfolio management processes and their underpinning management practices in their companies. The pilot studies demonstrate the practical utility of tool. Moreover, the tool and its deployment process can be configured according to firm needs. Managers can compare their assessment scores with other companies' scores as shown in the Table 7.3, which provides industry averages for each portfolio management practices in terms of their importance, consistency, execution quality and actualisation (or performance). This type of comparison would provide benchmarking insights.

The next section outlines the limitations of this research and suggests future research work.

8.4 Limitations and Future Work

Key limitations of this research and *future research work* options are:

- The insights from developing the portfolio management formalisation framework were derived from a large number of companies operating in wide range of industrial sectors. Although, the framework has a certain degree of generalisation in terms of portfolio management processes and their practices, it does not reveal industry specific nuances of portfolio management processes and their underpinning practices (as compared to a few studies in the extant literature, e.g. Wheelwright & Clark, 1992). *Future research could be carried out to tease out industry specific portfolio management practices.*

- The boundary conditions of portfolio management formalisation framework in terms of its applicability and consistency are limited to portfolio management practices in private sector companies, and there is a possibility that some of the aspects of the framework might not be valid for public sector and other non-commercial organisations (as indicated in Sections 5.3 and 5.4). *Future research could be carried out test the applicability of this framework in public sector companies and configure it to better reflect the portfolio management processes and their aspects in public sector companies.*

- This research does not reveal contingency factors of degree of portfolio management formalisation, as it might not be necessary to fully formalise each part of the framework to build a viable or optimal portfolio management system for a company. This is because the portfolio management system must be adapted or configured according to the context of company's structure and other business processes. *Future research could be carried out explore and reveal different levels and types of contingency factors of portfolio management formalisation.*

- Although the constructs of the portfolio management integration framework are based on comprehensive empirical data, the relationshops linking these constructs are more conceptual in nature and lack empirical evidence. *Future research could be carried out. to explore and test these exploratory relationships using large scale, cross-industry quantitative surveys with relevant portfolio management stakeholders.*

- Insights from deployment of the portfolio management diagnostic tool do not reveal which portfolio management practices are statistically significant for portfolio management performance, as it does not use quantitative methodology and related instruments. *Future research could be carried out to establish statistical significance of portfolio management practices for portfolio management performance.*

8.5 Final Conclusion

Overall, this research argues that portfolio management processes and stakeholder functions have implications for portfolio management performance and eventually firm performance as well. The problem of portfolio management ineffectiveness has been unaddressed in both theory and practice. This research addresses this problem by demonstrating how to formalise, integrate and continuously improve the maturity of portfolio management processes and relevant stakeholder functions. As a result, this research makes knowledge contributions to the innovation management domain by developing frameworks for portfolio management formalisation, integration and a tool for diagnosing portfolio management processes and stakeholder functions. The findings from this research lay a foundation for future work aiming to reveal industry specific portfolio management practices and test the statistical significance of these practices for portfolio management performance.

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APPENDIX 2A: PORTFOLIO MANAGEMENT PERFORMANCE AND FIRM PERFORMANCE

Portfolio Management Performance

The literature has consensus that due to time lag between portfolio decisions and their outcomes, it is quite difficult to assess portfolio management performance. The indicators of portfolio performance have been developed conceptually and applied empirically in number of studies. For example, in benchmarking studies by Cooper and his colleagues, used the three portfolio management goals as performance indicators, which in turn became a ‘standard’ in other studies (e.g. Kester et al., 2014). Some studies further argued that portfolio management also entails the responsibility of success of its individual components such as projects, and therefore included average project success and average product success among other indicators (Urhahn & Spieth, 2014; Meskendahl, 2010; Jonas et al., 2013). Additionally, some studies also argue that the role of portfolio management is to exploit synergies across projects in a portfolio, whether a portfolio enables a firm to prepare for future (Meskendahl, 2010), to what extent portfolio reflects degree of innovation in terms of market and technology (Urhahn & Spieth, 2014), and general business success. See Table 2A.1 for more information about the list of items used to operationalise these indicators and key references of studies assessing portfolio management performance.

Table 2A.1: Portfolio management performance and item scales (Source: Author’s own depiction based on references mentioned in the table below)

*The bold reference is the main reference whose items of portfolio management performance are included in this table. The non-bold reference either uses the same or modified items for the similar performance indicator.
** The study exploring relationship between portfolio management performance and firm performance

Portfolio Management Performance Indicators	**Items used to operationalise these indicators**	**Key References***
Strategic Alignment	• Our NPD portfolio is aligned with our business goals • Our NPD portfolio is aligned with our innovation strategy	**Kester et al., 2014**;** Jonas, 2010; Spieth & Lerch, 2014**;

	• The projects in our NPD portfolio collectively contribute to achieving our strategic goals • Our spending on projects for our NPD portfolio is consistent with our business strategy • The projects funded for development reflects the priorities of our business strategy	Cooper et al., 1998**; Beringer et al., 2012; Teller & Kock, 2013; Unger et al, 2013; Biedenbach & Muller, 2012; Patanakul, 2015
Balance	• Our NPD portfolio is balanced in terms of incremental and radical projects • Our NPD portfolio has the right number of projects for our available resources • The projects in our NPD portfolio are balanced across the various development stages (idea-launch)	**Kester et al., 2014****; Jonas 2010; Spieth & Lerch 2014**, Cooper et al., 1998**; Jugend et al., 2016; Padovani & Carvalho, 2016; Teller & Kock, 2013; Biedenbach & Muller, 2012
Value Maximisation	• Our NPD portfolio contains several high-impact projects in terms of revenues • Over the past three years we maximised the return on investment from our NPD portfolio • We believe that the current composition of our NPD portfolio will maximise long term (> 3 yrs.) profitability • We believe that the current composition of our NPD portfolio will maximise market share growth over the long term (> 3 yrs.)	**Kester et al., 2014**;** Spieth & Lerch, 2014**, Cooper et al., 1998**; Teller & Kock, 2013; Biedenbach & Muller, 2012; Patanakul, 2015
Average Project Success	• On average, our projects have a high schedule adherence • On average, our projects have high budget adherence • On average, our projects have high quality adherence • On average, our projects are completed with high customer satisfaction	Jonas, 2010; Spieth & Lerch, 2014**; Muller et al., 2008; **Jonas et al., 2013;** Padovani & Carvalho, 2016; Beringer et al., 2012; Teller & Kock, 2013; Biedenbach & Muller, 2012

Use of Synergies		
	• We are able to capitalise on synergies between projects in our portfolio • We rigorously exploit technical synergies (e.g. shared usage of modules, platforms, technologies, etc.) between our projects • We rigorously exploit technical synergies (e.g. shared distribution channels, infrastructure, etc.) between our projects	Jonas, 2010; **Jonas et al., 2013**
Preparedness for Future		
	• In current portfolio new technology was developed or acquired and patents were registered • In current portfolio new markets developed • In current portfolio new line of products developed • In current portfolio new competences developed • In current portfolio production capacities or diversification observed	**Padovani & Carvalho, 2016;** Jonas, 2010; Biedenbach & Muller, 2012
Average Product Success		
	• Our project results reach level of market goals planned in the project (e.g. market share) • Our project results reach the level of financial goals planned in the project (e.g. ROI) • Our project results reach the amortisation periods planned in the project	**Teller & Kock, 2013**

Portfolio Management Performance and Firm Performance

In management research, firm performance has been operationalised from various perspectives such as financial performance and sustainable performance among others. However, the majority of studies in portfolio management assess firm performance in terms of customer satisfaction, market effectiveness and profitability (Vorhies and Morgan, 2005). The firm performance is measure in last three years in comparison to competitors, customer satisfaction is primarily about delivering value to customers and retaining them, market effectiveness is about achieving sales growth and acquisition of new customers, and financial profitability is about increasing return on investment and return on sales (Vorhies and Morgan, 2005; Kester et al., 2014).

As depicted in Figure 2A.1, most of the empirical studies studying relationship between portfolio management performance and firm performance tends to converge to the conclusion that the relationship is positive. An informal logic behind this is that the ability to successfully develop and introduce new products into the market is critical for firm performance, therefore collectively, as portfolio of products (new and existing) also influences firm performance. An increasing number of studies are qualitatively pointing towards the importance of portfolio

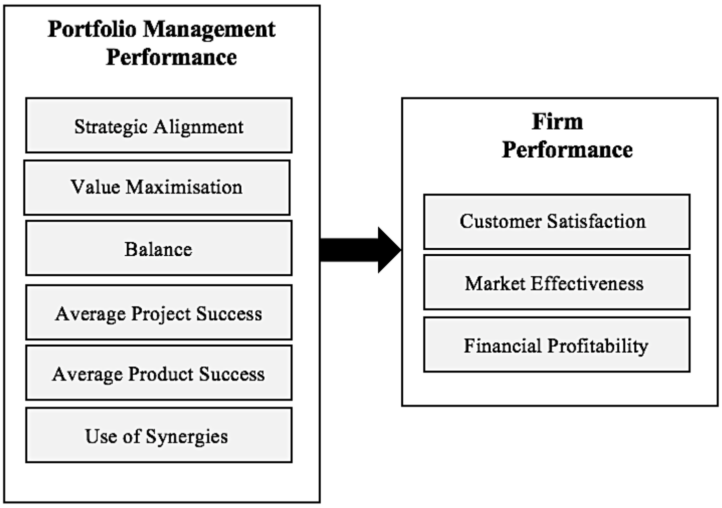


Figure 2A.1: Portfolio Management Performance and Firm Performance
(Source: Author's own depiction based on work by Cooper, 2002; Urhahn & Spieth, 2014; Meskendahl, 2010; Kester et al., 2014; Vorhies & Morgan, 2005)

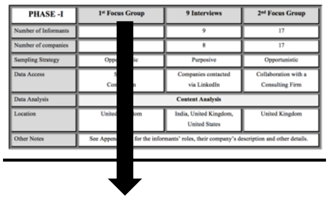
management for firm success (e.g. Killen et al., 2008; Petit, 2012). However, Cooper and his colleagues (1998, 2001) provided early quantitative evidences for the positive relationship. In similar vein, in a large, cross-industry study exploring portfolio decision-making and firm performance, Kester and her colleagues (2014) found that different constituents of portfolio management performance have different impact on firm performance. For example, firms particularly looking to improve customer satisfaction might focus on strategic alignment of portfolio or firms trying to increase market effectiveness could focus on maximisation of portfolio value. Furthermore, firms with portfolio mindset and focus might achieve better strategic alignment as it enables them to have detailed project knowledge and understand portfolio synergies (Kester et al., 2014). Similarly, Spieth & Lerch (2014) found the positive association between portfolio management performance and firm performance.

Overall, it can be concluded that understanding of the portfolio performance appears to be quite conceptually and empirically grounded in the literature and firm performance can be positively impacted by portfolio management performance.

APPENDIX 3A: PHASE I INFORMANTS' ROLES & COMPANY'S DESCRIPTION

* **R**: Recorded; **NR**: Not Recorded

** **O**: Online; **F**: Face to Face

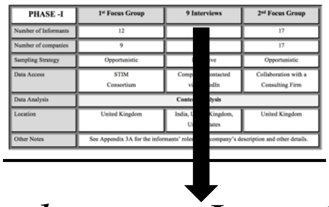


PHASE -I	1st Focus Group	9 Interviews	2nd Focus Group
Number of Informants		9	17
Number of companies		8	17
Sampling Strategy	[illegible]	Purposive	Opportunistic
Data Access	[illegible]	Companies contacted via LinkedIn	Collaboration with a Consulting Firm
Data Analysis	Content Analysis		
Location	[illegible]	India, United Kingdom, United States	United Kingdom
Other Notes	See Appen[illegible] for the informants' roles, their company's description and other details.		

(adapted from Table 3.4)

Ist Focus Group

Informant ID	Informant Role	Company's/University's Name/Description
1	Project Manager	American Life-Science company developing analytical laboratory instruments
2	R&D Portfolio Manager	Danish mechanical engineering company developing pumps and related systems
3	Project Manager	
4	Head of Technology	British company specialising in diamond exploration, diamond mining and industrial diamond manufacturing
5	Head of R&D	
6	Technology and Innovation Manager	
7	Global Open Innovation Lead	Swiss biotech company producing agrochemicals and seeds
8	Research & Technology Manager	French aerospace company building electrical systems
9	Strategy Advisor	British petrochemical company producing oil and gas
10	R&D Lead	British pharmaceutical company producing drugs for diseases such as cancer, diabetes
11	Collaborative Project Manager	British research and technology company specialising in welding
12	Associate Professor	A leading technical university in Denmark
Location	United Kingdom	
Duration	120 Mins	

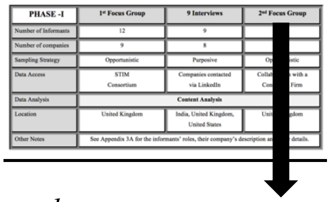


9 Exploratory Interviews

Informant ID	Informant Role	Company's Description	Location	Duration*	Mode**
13	General Manager, R&D	French company providing energy management & automation solutions	India	40 Mins, NR	O
14	General Manager, R&D	Swedish engineering company providing tools for mining & metal cutting	India	46 Mins, NR	O
15	Collaboration Director, Technology	Chinese company manufacturing telecommunications equipment and providing networking services	United Kingdom	40 Mins, NR	F
16	Chief Technology Officer	Indian company manufacturing products for power generation, transmission	India	60 Mins, NR	F
17	Head of R&D	American company producing consumer goods such as cereals, snacks	India	35 Mins, NR	F
18	Innovation Leader	American company supplying industrial tools and materials such as blades, wheels and axles for rails	United States	30 Mins, NR	O
19	Head of Strategy	British company doing aircraft maintenance, modification, and design, and providing logistical support to private and public aircrafts	United Kingdom	55 Mins, NR	F
20	Project Manager	Indian multinational conglomerate having subsidiaries for example in steel, motor, communication, and chemical industrial sectors	India	60 Mins, NR	F
21	Vice President		India	30 Mins, NR	O

* **R**: Recorded; **NR**: Not Recorded

** **O**: Online; **F**: Face to Face

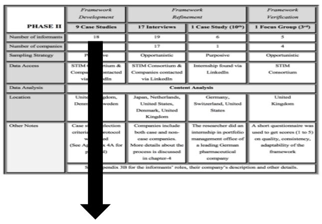


2^{nd} *Focus Group*

Informant ID	Informant Role	Company's Description
22	R&D Application Manager	French company supplying industrial gases and services to medical, chemical manufacturers
23	Global R&D Director	American company manufacturing self-adhesive labels, apparels and tags
24	Innovation & Growth Leader	American company developing aerospace and defence products such as armed vehicles
25	Director, Technology Management	British petrochemical company producing oil and gas
26	Head of Corporate Innovation Strategy	German company specialising in manufacturing of chemicals
27	Business Development Manager	Danish company supplying chemicals for fertilisers and power plants
28	Director, Global Operations	American pharmaceutical company developing drugs for opioid addiction
29	Business Development Manager	British company providing solutions for managing intellectual property and assets
30	Innovation Portfolio Manager	Danish company providing logistical products and services such as container ship
31	Technology Manager	British company doing business in transmission of electricity and gas
32	Vice President, Technology	British company manufacturing glasses
33	Innovation Strategy Lead	British utilities company doing business in wastewater treatment
34	Global Innovation Director	British pharmaceutical company producing chemicals such as polymer, pharma chemicals
35	R&D Manager	British company providing groceries and general merchandise
36	Group Director, Innovation	American company producing carbonated drinks
37	R&D Projects Office Manager	American biotechnology company producing laboratory equipment
38	R&D Director	Dutch company producing and selling consumer goods
Location	United Kingdom	
Duration	180 Minutes	

APPENDIX 3B: PHASE II INFORMANTS' ROLES & COMPANY'S DESCRIPTION

Stage I: Framework Development



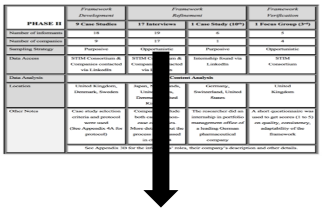
(adapted from Table 3.5)

9 Case Studies

Informant ID	Informant Role	Company's Description	Duration*	Mode**
CASE -1				
39	Vice President, R&D	Danish company providing cleaning equipment and solutions. The size of company is 2000-5000 employees and generated more than 1 Billion USD annual revenue recently.	90 Mins, R	F
40	Director, Product Portfolio Management		90 Mins, R	F
41	Manager, Product Portfolio			
CASE-2				
42	Senior R&D Director. Project & Planning	Danish company providing pumps and related solutions for heating, groundwater, irrigation. The size of the company is 18000-19000 employees and generated more than 2.5 Billion USD annual revenue recently.	30 Mins, NR	O
43	Head of Global Portfolio Management Office		110 Mins, R	F
CASE-3				
44	Global Portfolio Manager, R&D	British company manufacturing glass and glazing systems. The size of company is 27000-28000 employees, and generated more than 5 Billion USD annual revenue recently	175 Mins, R	F
45	Incubation Portfolio Manager		30 Mins, R	F
CASE-4				
46	Senior Vice President, Portfolio	Swedish company providing healthcare and treatment solutions such as radiation therapy. The size of company is 3000-4000 employees, and generated more than 1.5 Billion USD annual revenue recently	130 Mins, R	F
47	Vice President, Portfolio Lead			
48	Vice President, Portfolio			
49	Vice President, Portfolio Plan			
CASE-5				
50	Manager, R&D Portfolio & Strategy	Danish company developing dermatological products, having 4500-5500 employees, & generated more than 1.5 Billion USD annual revenue recently	129 Mins, R	F
CASE-6				
51	Project Portfolio Manager, Manufacturing Devices	Danish pharmaceutical company developing products for managing chronic conditions such as diabetes, obesity, having more than 40000 employees, and generate more than 17 Billion USD annual revenue recently.	121 Mins, R	F

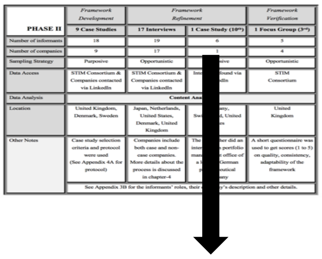
CASE-7				
52	Director, Innovation Portfolio	Danish company manufacturing hearing aids and has about 3500-4000 employees. The company generated more than 0.5 Billion USD annual revenue recently	51 Mins, R	F
53	Director, Innovation Planning			
54	Project Portfolio Manager			
CASE-8				
55	Director, Innovation Project Management	Danish company supplying medical devices to hospitals, have 2000-3000 employees, and generated more than 0.35 Billion USD annual revenue recently	46 Mins, R	F
CASE-9				
56	Global Innovation Operations Manager	Swedish company manufacturing consumer electronic appliances, have more than 50000 employees, and generated more than 15 Billion USD annual revenue recently	60 Mins, R	O

Stage II: Framework Refinement



17 Interviews

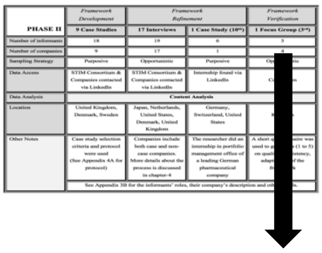
Informant ID	Informant Role	Company's/University's Name/Description	Location	Duration*	Mode**
57	Professor in Innovation	A leading technical university in Japan	Japan	90 Mins, NR	F
58	Project Director	Japanese Information Technology and Services provider	Japan	120 Mins, NR	F
59	General Manager, Corporate R&D	Japanese manufacturer of heavy equipment such as ships, aircraft engines	Japan	30 Mins, NR	F
60	Professor in Innovation	A leading technical university in Japan	Japan	120 Mins, NR	F
61	Former Vice President, Television Division	Japanese manufacturer of consumer electronic goods such as television, phones	Japan	60 Mins, NR	F
62	Independent Board Director	Japanese manufacturer of printers, phones	Japan	60 Mins, NR	F
63	General Manager, Open Innovation	Japanese manufacturer of medical devices such as thermometers, nebulizers	Japan	60 Mins, NR	F
64	Adjunct Assoc. Professor in Business Administration	A leading university in United States	United States	60 Mins, NR	O
65	Senior Research Associate	A leading university in United Kingdom	United Kingdom	60 Mins, NR	F
66	Senior Consultant in Product Innovation	Dutch manufacturer of consumer electronics such as television, grooming machines	Netherlands	60 Mins, NR	F
67	Director, Innovation & Front-End Portfolio	Case-7 company	Denmark	60 Mins, NR	F
68	Project Portfolio Manager, Medical Devices	Case-6 company	Denmark	60 Mins, NR	F
69	Head of Technologies	British manufacturer of industrial diamonds	United Kingdom	45 Mins, NR	F
70	Head of Global Portfolio Management Office	Case – 2 company	Denmark	60 Mins, NR	F
71	Global Head, Innovation Management	Dutch company providing financial and banking services such as retail banking, asset management and insurance services	Netherlands	65 Mins, NR	F
72	Innovation Management Consultant I				
73	Innovation Management Consultant II				
74	Global Portfolio Manager, R&D	Case-3 company	United Kingdom	45 Mins, NR	F
75	Vice President, Research	Dutch company producing oil and gas	United Kingdom	60 Mins, NR	F



10th Case Study

Informant ID	Informant Role	Company's Description	Location	Duration*	Mode**
76	Senior Director, Head of Global Portfolio Management	European pharmaceutical company producing drugs for treating chronic diseases such as cancer. The company employees 20,000-50,000 employees and generated more than 8 Billion USD annual revenue recently.	United States	30 Mins, NR	O
77	Director, New Product Planning			30 Mins, NR	O
78	Vice President, Head of Global Portfolio Management		Germany	45 mins, NR	F
79	Director, R&D Controlling			60 Mins, NR	F
80	Senior Director, Head of Global Portfolio Management			90 Mins, NR	F
81	Head of Strategy Development			45 Mins, NR	F
82	Senior Vice President, Research		Switzerland	30 Mins, NR	O

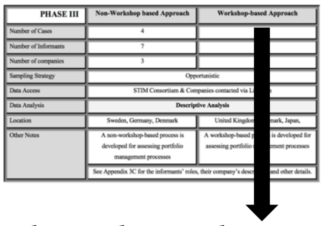
Stage III: Framework Verification



3rd Focus Group

Informant ID	Informant Role	Company's Description
83	Technology Transition Lead	British pharmaceutical company producing drugs for diseases such as cancer, diabetes
84	Coordination & Technology Manager	Spanish chemical company specialising in energy materials
85	Innovation & Growth Leader	
86	R&D Product Manager	British research and technology company specialising in welding
87	Technology Assurance Manager	British company managing licensing of nuclear technology
Location	United Kingdom	
Duration	90 Mins	

APPENDIX 3C: PHASE III INFORMANTS' ROLES & COMPANY'S DESCRIPTION



PHASE III	Non-Workshop based Approach	Workshop-based Approach
Number of Cases	4	
Number of Informants	7	
Number of companies	3	
Sampling Strategy	Opportunistic	
Data Access	STIM Consortium & Companies contacted via Li[illegible]	
Data Analysis	**Descriptive Analysis**	
Location	Sweden, Germany, Denmark	United Kingdo[illegible]mark, Japan,
Other Notes	A non-workshop-based process is developed for assessing portfolio management processes	A workshop-based p[illegible] is developed for assessing portfolio [illegible]ement processes
	See Appendix 3C for the informants' roles, their company's descr[illegible] and other details.	

(adapted from Table 3.6)

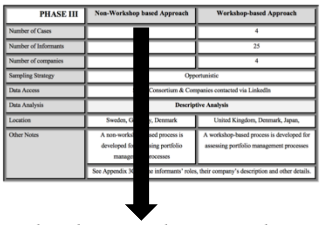
Workshop-based Approach

WORKSHOP BASED ASSESSMENT- 1	
Location	Japan
Duration	240 Mins
Company's Description	Japanese manufacturer of heavy equipment such as ships, aircraft engines, turbochargers
Informant ID	**Informant Role**
88	R&D Manager, Advanced Applied Science
89	R&D Manager, Materials
90	R&D Manager, Structural Strength
91	R&D Manager, Vibration Engineering
92	R&D Manager, Heat & fluids
93	R&D Manager, Computational & Mathematical

WORKSHOP BASED ASSESSMENT- 2	
Location	United Kingdom
Duration	240 Mins
Company's Description	British company specialising in diamond exploration, diamond mining and industrial diamond manufacturing
Informant ID	**Informant Role**
6	Technology Innovation Manager
4	Head of Technology
5	Head of R&D
97	Technical Manager
98	Program Manager

WORKSHOP BASED ASSESSMENT- 3	
Location	United Kingdom
Duration	240 Mins
Company's Description	See Case-3 company in Phase II
Informant ID	**Informant Role**
44	Global Portfolio Manager, R&D
45	Incubation Portfolio Manager
101	Portfolio Manager, Automotive
102	Portfolio Manager, Architectural
103	R&D Program Manager

WORKSHOP BASED ASSESSMENT- 4	
Location	Denmark
Duration	240 Mins
Company's Description	See Case-2 company in Phase II
Informant ID	**Informant Role**
43	Head of Portfolio Management Office
105	Senior Project Manager, Project Setting
106	Lead Project Manager
107	Process Consultant
108	Senior Project Manager, End to End Excellence
109	Portfolio Analyst
110	Senior Master Data Consultant
111	Project Manager
112	Project Assistant



Non-workshop-based Approach

NON-WORKSHOP BASED ASSESSMENT -1	
Location	Sweden
Company's Description	See Case-9 company in Phase II
Informant ID	**Informant Role**
56	Global Innovation Operations Manager

NON-WORKSHOP BASED ASSESSMENT -2	
Location	Denmark
Company's Description	See Case -6 company in Phase II
Informant ID	**Informant Role**
52	Director Innovation & Front-end Portfolio

NON-WORKSHOP BASED ASSESSMENT -3	
Location	Germany
Company's Description	Germany company providing telecommunication devices and services
Informant ID	**Informant Role**
113	Innovation Consultant
114	Innovation Consultant
115	Innovation Consultant
116	Innovation Consultant
117	Innovation Consultant

APPENDIX 5A CASE STUDY PROTOCOL

Background information of the interviewee & general idea about portfolio in discussion

- What is your current role in this organisation?
- Can you give a brief overview of your business unit/division?
- Are you involved in portfolio management in this organization and how?
- Can you describe the portfolio (and its context) which will be referred in further discussion?
- What does portfolio management mean in this organization and how important is it?

Portfolio Management Process

- Can you describe the process of portfolio decision-making in this organization?
- Is there any formal guide which is used to carry out portfolio management activities?

Planning

- How would you describe the overall portfolio planning in this organization?
- What is the role of business strategy in shaping a portfolio?
- What kind of information is needed to plan a portfolio, & how do you get it?
- Who are involved in portfolio planning and how (e.g. method)?
- How would you describe the overall focus (e.g. time, capability, technology, strategy) of a portfolio?
- What role does a customer play in defining a portfolio and how?

Decision-Making

- How would you describe the overall portfolio selection process?
- What type and levels of details are needed about a project to be considered in a selection process?
- How do you obtain project level information and how useful these details are usually?
- How would you describe resource management in context of a portfolio?
- How would you describe the level of resource commitment to new projects in a portfolio during selection process?
- What type of methods and criteria are used for selecting projects in a portfolio?
- How would you describe the overall portfolio review process?
- On what basis projects are terminated, and how often?
- How do you plan or prepare for risk and uncertainty in portfolio context?
- How adaptable a portfolio is in this organization?
- How does the learnings/value from previous and ongoing projects in a portfolio are captured?
- What role does this learning play in overall portfolio management process?

Performance

- How do you assess the performance of a portfolio?
- How would describe tangible and intangible value (its management) of a portfolio?
- How would you describe strategic alignment of a portfolio?
- What does portfolio balance signify in this business/organization context, and how is it obtained?

Characteristics of portfolio management process

- Which internal and external factors influences a portfolio?
- How formal is the portfolio management process?
- How consistent is this process?
- How often this process is changed, and what kind of changes (and triggers) are made in process?
- What do you think is working well in the existing portfolio management process?
- What are the weaknesses/challenges of this process?
- Any other point which you would like to mention about portfolio management in this organization which we have not touched upon so far?

APPENDIX 5B SAMPLE OF CODING

Extract from one of the interview transcripts

Codes

So, we will end up with a ranking of ideas based on financial attractiveness and we'll have a rank from number one down to, for instance, project number 50 as lowest interesting project. But we have not looked, at that time, at strategic fit. We will do that later on because, I will say, seeing it from an execution point of view, I know how many projects we can run in parallel. I know we can, in this company, we can run 20 projects of a certain complexity at the same time. Nothing more, that's the absolute limit we have. Then I check the top 20 and say, okay, these are the most financially attractive projects, and they should be timed in a certain order to avoid bottle necking…[…], here with the portfolio review, we will have that ranking and then we'll see, well may be rank num-ber 30 and 40, those two projects, they have so high strategic importance, but it's highly innovative…[…]..so, we rank them higher, we put them among the top 20.

Assess business cases using criteria such as financial attractiveness

Check resource availability for ranked projects

Become aware of operational capability

Decision-makers prune priority list

APPENDIX 5C FEEDBACK FORM FOR FRAMEWORK V.2/V.3

FEEDBACK FORM

Portfolio Management Process Framework

The aim of this questionnaire design is to capture feedback on the portfolio management process framework discussed recently and identify opportunities to make it more practical and robust.

Filled by: Name:
Company:
Date:

1. What is the level of intuitiveness of the framework in terms of designing or improving an overall portfolio management approach- how self-explanatory is it (i.e. **usability**)?

Low (challenging to	1	2	3	4	5	High (easy to use)

2. Does the framework have an appropriate level of depth and breadth of details & scope capturing key aspects of portfolio management in practice (i.e. **completeness**)?

Low level of completeness	1	2	3	4	5	High level of completeness

3. Using this framework, can you generate useful insights or pointers for understanding/designing/improving portfolio management in your organization (i.e. **quality of framework**)?

Low level of quality	1	2	3	4	5	High level of quality

4. What level of clarity (or coherence of content) did this framework have in depicting portfolio management in your organization (i.e. **consistency**)?

Low level of consistency	1	2	3	4	5	High level of consistency

5. Can this framework be adapted or configured according to context of portfolio management in your organization (i.e. **adaptability**)?

Low level of adaptability	1	2	3	4	5	High level of adaptability