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DEVELOPMENT OF A PROJECT MANAGEMENT METHODOLOGY FOR USE IN A UNIVERSITY-INDUSTRY COLLABORATIVE RESEARCH ENVIRONMENT

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ABSTRACT

This study examines the growth, need for and demands on university-industry collaborative (UIC) partnerships as a vehicle for the nation's development through technological innovation. In Malaysia, gaps and weaknesses exist when compared to best practices, these limit the establishment and overall effectiveness of UICs. In the Malaysian context, UICs are by no means a new phenomenon, however the approaches adopted, the success stories and related issues have not received significant academic attention. Thus, this study aims to provide an insight into collaborative endeavours in Malaysia. This study adopted an exploratory interpretative case study approach via semi-structured interviews and self-administered questionnaire survey to collect data from university researchers, industry players and research agencies. This data, along with the findings from an extensive literature review were used to benchmark best practices and define the requirements that are placed on a PMM designed specifically for use in the Malaysian UIC project environment. Based on this analysis, a novel and appropriate PMM was developed and subsequently evaluated by an expert panel and iteratively refined. The primary outcome of this study is a PMM guidebook for use in the initiation, planning, execution, monitoring and closing of UIC research projects. The PMM developed aims to make project management best practices accessible and appropriate for the needs of UIC researchers and also encourages academic researchers to embrace project management knowledge which in turn helps them to understand industrial needs and wants. The PMM developed is customisable for project size and nature. It consists of a set of processes, templates, tools and techniques to assist in the planning and management of the project throughout the entire life cycle. The components of the PMM are (1) project management processes such as initiating, planning, executing and monitoring project progress with (2) a selection of tools and techniques to communicate delivery to the satisfaction of all stakeholders; (3) consolidated and integrated set of appropriate best practices and values of project management and (4) a list of references of terminology as a common denominator and language for us in the project environment.

PUBLICATION

JOURNAL PAPERS

1. **Chin, C.M.M.,** Yap, E.H. & Spowage A.C., (2011), Project Management Methodology for University-Industry Collaborative Project, published in the **Review of International Comparative Management**, Vol 12, Issue 5, ISSN 1582-3458
2. **Chin, C.M.M.,** Yap, E.H. & Spowage A.C., (2011) Project Management Methodologies: A Comparative Analysis published in the **PM World Tomorrow Journal**, Summer, Vol 1, Issue 1.
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4. **Chin, C.M.M** & Spowage A.C., (2010), Classifying & Defining Project Management Methodologies, published in the **PM World Today eJournal** Feature Paper, May 2010, Vol XII, Issue V.
5. **Chin, C.M.M.,** Yap, E.H. & Spowage A.C., (2010), Reviewing Leading Project Management Practices, published in the **PM World Today eJournal** Feature Paper November 2010 Vol XII, Issue XI.
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CONFERENCE PROCEEDINGS

1. **Chin, C.M.M.,** Yap, E.H. & Spowage A.C, (2011), Development of a Project Management Methodology for Use in a University-Industry Collaborative Research Environment, accepted for the **10th European Conference on Research Methodology for Business and Management Studies** on 20 -21 June 2011 in Caen, France.

2. Jamaluddin, R., **Chin, C.M.M**. & Lee, C.W., (2010), Understanding the Requirement of Project Management Maturity Models: Awareness of the ICT Industry in Malaysia, presented at the **IEEE International Conference on Industrial Engineering and Engineering Management** on the 7 – 10 December 2010 in Macau.
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POSTER PRESENTATIONS

1. **Chin, C.M.M**., (2010), Developing a Project Management Methodology for University-Industry R&D Collaborative Projects, poster presentation for **Celebrating the role of women in Science, Technology, Engineering and Medicine (STEM)** at the University of Nottingham, UK on 13 October 2010.
2. **Chin, C.M.M.,** (2009), A Project Methodology for Managing University-Industry R&D Collaborative Projects, poster presentation at the **UNMC Graduate School Conference** on 7 August 2009, University of Nottingham Malaysia Campus
3. **Chin C.M.M,** (2008), A Project Methodology for Managing University-Industry R&D Collaborative Projects, poster presentation in the **Malaysia Nottingham Doctoral Programme (MNDP)** on 10 November 2008, University of Nottingham Kuala Lumpur Teaching Centre.

CONTRIBUTIONS / ACHIEVEMENTS

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2. Participant in the Malaysian Education Colloquium – Closing the Education-Industry Gap: The Way Forward on 29 June 2010 organised by University Tunku Abdul Rahman (UTAR)
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4. Reviewer for the IEEE International Conference on Industrial Engineering and Engineering Management (IEEM) 2009 & 2010

5. Reviewer for the IEEE International Conference on Management of Innovation Technology (ICMIT) 2010
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7. Deliver talk to University of Nottingham Malaysia Campus Final Year Computer Science Undergraduate on Project Management Methodology for use in Research Project in the Autumn 2008 semester, Autumn 2009 semester and Autumn 2010 Semester.
8. Developed a Project Management Methodology Guidebook for Doctoral Research Project in University of Nottingham Malaysia Campus- 2009
9. Developed a Project Management Methodology Guidebook for Final Year Undergraduate Projects in University of Nottingham Malaysia Campus - 2008

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CHAPTER 1 INTRODUCTION

1.1 Background of the Research

The concept of university-industry collaboration (UIC) is nothing new. Related research works on UIC were initiated more than 30 years ago in the United States (Bacila & Gica, 2005; Romero, 2007; Zaky & El-Faham, 1998). Two decades later, Europe and the UK were leading the research effort to bridge the gaps and to establish closer links between universities and industry. Today the need to form a strong partnership between university and industry still exists (Zaky and El-Faham, 1998, Elmuti et al., 2005, Yee et al., 2009a).

The formation of UIC partnerships can be as simple as a hand-shake based on a prior relationship to a complex negotiation involving issues of intellectual property rights (IPR), licensing or other forms of contractual agreement. These negotiations frequently increase complexities and causes conflicts between the industrial and university actors. Yet substantial research suggests that discussion and subsequent agreement on such matters is essential to mitigate longer term issues, facilitate the formation and subsequently sustain the partnership (Matthew and Norgaard, 1984, Koech, 1995).

Nevertheless it is the perceived potential of UIC partnerships which has caught the attention and focus of governments, industry and universities. By collaborating, all partners have the potential to access a wider range of ideas, facilities and expertise (Butcher and Jeffery, 2007), lower risks by sharing resources (Parnami and Bandyopadhyay, 2008), enhance knowledge creation (Herman and Castiaux, 2007) and subsequently technology transfer (Klawe, n.d.). Thus, establishing the foundation of such partnerships and ensuring that they function in an efficient and effective manner offers significant promise for development.

However, the initiation and operation of UIC partnerships are beset with various problems (Koech, 1995). Some of the primary barriers to the formation of significant UIC partnerships are associated with the vastly different cultures and motivations (Augustine and Cooper, 2009, Sherwood et al., 2004) and the distinct operational environments of the relevant organisations (Harris, 2007). The most frequent obstacles cited are associated with the bureaucratic structures and processes that are unresponsive to the unique needs of upstream collaborations (Matthew and Norgaard, 1984). Other commonly cited reasons for UIC project failure includes the different objectives of the organisations, variable level of commitment (Harris, 2007), the failure to establish trust (Davenport et al., 1999), a lack of insight into the importance of planning and management of the projects and poor partner selection (Holmberg and Cummings, 2009, Butler and Gill, 2001, Sherwood et al., 2004).

To enhance the successful operation of UIC, Katz and Martin (1997) identified a need for more formal management procedures. Gist & Langely (2007) further noted the importance of project management tools and techniques as an added value for university researchers. Whilst others believe the benefits and importance of a project management methodology (PMM) are associated with its structured approach to the management of collaborative research projects. Despite considerable effort given over to the promotion of UIC partnerships, only limited efforts have been made to improve the project management skills of the actors involved (Kirkland, 1992).

Although there are contradicting views, this study aims to establish a clear need for an appropriate PMM by identifying the benefits of using PMM to manage UIC research projects. Furthermore, it also aims to extract the best practices associated with the management of UIC projects and to use these to develop a comprehensive and detailed PMM guidebook suitable for managing UIC projects in Malaysia. The PMM guidebook is aimed at guiding university and industrial partners to initiate, plan, execute, monitor/control and close their projects. Through the use of the PMM, this study anticipates that the challenges of sustaining UIC partnership in the Malaysian research environment will be minimised and the probability of delivering projects enhanced.

1.2 Research Problem and Objectives

Numerous previous studies have focused on the success elements, planning and management of UIC projects to examine how to strengthen the relationship between industry and university (Carboni, 1992, Matthew and Norgaard, 1984, Mattessich and Monsey, 1992, Harris, 2007). Creating a successful collaboration is now considered to be more than a matter of creating an effective and orderly structure. Rather there is a need to integrate the concepts of project management with the research processes and simultaneously leveraging on the respective mutual strengths.

The utilisation of a PMM is widely recognised to enhance the probability of completing projects on time. Although PMMs have existed for over 30 years, their use is not widely adopted in the management of UIC research projects. The key reason identified being that the academic mindset commonly has a preconceived notion that project management is impractical for the management of research projects and also places a significant administrative burden on researchers. This contributes to the impending intellectual exposure of project management knowledge and practices at the university level. In order to leverage on the advantages associated with the use of modern project management methods, a need exists to integrate project management concepts into the research process.

Matthew & Norgaard (1984) further noted that the most frequent obstacles tend to be its bureaucratic structures and its unresponsiveness to the needs presented by the collaborators where many universities are not appropriately equipped to handle these linkages. This has resulted many partnership structures were established on ad hoc basis. In support of Matthew & Norgaard (1984) studies, the findings by others (Royal Irish Academy, 2006, Gist and Langley, 2007, Newby, 1997) equally indicated a lack of understanding and awareness of PMM, citing that the majority of academic see project management as an additional bureaucratic and administrative burden rather as a management tool.

In addition, university researchers carry multiple and complex roles (Oosterlinck, 2005, Kanter, 1994) for example, to attract, negotiate and execute research collaborations with industry partner and other funding institutions while simultaneously administering the various parts of the project structures to ensure both parties work together smoothly (Business-Higher Education Forum, 2001). Though there are contradicting reports, this study aims to clarify that whilst identifying the requirements suitable for designing a PMM and to highlight its benefits for managing UIC research projects. Furthermore, this study aims to extract the best practices and lesson learned in the planning and management of UIC projects for utilisation and implementation in the Malaysian UIC research environment.

A need therefore exists in theory as well as practice for a more thorough insight into the application of PMM consolidating the best practices for the management of UIC R&D projects. This study aims to fulfill this inquiry by developing a PMM guidebook which will guide university researchers and industrial partners in the process of initiating, planning, executing, monitoring, closing and sustaining UIC partnership by instilling these best practices to mitigate the raising challenges of running a UIC in the Malaysian market.

Thus, the study will investigate on the available best practices adopted by university and industry in the management of UIC research partnerships in Malaysia. The theoretical principles and practices will be extracted and consolidated into a concise PMM guidebook as the final output from this study. The specific research objectives (RO) are as follows:

RO1: To identify the requirements to be placed on a PMM suitable for the management of UIC research projects.
RO2: To review the significant growth and need of UICs in the Malaysian context and to investigate the current practices used to manage UIC partnerships.
RO3: To conceptualise and develop a PMM guidebook for adoption in a Malaysian UIC research environment.

RO2 which is a pre-requisite for the construction of the methodology is sub-divided into the following research questions which are discussed in detail in chapter 3.

- What are the driving factors for the formation of UIC?
- What are the problems/challenges anticipated in UIC?
- What are the best practices for the management of UIC?
- What are the processes involved in the operation/management of UIC?

1.3 Research Methods and Procedures

The research method adopted in this study is the exploratory case study. Two techniques are used to gather data from respondents in the university and industry; semi-structured interview and questionnaire survey. The collected interview data is then transcribed, categorised, presented and cross-checked with other sources of evidence using the triangulation process. The completed interview analysis reports will be send to key respondents to validate their supplied information and to supplement any recommendations and improvements prior to the development of the pilot PMM. The pilot PMM will evaluated by an expert panel group to assess three criteria; feasibility, usability and usefulness. Results obtained will be analysed to improve the pilot PMM. To evaluate the practicality and applicability of the final model of the PMM guidebook, it will be sent to the expert panel group for final validation.

1.4 Contribution of the Research

Actors from the industrial sector have strongly voiced difficulties in matching their practical approaches with academicians' theoretical view (Wu, 2000) especially in relation to the way projects are managed. University researchers who lack the skills to manage and plan research projects (Gist and Langley, 2007) tend to disregard the importance of the project management elements and functions in the management of collaborative projects while concentrating only on the technical deliverables of the project. Industry players' alternatively, often lack the understanding and appreciation of the academic research process. Communication issues are perhaps the most universally cited reason for UIC failures (Zahedi et al., 2000). Therefore an important element in this study is to develop supporting processes for communication between different players (Keraminiyage et al., 2009).

This study also creates awareness of the importance of recruiting a project manager, who has exposure to the academic environment as the collaborative agent (Gerardi and Wolff, 2008, Walker et al., 2009). As observed by Gerardi and Wolff (2008), each partner should have their own agent, a mediator in the partnership. The importance of the collaborative agent's role is to oversee the project work, reporting to the industrial partners and to act as a communicator between researchers and the technical liaison to oversee the potential conflict and cultural differences inherent between organisations and the various players. Based on the interview data analysed, none of the UIC partners appoints their own project manager to oversee the project. The majority of project managers are assigned by the industry players. Hence, this research would like to stress the need and importance to recruit a project manager as the collaborative agent to act as a liaison officer in the management of UIC projects.

Finally, this study contributes to the body of knowledge regarding UIC in Malaysia which have previously received very little academic attention. It further explores the work by Yee et al. (2009b) by focusing on the aspects of project management for UIC that were not explored in their study (Yee et al., 2009b). It also aims to contribute to the policy and practices of Malaysian UIC partnerships in the aspect of project management knowledge and application which has previously not been investigated. Studies by other research teams also agreed that the level of interaction and collaboration between UIC in Malaysia are still very limited which significantly impedes collaborative potential (Ali, 2003, Abdul Razak, n.d., Zakariah et al., 2004, Malairaja and Zawdie, 2008). With a growing number of initiatives initiated by the Malaysian government in recent years, strong drivers exist to collect more data on the conduct of UIC project management processes and further enhance the management of UIC projects.

In summary, this study provides a dyadic view on the best practices and lesson learned from previous and existing UIC projects derived from the literature and case studies carried out. The final output and contribution of this study relates to the development of a generic PMM guidebook encompassing project management best practices, project management processes, tools and techniques, templates and checklist designed for use in the management and planning of UIC projects.

1.5 Limitations and Key Assumptions

This study has several limitations which need to be identified clearly to minimise the risk of scope extension. These include:

1. The willingness and ability of the organisations and the project leaders (respondents) to voluntarily participate in this study. Privacy and confidentiality

of information obtained needed to be ensured. Thus an ethical protocol was developed and strictly adhered to; this limited the use of the information collected.

2. This study collected data from public higher educational institutions (PHEI) in Malaysia (West Malaysia and East Malaysia). However, geographical distance affected the practicalities of face to face relationship building with some respondents.
3. Organisations that are geographically dispersed were interviewed via non-conventional communication mediums such as Skype or electronic mail. Potential technical distortion and viability of such communication tool may affect the data collection process and the different assessment methods may results in biased interpretation.
4. Due to the nature of this type of research work and the research methods employed, misinterpretation, bias or under representation may have occurred. Every attempt has been made to minimise these errors by applying tested analytical methods, validating the finding and rigorously analysing the results.
5. This study focused on examining UIC engineering based R&D projects. It is therefore possible that some findings may not be representative of projects in different disciplines.
6. Data will be collected from a dyad perspective (industry, university and government and research agency). However, it is limited within the parameters of public higher education institutions in the Malaysian context.

1.6 Outline of Thesis

Chapter 1 provides an introduction to the background of the research problem. This chapter outlines the research objectives, problems, significant contributions and motivation behind the proposed research. It also provides an outline of the thesis and boundaries of the research.

Chapter 2 starts with an overview of the literature, first defining what project management methodologies (PMM) are. By leveraging the literature, this chapter classified the PMM into five different levels based on their degree of specificity. The next section of this chapter focuses on conventional project management best practices, standards and principles which will form the theoretical basis for any methodology developed. A comparison of the five groups of leading approaches to project management practices, their merits and drawbacks, the structures and components of each are discussed. The aim of this work is to define the combination of project management practices which, when integrated together, give the optimum probability of delivering the project objectives within budget and on time within the specific UIC project environment. Section three reviews and compares existing PMM used by academic institutions, industry and government linked organisations. Methodologies from a total of 34 organisations were identified, examined and categorised into academic institutions methodologies; industry methodologies and government methodologies. All the PMM identified were compared using the same list of elements to give a balanced view and a list of identified requirements to be placed on a PMM was derived.

Chapter 3 presents an overview and critical analysis of the literature related to the definition of UICs, the driving and motivational factors leading to their formation and challenges commonly encountered from a dyadic perspective. A generic UIC lifecycle that describes the stages of UIC's establishment (initiation), operation (project planning, executing & monitoring) and evaluation (closing) are discussed. The next section concentrates on Malaysia's UIC challenges and concerns which limit the potential they hold to contribute to the national agenda.

Chapter 4 discusses the research workflow, paradigm, strategy and experimental approach utilised in this study and its rationale for adoption. The following section in this chapter explain the cases selected for assessment, selective unit of analysis, data collection techniques and method of data analysis based on the examined research methodology. This chapter concludes by discussing the techniques used to test the reliability and validity of results obtained.

Chapter 5 presents the results obtained from the semi-structured interviews conducted with both university and industry partners involved in the UIC partnerships identified. Each interview was transcribed, reviewed and coded to generate themes for discussion in chapter 6. The second section includes an analysis of the results obtained from survey's which aim to validate the requirements and practices of a PMM and its maturity level in Malaysian UIC project environment.

Chapter 6 discusses the formation of the PMM framework derived from the extensive literature and data collected from interviews and surveys. The following section describes the pilot PMM, the feedback, review and suggestions for improvement obtained from subject matter experts in validating the conceptualised PMM.

Chapter 7 presents the final PMM components and structures upon refinement that incorporates the suggestions from experts in the evaluation process. A detailed discussion of each module and its activities from the PMM guidebook are described and presented. Evaluation and validation results from the final PMM guidebook are presented and the complete PMM guidebook is enclosed (see Volume II).

Chapter 8 concludes by restating the purpose of the research and concludes with the key findings from each research objectives. It also presents the contribution of this study and its implications to policy and practice. Finally, chapter 8 reflects on the limitations of this study and its direction for future research.

This chapter provided an overview of the research background, objectives, research significance and the structure of the thesis as shown in Figure 1.1. In the next chapter, a detailed literature review on existing PMM is presented.

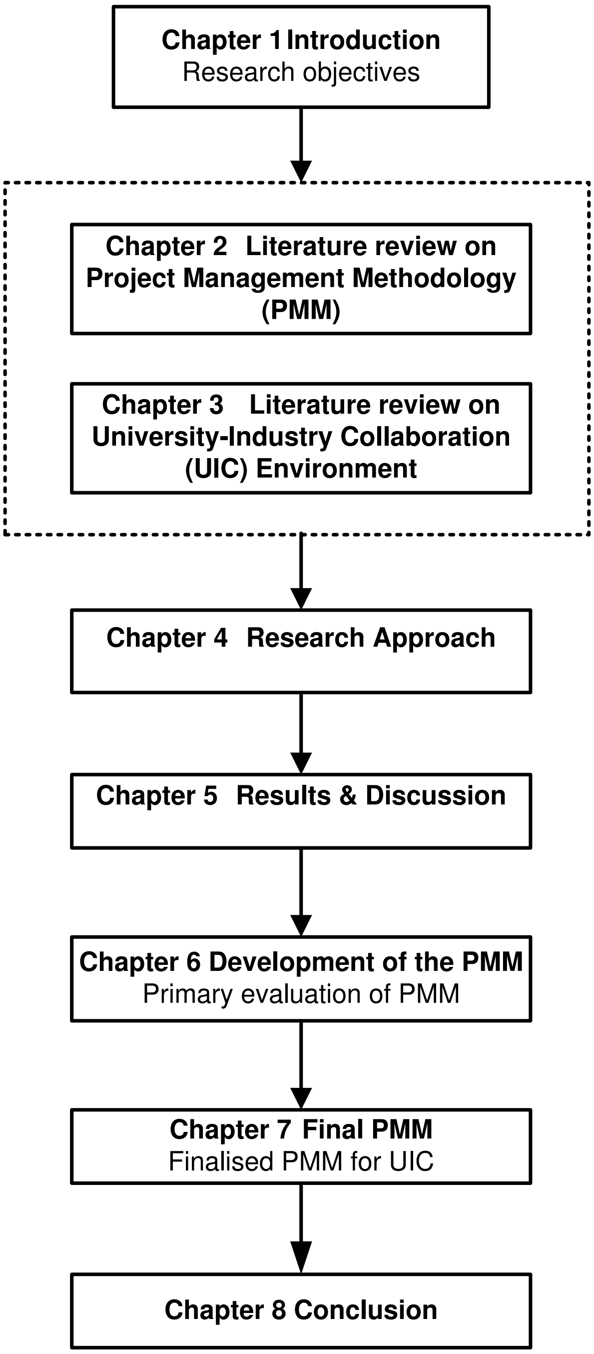


Figure 1.1 Structure of thesis

CHAPTER 2 LITERATURE REVIEW ON PROJECT MANAGEMENT METHODOLOGY

2.1 Introduction

This chapter presents a review of the pertinent literature which supports the development of the project management methodology (PMM) in this research. The objective is to identify the requirements to be placed on a PMM suitably designed for the management of university-industry collaborative (UIC) research projects. This chapter contributes to this objective through review, comparison and evaluation of five groups of leading project management best practices. This work will distil the most appropriate best practices for integration into a PMM designed specifically for the UIC project environment. This chapter will also review three categories of organisation specific methodologies and classify the methodologies into five distinct levels.

2.2 Defining a Project Management Methodology

Across all industrial sectors, project management has become an essential element in the successful delivery of projects. Regardless of the industrial sector or the size of project, PMM can be applied to improve the probability of meeting project goals. It is also widely recognised by researchers that the use of a suitable PMM will increase the likelihood of project success (Charvat, 2003, Milosevic and Patanakul, 2005, Pitagorsky, 2003). The advantages of using a PMM have been expressed by a number of authors (Charvat, 2003, Pitagorsky, 2003, Turbit, 2005, Kautz and Pries-Heje, 1999). For example, by applying a formalised PMM it helps to clarify goals, identify the resources required and ensure high accountability of results and enhance performances (Project Management Fact Sheet, 2004). By implementing a methodology, the likelihood of the project succeeding will be higher as well as the probability of delivering the project within scope, budget and on time. One of the best practices in facilitating the adoption of PMM is to ensure that the methodology clearly defines the roles and responsibilities, promotes open and direct channels of communication (Charvat, 2003) and allows those involved to immediately see the advantages to be gained through using a rigorously developed methodology. Though the use of PMM increases the likelihood of project success, this is conditional on the project manager's understandings on the nature of the project and how he is able to customise the methodology to suit the projects.

By definition there can be no single generic PMM that can be universally applied to manage all projects across all sectors (Cockburn, 2004, Charvat, 2003). A wide range of sector specific methodologies exist, however many are not fully developed and none met the specific needs of UIC research projects. In addition, a number of studies have also revealed that PMM are often underused, wrongly used, are unusable or simply oversold (Charvat, 2003, Kautz and Pries-Heje, 1999). Therefore there is no universal agreement as to what constitutes a PMM. However, from a detailed examination of the many definitions, descriptions and general discussions within the literature one can extract the components and the requirements to be placed on a PMM.

In general, a PMM must be clear in what it covers; be simple to understand and apply and above all it should be useful (Charvat, 2003). It should provide standard methods and guidelines to ensure that projects can be completed on time, within budget and are conducted in a disciplined, well-managed and consistent manner that serves to promote the delivery of quality results (Josler and Burger, 2005). According to Murch (2001), it is a road map to get you from where you are to where you want be. It is definitely not merely a series of templates, forms and checklists although it will typically contain these (Turbit, 2005). PMM identify specific approaches to managing each aspects of the project in the form of general and sector specific procedures, rules and regulations which set the standard to ensure quality and control (Josler and Burger, 2005, Pitagorsky, 2003). It also provides a means of identifying the risks and opportunities associated with the project. In a broader sense, a PMM includes a wide range of knowledge areas and a set of tools and techniques for supporting and managing each aspect of the project (Pitagorsky, 2003, Milosevic and Patanakul, 2005).

Utilising PMM is widely cited to enhance the probability of completing projects on time, within budget and to deliver the product to the satisfaction of all involved (Charvat, 2003, Munns and Bjermi, 1996, Milosevic and Patanakul, 2005, Pitagorsky, 2003, Josler and Burger, 2005). It should however, be noted that these conclusions are typically based on larger, more complex projects in a commercial environment.

According to Cockburn (1999), project methodologies need to function effectively for the full range of projects carried out within a specific company even when project characteristics such as team size, project criticality, nature and scope all vary widely. Thus the methodology needs to be adaptable to project scale, for example as the project size grows larger, the scale and adaptation of the methodology will typically increase. In such cases it will typically be used to manage more resources and manpower, more tasks and larger budgets. As a consequence, the sophistication of the tools, techniques and processes employed will need to be similarly expanded. However, with the significant increase in project scale, every project requires the same level of transparency, accountability and traceability in documentation. In addition, the number of communication channels between team members, suppliers and stakeholders will be more complex as the project scale increases.

Hence, a PMM must provide the project team with a set of processes which can be scaled or substituted as required on a project by project basis to assist their management throughout its entire lifecycle. By using a PMM, project teams will be able to clearly understand their scope of work, what each of them needs to accomplish, how their work fits in which contributes to the project as a whole and to provide the tools and techniques to aid the project success.

Based on the previous discussion, a list of selected definitions on PMM from leading researchers and practitioners is examined below;

> A good project management method will guide the project through a controlled, well-managed, visible set of activities to achieve the desired results. It means managing the project in a logical, organised way following defined steps (PRINCE2, 2005), p.2.

"A methodology is a set of guidelines or principles that can be tailored and applied to a specific situation. In a project environment, these guidelines might be a list of things to do. A methodology could also be a specific approach, templates, forms, and even checklists used over the project life cycle" (Charvat, 2003), p.17.

"An assembly line that defines who should perform what task, when, where, why and how (4W+H). It consist of a WBS, to shows the dependencies between steps in a project, using a different level of abstraction which breaks the project into smaller, more manageable pieces/phases/activities. Includes a beginning phase for planning, *middle phase for execution and final phase for review/audit"* (Bryce, 2008).

"It provides a standard method and guidelines to ensure that projects are completed on time and within budget and are conducted in a disciplined, well-managed and consistent manner that serves to promote the delivery of quality products and *results"* (Josler and Burger, 2005).

"It is a road map to get you to where you want to be. It delivers value and productivity to the organisation. It converges with project management techniques, process management techniques and others to address application development *problems"* (Murch, 2001).

The above definitions can be used to further extract the requirements to be placed on a PMM. A PMM is the management of projects through the use of appropriate methods according to prescribed practices within a particular project environment. It is concerned with the planning and coordination of projects from conceptualisation to closing with one objective in mind; to meet the requirements of stakeholders within budget and the given timeline. It must be consistent with the standards, rules, regulations and best practices relevant to the project. PMM should be customisable to meet the requirements of every project since it may be impractical to apply one methodology for all projects in the organisation. By using the right methodology, a project manager is able to identify and minimise risks, satisfy stakeholders' expectations and internalise learning from the process. However, in the adoption and use of a methodology, one of the key criteria in this research is to design a dynamic, flexible and adaptive PMM guidebook which should be viable and scalable to suit any project within the specific environment.

Based on the literature discussed above, this study defines a PMM as a comprehensive set of best practices, tools and techniques; that is dynamic, flexible, adaptive and customisable to different projects within a specific environment. The PMM should therefore consist of a set of processes, templates, techniques and tools to assist in planning and managing the project throughout its entire life cycle. The components of the PMM will cover (1) project management processes such as initiation, planning, executing and monitoring project progress with a (2) selection of tools and techniques to communicate the delivery to the satisfaction of all stakeholders; (3) consolidated and integrated set of appropriate best practices and values of project management and (4) a list of terminology as a common denominator and language for use in the project environment.

2.3 Classification of Project Management Methodologies

To develop an effective PMM it is important to leverage on the most effective best practices available. Currently, there is no universally agreed definition of what constitutes a PMM. In order to effectively leverage on existing best practices, it is important to be able to classify them. Thus the aim of this section is to examine, identify and categorise all the leading PMM. This classification will also allow appropriate level of methodologies to be identified and reviewed in section 2.5.

Based on investigated literature, PMM can be classified into two categories (Charvat, 2003, Pitagorsky, 2003, Turbit, 2005, Wideman, 2006); project management methodologies (that provide a high-level framework of the project) and application development methodologies (which provide details on project design and development). The most apparent difference between these two classes is that application development methodologies have a stronger focus on system testing, which is not covered in a PMM.

These earlier attempts at classification were rather coarse, do not clear up the ambiguity regarding the definition of what exactly constitutes a PMM discussed in section 2.2, holds little relevance to sectors other than the IT sector, do not easily facilitate the classification of all available methodologies and further have little practical value or applicability. The confusion within the published literature and by project practitioners as to what constitutes a methodology is understandable as opinions vary widely. Therefore, a more rigorous approach to classification of these PMM was required. As a result of the discussion above, in this study a PMM five level classification system based on their degree of specificity was developed (see Figure 2.1). The levels of the classification system can be summarised as: L1-Best practices, standards and guidelines; L2-Sector specific methodologies; L3-Organisation specific customised methodologies; L4-Project type specific methodologies and L5-Individualised methodologies. Each methodology has a degree of specificity increasing from the root (L1) to the tips of the branches (L5) as illustrated in Figure 2.1.

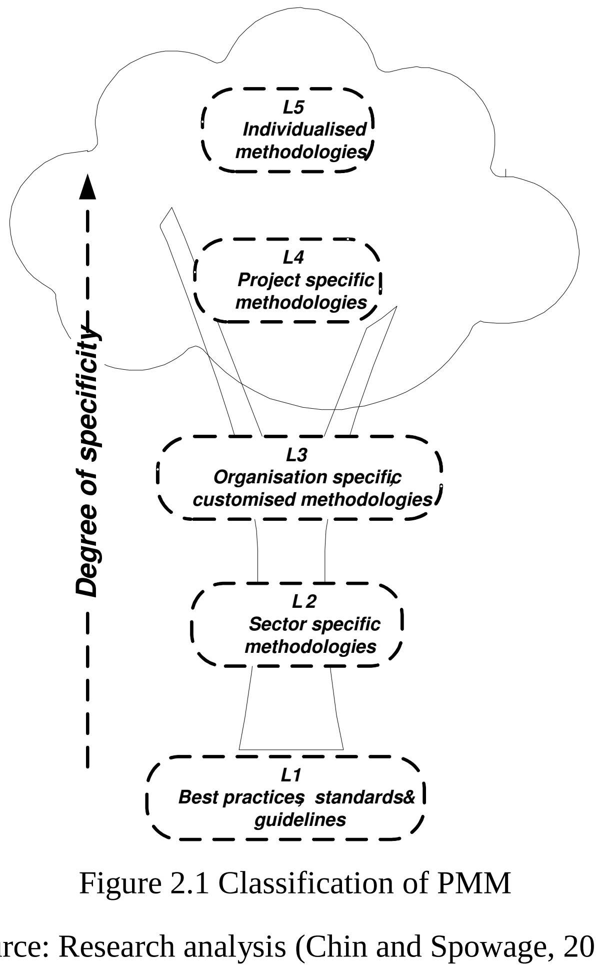


Figure 2.1 Classification of PMM

Source: Research analysis (Chin and Spowage, 2010)

2.3.1 L1 Best practices, standards and guidelines

This group is frequently called "methodologies". However, other prominent authors support the view that these are not methodologies rather they are considered to be the encyclopaedias of best practices (Wideman, 2006, Bolles, 2002). The views of the authors are that L1 lacks the organisational or sector specific characteristics that constitute one of the fundamental characteristics of a methodology. Thus L1 is better described as "best practices". These best practices are extremely valuable sources of information for the development of new PMM particularly when they commonly comprise the syllabus of many project management training courses. The primary material in this group include the Project Management Institutes Body of Knowledge (PMBOK) (PMI, 2000), the Association for Project Management Body of Knowledge (APM, 2000), Project in Controlled Environment Version 2 (PRINCE2) (PRINCE2, 2005), International Project Management Association (IPMA) (IPMA, 2006) and British Standard (BS6079-1:2002) which is discussed in section 2.4.

2.3.2 L2 Sector specific methodologies

The next level contains methodologies which are customised to fit a specific sector. Different industries require distinct variations in project management knowledge as well as sector specific regulations, rules and approaches to run projects. Sector specific methodologies are built by extracting the appropriate elements from the roots (L1) (see Figure 2.1) and adding components required by sector specific rules, regulations, best practices and mapping them to the natural flow of work within the sector.

Among the various industrial sectors, the construction sector makes the most frequent reference to PMM (White and Fortune, 2002, Crawford et al., 2006b, Themistocleous and Wearne, 2000, Betts and Lansley, 1995). Methodologies developed and applied in the construction sector have been very successful in saving developers and countries billions of dollars. However, these methodologies would be completely inappropriate to manage projects in other sectors such as information, communication and technology (ICT) projects. The need for specificity arises due to the differences in nature of the work, flow of work, pressures, skills set of the people involved and the risks and priorities between sectors.

The development and use of ICT sector specific PMM has also increased dramatically in the last decade (Themistocleous and Wearne, 2000). For example software development sector specific (L2) methodologies (e.g. Agile, SCRUM, RAD) are heavily used in the market (Wideman, 2006, Charvat, 2003, Pitagorsky, 2003) increasing competition and complexity as the primary drivers to the development of PMM which needs to meet more demanding projects. Therefore, the identification of the driving factors which make existing approaches inadequate is essential prior to the development of sector specific PMM.

2.3.3 L3 Organisation specific customised methodologies

At L3 organisation customised specific methodology are designed to meet the strategy, structure, nature of projects and needs of a specific organisation. For example, Microsoft has successfully designed, deployed and operated their well-integrated methodology known as Microsoft Solution Framework (MSF). The MSF consists of multiple components: foundational principles, models or disciplines, key concepts, proven practices and recommendations. Each of these components can be used individually or collectively to suit projects of any size or degree of complexity in a flexible and scalable manner (MSF, 2002). IBM similarly has its own effective PMM for the implementation and delivery of projects called the Rational Unified Process (RUP). The RUP is an iterative and adaptable process framework that was created based on Boehm spiral model. It is based on six key principles for business-driven development; **a**dapt the process, **b**alance stakeholders' priorities, **c**ollaborate across teams, **d**emonstrate value iteratively, **e**levate the level of abstraction, and **f**ocus continuously on quality (Kroll and Royce, 2005). Ericsson was an earlier user of the PMM approach introducing a common methodology for handling product development projects known as PROPS (Eskerod and Riis, 2009). PROPS consists of four well defined phase model separated by decision points called tollgates and milestones, a uniform reporting structure built in quality assurance system. The most important features of PROPS that reportedly accounts for its success is its three divisions; the steering function (management control), the project management function and the execution function (the work model) (Mulder, 1997).

Organisation specific customised methodologies have also been adopted by academic institutions. For example, the University of Cornell’s PMM (University of Cornell, n.d.), adopted from the Princeton University and the University of Tasmania’s methodology (University of Tasmania, n.d.) adapted from the Tasmanian Government Project Management Guidelines (Tasmanian Government, 2006). While in other universities, PMM are adopted for administrative, information and technology services (University of South Carolina, 2007, University of Sydney, 2008, University Michigan, 2005). The degree of leverage a specific organisation makes of a L1 and L2 methodologies varies considerably. However, failure of an organisation (particularly by smaller organisations) to extract the know how developed in L1 and L2, will result in their own methodologies missing valuable approaches as well as wasting development cost reinventing the wheel. An important step in implementing a L3 methodology within an organisation is to integrate the project processes with the organisation’s business systems. Without this vital element the organisation will find considerable difficulties in accessing information and will constantly have to duplicate administration.

2.3.4 L4 Project type specific methodologies

This level emphasises that the methodology must be scalable to cope with the various natures and project sizes within an organisation. L4 methodology should help the project team to clearly understand the scope of their work, what they need to accomplish, how the project fits in with the overall goals of the organisation and the tools and techniques to guide them in delivering the project. Thus the L4 methodology must map to the normal flow of work within the organisation and this may require separate branches of the methodology being developed for projects which differ widely in the nature of their work for example marketing vs. manufacturing. It is impractical to develop a completely new methodology for each new project within an organisation. However, by ensuring the branches have common trunks (L3) and roots (L1 & L2), the development time and organisational learning can be kept as low as possible. Thus, the key is to develop a methodology specifically for the organisation and type of project but which is also dynamic, flexible and adaptive facilitating easy tailoring to a given project.

2.3.5 L5 Individualised methodologies

At the highest degree of specificity in the design of the methodology, L5 is classified specifically for individual projects, effectively the tips of the branches of the L4 methodology (see Figure 2.1). Despite the relative simplicity of projects in any given environment, it often contains many elements of commercial projects for example stakeholders, specific deliverables, interaction with external and internal suppliers and to operate and interact with the organisational systems. Given the increasing exposure and expectations required, team members are increasingly asked to lead, manage, plan and even execute projects individually under pressure. Consequently, each team members will need to be adequately exposed to the processes, structures, tools and techniques of project management if they are to contribute or to lead the projects successfully. In such a case, the design of L5 methodology is facilitated by extracting the most important and relevant components from its branches (L4) that are fit for use in an individual based project environment.

To effectively leverage on existing methodologies in the market, it is important to be able to understand the need to adapt and classify them. For this reason, there is a need to define what is a PMM and classified it into five levels based on the degree of specificity as follows: best practices, guidelines and principles (L1); sector specific (L2); organisation specific (L3); customised to specific types of project within the organisation (L4) and customised to the individual needs of specific projects (L5).

In creating an effective methodology it needs to be tailored to the specific environment and adaptable to the dynamic nature of projects and stakeholder demands. The methodology must be flexible, easily customisable to any project within a given environment yet it should provide guidelines which leverage on both best practices and past experiences for adaptation by the organisation and project team to ensure the project goals are achieved.

2.4 Leading Project Management Practices

This section focuses on conventional best practices, standards and principles in the successful management of projects. The focus, merits, limitations, structure and components of each of the five groups of leading approaches to managing projects are discussed in this section. The aim of this work is to define the combination of project management practices which, when integrated together, give the optimum probability of delivering the project objectives on time and within budget. The five leading project management practices to be discussed are the Project Management Body of Knowledge (PMBOK), Projects in Controlled Environments Version 2 (PRINCE2), Association for Project Management Body of Knowledge (APMBOK), International Project Management Association (IPMA) and the British Standards (BSI) BS6079-1:2002.

2.4.1 Project Management Body of Knowledge (PMBOK)

The Project Management Body of Knowledge (PMBOK) is owned by the Project Management Institute (PMI). PMI was founded in 1969. However, the first standard guidebook was not produced until 1987; this was followed in 1996 with the release of an updated version. In early 2001, PMI updated the document and published a 2000 version (PMBOK's official second edition). Later in 2004, the third edition of the guide was published. The changes in the document were aimed at three different groups: the individuals preparing for the Project Management Professional (PMP) Certification Exam, the organisations that provide exam preparation courses and materials and the organisations that used the 1996 version as the basis guide for project management (PMForum, 2005). Recently in the year 2008, PMI released its latest fourth edition superseding the third edition (PMI, 2008). Based on the PMBOK, PMI was the first organisation to offer professional qualifications specifically for project managers. Today, PMI offers five types of certifications; Project Management Professional (PMP), Certified Associate in Project Management (CAPM), Program Management Professional (PgMP), PMI Scheduling Professional (PMI-SP) and PMI Risk Management Professional (PMI-RMP).

PMBOK is considered to be a 'best practice guide' and is widely recognised as the (de facto) standard of project management knowledge (Chin and Spowage, 2010, , 2008c, , 2008b). It has been applied in numerous industrial sectors to manage a wide range of projects including; management projects (general), departmental projects (functional), industrial specific projects (technical), product development (marketing) and governmental projects (public) (De Jaeger, n.d.). From the perspective of

PMBOK, project management is viewed as a number of interlinked processes which are directed towards delivering the desired results.

The PMBOK approach uses a framework which consists of several major components including; five groups of processes, nine knowledge areas, 44 sub processes (which have recently been reorganised to 42 in its latest edition) (PMI, 2008) and 592 sets of input, output, tools and techniques. The five major groups of management processes are initiation, planning, execution, monitoring & controlling and closing. The ‘Initiation’ process aims to facilitate the set-up and authorisation of the project. Initiation defines the overall direction, high level goals and major deliverables which will ultimately be used to determine if the project has been successful. The ‘Planning’ group process involves devising and maintaining a workable scheme to accomplish the project goals within the project’s constraints which are defined during initiation and refined during the progress of the project. In the ‘Execution’ group of process activities, people and other resources are coordinated to efficiently carry out the project plans. During execution the project plans are carried out and the progress against the various project plans, monitored and appropriately controlled through the project management monitoring and control process group. ‘Monitoring’ is generally carried out by the project manager through regular interactions, communication and discussion with stakeholders to ensure the project is on track. The ‘Controlling’ processes ensure that the project objectives are met by enacting change request plans whenever corrective measures/actions are necessary. Among the central process groups; planning, execution, monitoring and controlling groups of processes are iterative throughout each phases of the project. Finally, as the project activities are finalised and the project is formally accepted, the project is brought to an orderly end using the ‘Closing’ group processes (PMI, 2000).

Within each process group, individual processes are linked by their inputs, outputs, as well as specific tools and techniques. The second component of the framework is the nine knowledge areas which can be mapped to the process groups and provide the expertise to carry out the specific processes. The nine knowledge areas are; project integration management, project scope management, project time management, project cost management, project quality management, project human resource management, project communications management, project risk management and project procurement management. These knowledge areas are classified as either core or facilitative and describe the key competencies that project managers must develop in order to be effective. The core knowledge areas include scope, time, cost and quality management while the facilitating functions include human resources, communication, risks and procurement management.

Merits and drawbacks of PMBOK

PMBOK is a comprehensive knowledge-based project management guide covering widely proven practices (Wideman, 2005). Other methodologies which have subsequently been developed for example PRINCE2 are based on the same grounds as the PMBOK (Siegelaub, 2004). This fact combined with its descriptive knowledge areas and easy to understand concepts, makes PMBOK relatively simple and thereby accessible. PMBOK is considered (at least the current version) to be both a comprehensive and well-structured approach to the management of projects which can be applied regardless of the scale or nature of the project.

Despite its strengths, weaknesses have also been identified, many of these weaknesses relate to its application in practice. It is a common misconception that all the project manager needs to do is follow the processes and the project will take care of itself. However, PMBOK does not include any templates or checklists needed to construct a project plan (Yeong, 2007, Siegelaub, 2004). It has been argued that the processes are rather bureaucratic and may hinder the creativity of the project manager (Raziq, 2006). However, PMBOK do actually facilitates the need for adaptation by project team. The application of PMBOK also involves a lot of documentation and reports as the primary communication mechanism within its framework. Hence, the administrative burden may be considered to be too heavy, particularly for smaller projects and may meet resistance from people who are not fond of administration (Raziq, 2006).

Today many business environments, markets, customers and stakeholders are demanding more in terms of quality, value for money and rapid delivery. To respond to these demands, project management approaches must become more streamlined so that the processes can be easily adapted to better suit the complexity and context of the project. Yet the nature of PMBOK makes it difficult for project managers using

PMBOK to react quickly to unprecedented situations which is considered essential in highly creative or changeable project environments. In summary, the merits and drawbacks of PMBOK are outlined in Table 2.1.

Table 2.1 Merits and drawbacks of PMBOK

Merits	**Drawbacks**
Best practice guide	Does not include any template or checklist
Widely recognised as the de facto standard of project management knowledge	Bureaucratic hindering creativity
Comprehensive knowledge based project management guide as adaptive as team deem fit to do so	Lots of documentation and administrative work
Well structured	
Applicable regardless of scale or nature of project	

2.4.2 Projects In Controlled Environments Version 2 (PRINCE2)

PRINCE was first developed by the Central Computer and Telecommunications Agency (CCTA) in 1989. It is a structured method for effective project management originally based on a project management method created by Simpact Systems Ltd in 1975. It is also the de facto standard which has been used extensively to manage the UK Governments Information Systems Projects and today has received wider recognition and application both in the UK and internationally (PRINCE2, 2005).

Over the years, PRINCE has gained more wide reaching attention and has been used by many of the world's leading organisations. Through feedback from the adopters (organisations), PRINCE underwent a major revision in 1996 resulting in a more generic and business focused methodology (Bellis, 2003) known as PRINCE2. There are two qualification levels in PRINCE2; foundation level for those to learn the basics and terminology of PRINCE and practitioner level which is the highest level for those who need to manage projects within a PRINCE2 environment. Its unique approaches to managing projects include:

- Organisation of teams in managing a project and definition of their responsibilities;
- Processes that drive the undertaking in terms of the steps which can be taken to manage the project;

- A structure and content of the plans which should be constructed to document the intended progression of a project;
- A set of management and quality control applications that ensure a project is proceeding to work towards expectations.

PRINCE2 is also increasingly being viewed as a project management 'best practice' and has been adopted by leading organisations worldwide. PRINCE2 was designed to accommodate any size or type of project. However, PRINCE2 does not address every skill or technique required to operate a project, rather it concentrates on the steps or processes that a project manager requires in accomplishing the project. Therefore, PRINCE2 is often referred to as a process-based approach. The key features of PRINCE2 are its focus on business justification; defined organisation structure for the project management team and its product based planning approach. In addition, it also places emphasis on dividing the project into manageable and controllable stages therefore it is sufficiently flexible to allow application on to any level appropriate to the project (PRINCE2, 2005).

PRINCE2 is supported by processes, components and techniques. The process model covers activities from setting the project off on the right track through controlling and managing the project's progress to completion. The process model provides the flexibility to establish a number of stages, each forming a distinct unit for management purposes. Each stage consists of products or outcomes, activities, a finite lifespan, resources and an organisation structure (Bentley, 1998). The completion of each stage is determined by the satisfactory completion of the agreed products. These stages are very much like the phases of PMBOK process model. However, PRINCE2 calls these stages; starting a project, initiating a project, managing stage boundaries, controlling stage, managing product delivery and closing the project. Project oversight (by the project board) occurs throughout the project through directing a project. Planning is a generalised process that is accessed at all levels of the project as needed (Siegelaub, 2004). In managing stage boundaries, it needs to be appropriate in either the sequence of the delivery of the product, grouping of products into self-consistent sets or natural decision points for feedback and review (PRINCE2, 2005).

PRINCE2 identifies 8 key components or elements; business case, organisation, plans, controls, management of risks, quality management, configuration management and change control. These aspects describe the major elements of project management and how PRINCE2 incorporates and manages them. In PRINCE2, these aspects underpin the effective utilisation of project processes and provide a mean to keep track and review the different project processes. They are used for performance measurement with benchmark standards and project objectives to help control any deviations within the project. However, these components are not as comprehensively described as the PMBOK knowledge areas.

Both processes and components are well supported by three specific project management techniques which are unique to PRINCE2. These techniques such as product based planning, change control and quality reviews help effective execution of project processes in support of the different project components. Product based planning involves the production of product breakdown structures, product descriptions and product flow diagrams that lead to a comprehensive plan based on the creation and delivery of the required project outputs. The creation of a product breakdown structure helps to clarify what is to be delivered by the project and develops a better understanding of product. PRINCE2 recommends techniques such as change control and quality review both of which are vital for tracking deviation. The procedure involved in change control ensures that all project issues are controlled including the submission, analysis and decision making. The quality review works as a structured and organised procedure designed to assess whether a product is ‘fit for purpose’ or conforms to requirements (Yeong, 2007).

Merits and drawbacks of PRINCE2

PRINCE2 does not cover all subjects relevant to project management. However it provides some significant benefits such as producing highly standardised projects sharing a common approach. PRINCE2 is a structured methodology (Siegelaub, 2004) which provides organisations with a standard approach to the management of projects. More importantly it provides a methodology that can be tailored to suit the requirements of a specific organisation. Due to the flexibility associated with decision points, work can be directed most appropriately and thus the probability of delivering good results are optimised. PRINCE2 also allows high level and full involvement from management and stakeholders. Importantly this involvement can be given at the optimal time through the strategic positioning of ‘gateway points’. In this way, PRINCE2 encourages communication between project managers and the stakeholders.

Appropriate use of PRINCE2 at project start-up, particularly in the creation of a project initiation document defines the boundaries of the project and protects the project from scope creep. PRINCE2 provides a controlled start, middle and end to projects. It also includes regular reviews of project progress through a framework that has the buffer for automatic managerial control of any deviations from the plans. The framework acts as a guiding rule protector which allows the project manager to do their tasks without interference but if things move badly off the plan, it allows higher level managers to get involved appropriately.

PRINCE2 is suitable for any project size. It benefits individual projects at each level in terms of defining roles and responsibilities and appropriate long to short term planning. It also creates a deeper understanding by separating management activities from technical activities and project risks. In addition, each type of document required by PRINCE2 is shown as templates which are comprehensive, standardised and easy to complete, such a feature is not part of PMBOK’s 447 page guidebook (PMI, 2008).

Despite worldwide recognition and implementation of PRINCE2, some negative impressions have been published. PRINCE2 is sometimes viewed as cumbersome, regimented or bureaucratic (Raziq, 2006). Although it is appropriate for managing complex projects in the areas of business change, business performance improvement, system development/implementation and product development. Its structured approach often limits the organisation’s flexibility in coping with a changing environment. As every project is different, a generic structured approach may not always be appropriate, furthermore the generic nature of the templates may not be suitable for every type of project (Raziq, 2006).

The PRINCE2 structure has been perceived as increasing project’s length, costly, delaying return on investments, risk of failure and the possibility of real requirements, objectives and expected standards not being met. In addition, PRINCE2 requires a lot of documentation which adds little value to the overall performance of the project. Although the documentation certainly aids traceability and accountability throughout the project cycle, it also facilitates corporate governance in a distributed project environment. However with these perceived weaknesses and the heavy administrative workload involved, PRINCE2 is often argued as unsuitable for use on small projects (Raziq, 2006, Yeong, 2007). In summary, the respective merits and drawbacks of PRINCE2 are outlined in Table 2.2.

Table 2.2 Merits and drawbacks of PRINCE2

Merits	Drawbacks
Widely recognised in the UK and internationally	Does not address every skill or technique to operate project
Flexible for application to any level of project	Does not cover all subjects relevant to project management
Highly standardised project approach	Cumbersome and bureaucratic
High level and full involvement of management and stakeholders	Limits organisation’s flexibility in coping with changing environment
Suitable for any project size	Generic nature of template not suitable for every project type
Comprehensive, standardised and easy to complete templates	Requires a lot of documentation
	Unsuitable for use on small projects

2.4.3 Association for Project Management Body of Knowledge (APMBOK)

The Association for Project Management (APM) was developed in the early 1990s. Its first version was compiled and produced by APM members based on expert’s judgement and released two years later in 1992. APM then updated its body of knowledge (BoK) resulting in a third version being released. Later in 1996, APM updated its BoK third version which consists of 40 key areas that are categorised into four major headings; project management, organisation and people, processes and procedures and general management.

In mid 1997, APM approached the Centre for Research in the Management of Projects (CRMP) at the University of Manchester Institute of Science and Technology (UMIST) to conduct empirical research to further update its BoK. The significant results from the research produced the fourth version of the APMBOK consisting an additional two topics listed under its seven headings. The purpose of the fourth edition claimed to be the practical document in defining the broad range of knowledge that the project management discipline encompasses which provide the basis of project management element general competencies framework (Crawford, 2004).

Following the release, three years later, APM commissioned the University College London (UCL) to conduct further reviews to update its fourth edition (Morris et al., 2006b). With the updated version, APM aimed to reflect on developments in the project management trends and practices, new terminology, research and publications. Rigorous reviews were carried out to substantiate the revision and subsequent update. Ultimately, the published fifth edition which was released in 2006 had a number of re-sequenced and re-naming of topics (or sections), ten new topics were added whilst some were combined to fit the new structure (Morris et al., 2006b). In its latest edition, APMBOK was significantly revised and it is now structured into seven sections consisting of 52 topics. These sections are project management in context, planning the strategy, executing the strategy, techniques, business and commercial, organisation and governance and people and profession.

Over the next decade, the APM model is considered to have worked well and has been widely used as a basis for competency assessment in many European countries. It has become one of the most influential UK based professional project management bodies and has been certifying people who have met a distinctive level of knowledge and standard of practices since the mid 1970s (Morris et al., 2006a). It is an independent professional body aimed at promoting the development and application of project management across all industrial sectors. Currently, it is the second largest body of its kind in Europe with over 15,500 members and a growing reputation throughout UK and abroad (ZDNet, 2005).

The APMBOK considers professionals in project management as experts in their specific industry and sector. Hence it assesses a broader context essential for the effective management of projects namely; strategic, technical, commercial, organisational, control and people based elements. Like other formal project management BoK, it introduces a competency assessment via examination, certification and accreditation practices based on its normative documents (Morris et al., 2000) which are aligned with IPMA's four levels of certification system (IPMA, 2006).

Merits and drawbacks of APMBOK

APMBOK is one of the most influential publications on what constitutes the knowledge base of the profession (Morris et al., 2006b). APMBOK is more comprehensive in terms of the knowledge required to accomplish projects successfully than many other BoK's. Its BoK represents a broad generalisation of knowledge compared to PMBOK. In addition, there are four levels of certification provided while PMI are more heavily focused on its PMP (Project Management Professional) certification. It is also a less method-oriented approach than PMI's PMBOK. It is well-recognised and accepted globally with the leading French and German BoKs being modelled closely on APMBOK. However, in terms of strength and influence, APM may be less influential than PMI, yet in certain geographies it is locally influential (Morris et al., 2006a).

Because APMBOK is so comprehensive it is perhaps more appropriate for the management of projects regardless of industry or sector. It has been emphasised that the use of the BoK guide is targeted for people whom are already involved in project management having both the required knowledge and experience (Crawford, 2004). Based on competency assessment via exams and certifications, it is not as flexible as PMI's PMBOK. It is also clearly stated that it is not a set of competencies but comprises of a general competency framework for use in organisations. The contradicting view and use of the framework will need to rely on the competence of the project manager in handling and managing project accomplishments.

A review by Morris on APMBOK further elaborates some issues which still need to be refined (Morris et al., 2000, Morris et al., 2006a, Morris et al., 2006b). Firstly, its initial compilation was based on anecdotal rather than empirical evidence; therefore it still needs further revision because of varied professional societies and organisations in different countries which contributed. Secondly, claiming to be a practical document to be carried in hand by professional project managers, it may lack focus in addressing technical, commercial or environmental issues (Branje, 2006) that may impact on project performed.

APMBOK has also been referred to as a more proper set of practices commonly adopted to govern projects (Morris et al., 2006a) and its places emphasis on the management of people (soft skills). In comparison, APMBOK unlike PMBOK, does not make any distinction between its core and functional project management topics. In APMBOK, the approach is to define and briefly discuss each of its 52 topics supporting this through substantial references (Stretton, 2010). This has the obvious advantage of enhancing usability by keeping the number of pages down. However, the requirement to make reference to external sources for more detail will not always be practical nor time efficient. In summary, the merits and drawbacks of APMBOK are outlined in Table 2.3 below.

Table 2.3 Merits and drawbacks of APMBOK

Merits	Drawbacks
Widely used for competency assessment	Targeted to people with experience and knowledge in project management
More comprehensive than other BoKs	Lack of flexibility
Less method-oriented	Lack of focus in technical, commercial or environmental issues
Emphasis on people management	

2.4.4 International Project Management Association (IPMA)

The International Project Management Association (IPMA) was founded in 1965 by a group of project managers as a forum to network and share information. Over the decades, it has grown into an international network consisting of 45 national project management associations and today it has over 40,000 members in more than 40 countries worldwide.

In the 1993, IPMA initiated a revision of the IPMA Competence Baseline (ICB) with reference to the National Competence Baseline, further enhancing the content via continuous improvement. The fundamental elements of ICB IPMA BoK are based on APMBOK version 3 (Morris, 2001). The first version of ICB was only released in 1998. The main aim of ICB was to '*harmonise'* all of the distinct European nations BoK's. It also provides an official definition of the competences expected from project management personnel through IPMA certifications.

In its initial structure, there were 24 core elements of project management knowledge and experience presented in a 'sunflower' model. This structure was adopted to regulate and symmetrically arrange the BoK elements in a way that was more acceptable to the different national societies (Morris, 2001, Crawford, 2004). The reason for doing so was obvious as the competence baseline was developed through the involvement of 40 national project management associations and thus embraced significant national culture and differences (IPMA, 2006).

IPMA consists of the same set of personality characteristics for a certified project manager as APMBOK. However, these characteristics lack empirical evidence since it was developed through a series of workshops among its multinational members. Therefore in 2001, IPMA replaced its IPMA Competence Baseline version 2.0b with version 3, which featured a number of major changes (IPMA, 2006). An additional four core elements were introduced with the aim of overcoming the difficulties of achieving agreements on its knowledge structure due to its multinational membership (Crawford, 2004).

In 2006, the release of ICB version 3, replaces its 'sunflower' motive of 28 elements with three main competency elements. These three competences are technical competence, behavioural competence and contextual competence. IPMA called it the 'eye of competence' which represents the integration of all elements of project management as seen through the eyes of the project managers in evaluating specific situations with clarity and vision in mind (IPMA, 2006). Each of these competencies consists of a range of elements. The technical competence consists of 20 sets of elements which deals with project management matters. Behavioural competence consists of 15 elements focusing on personal relationship between individuals and groups in the project, programme and portfolio. The third competence consist of 11 elements and are contextual in that they deal with the interaction of the project team within the context of the project and within the permanent organisation.

Recently at the PMI Global Congress 2008, PMI and IPMA collaborated to promote the profession of project management globally. They aimed to address the possible risks of project management skills shortage predicted by PMI 2008 Chair Philip Diab to become problematic by the end of 2016. Their partnership aimed to counteract this potential risk by improving the quality and quantity of academic research on the project management profession and its application through embedding project management courses in universities worldwide (Institute Project Management Ireland, 2008).

Merits and drawbacks of IPMA

IPMA is the world's oldest project management organisation. It is a universally incorporated framework from an international network of project management societies aiming to provide a holistic model for project and programme managers (Naybour et al., n.d.). It seeks to identify what skills and abilities are needed to service challenges in specific project environments. Therefore, its three competences are seen as the eyes of the project manager to demonstrate the delivery of successful projects. From this view, IPMA extends the scope of project management with contextual and behavioural aspects which are not covered in the PMI PMBOK guide.

The IPMA certification considers knowledge, experience and personal attitude. It is also supported by a qualification process which includes training and coaching. However, the certification tends to enforced project management experiences as a mandatory certification aspect (Muller and Rietiker, 2006). In comparison with PMI, the IPMA competence baseline is merely an extended focus on project management by including programme management, as well as business, organisation and behavioural aspects.

PMI on the contrary is more strongly focused on project management and execution on a single project. IPMA contents are moderately detailed and delivered in a high level structure in contrast with the PMI PMBOK guide. In comparison, PMI with over 200,000 members and the accepted de-facto standard, IPMA still only stands within a relatively 'small' community (40,000 members) (Muller and Rietiker, 2006). In summary, the merits and drawbacks of IPMA are outlined in Table 2.4.

Table 2.4 Merits and drawbacks of IPMA

Merits	Drawbacks
A holistic model for project management	Content are moderately detailed, delivered in high level structure
Emphasis on contextual and behavioural aspects	Acceptance through national associations
Extend focus on project management	Small community

2.4.5 British Standards (BS6079-1:2002)

Founded in 1901 as the Engineering Standards Committee, it was the world's first National Standards Body (NSB). The current organisation, the British Standards Institute (BSI) is a non-profit organisation whereby profits obtained are reinvested into the services it provides. Over the decades, it has grown into a leading global independent business service organisation providing standard based solutions across more than 120 countries. Currently BSI manages around 27,000 national and international standards many of which are used daily by millions of enterprises worldwide. BSI's most widely used standard is the ISO 9001 (Quality Management System Requirements) by over 670,000 organisations in 154 countries. Today it has become the leading provider of standards and consortia services through its BSI Professional Services (BSI, 2006).

One of the standards of particular importance to project management was established in 1996 as BS6079. A few years later it was withdrawn and replaced with BS6079-1:2002. In its updated version, the document is issued in four parts:

- Part 1: Guide to project management (BS6079-1:2002);
- Part 2: Vocabulary (BS6079-2:2000);
- Part 3: Guide to the management of business related project risk (BS6079-3:2000);
- Part 4: Guide to project management in the construction industry (PD6079-4).

The first part of BS6079-1:2002 series provides guidance on the planning and execution of projects and the application of project management techniques. It is aimed at broad projects in different industries and sectors. BS6079-2:2000 is a documented standard in terms and definitions used in project management and network planning. BSI has prepared this document as a supplementary support to the other parts of BS6079. Another standard introduced in relation to project management is BS6079-3:2000 giving guidance to managers on the identification and control of business related risks in a project. Finally, to help organisations achieve successful delivery of construction projects, BSI published PD6079-4. The guide aimed to deal with construction processes from inception to handover by integrated guidance related to construction project management.

These documents are designed to fit different types of projects across the industrial and the public sectors. Hence, in order to ascertain if it fits into various environmental activities, concerns and standards, it was revised over a period of seven years to enable it to incorporate the current technology, techniques and developments. The BS6079 standards is also aimed to provide guidance to general managers, project managers, project support staff, educators and trainers to manage problems in different project environments and be able to present possible solutions (BSI, 2002).

Merits and drawbacks of BS6079-1:2002

BSI is an independent national body responsible for preparing British Standards which presents how the UK views standards (BSI, 2005). It is constantly updated and revised by its committee board to meet the current needs and adapt to changes in the international market. BSI also provides training, assessment and certification to businesses in various countries.

The BS6079-1:2002 guide to project management has been accepted by both the British government and industry. It aimed to provide guidance for general managers to enable them to provide appropriate support for project managers and their teams; for project managers' to improve their ability to cope; for project support staff to help them understand the problems that may occur and to help provide possible solutions and finally for educators and trainers to help them understand the industrial context in which project management techniques are used.

In comparison to PMI's PMBOK guide, BS6079-1:2002 is significantly less comprehensive. It is lighter concentrating largely on the knowledge areas of project management. Since the 2002 edition, BS6079-1:2002 has not been revised thus it does not incorporate the latest developments in the field. Unlike PMBOK, APMBOK and IPMA ICB, BS6079-1:2002 certification is aimed at organisations and not at individuals. It develops standards for a list of various sectors and industries with access of over 20,000 portfolios of publications which are accessible via its knowledge centre online. According to BSI, a new ISO 21500 is currently under development to replace the BS6079 standard. In summary, the merits and drawbacks of BS6079-1:2002 are outlined in Table 2.5.

Table 2.5 Merits and drawbacks of BS6079-1:2002

Merits	**Drawbacks**
BSI is world first and oldest national standards body	Less comprehensive
Acceptance by both UK government and industry	Lighter and less extensive on the knowledge areas of project management
Provides guidance and support for project managers, project support staff, educators and trainers	Have yet been revised since 2002 edition
Access of portfolios via knowledge centre online	

Summary

By examining the structure, components, strengths and limitations of each of these leading best practices, the best combination of project management approaches has been determined and can be integrated together to build upon their similarities in the field of project management. Based on the discussions above, a list of elements on how each of the leading project management practices differs from one another is presented in Table 2.6.

In Table 2.6, it is apparent that only PRINCE2 fulfils all the comparison elements with the exception of its lack of comprehensive discussion in the knowledge areas.

Secondly, PRINCE2 is the only project management practice which is easy to apply, flexible and fully scalable because it is complete with templates, checklists and tips for project managers. Conversely, though PMBOK is as influential as BS6079-1:2002, both are generally suited for large scale projects unlike PRINCE2, APMBOK and IPMA. Amongst these five project management practices, BS6079-1:2002 contains the least identified elements shown in Table 2.6. Though it is standardised with a structured approach, it is the only project management practice that is not frequently updated. Overall, all five project management practices are widely adopted in various industries and readable in many different languages such as German, French, Chinese and Japanese. Each practices offers its own assessment and competency examinations using various levels of certifications for project managers in the industry.

Table 2.6 Comparison elements between five leading project management practices

Comparison elements	PMBOK	PRINCE2	APMBOK	IPMA	BS6079-1:2002
Knowledge area	✓	-	✓	✓	-
Project phases	✓	✓	✓	✓	✓
Project processes	✓	✓	✓	✓	-
Project types (**S**mall, **M**edium, **L**arge)	L	M, L	M, L	M, L	L
Inputs	✓	✓	-	-	-
Outputs	✓	✓	-	-	-
Tools & techniques	✓	✓	✓	✓	✓
Available templates	-	✓	-	-	-
Checklists	-	✓	-	-	-
Hints and tips	-	✓	-	-	-
Terms & definition	✓	✓	✓	✓	✓
Frequent update	✓	✓	✓	✓	-
Standard	✓	✓	✓	✓	✓
Structured approach	✓	✓	✓	✓	✓
Accessibility (local & international)	✓	✓	✓	✓	✓
Ease of application	-	✓	-	-	-
Flexible & scalable	-	✓	-	-	-
Industry applicable	✓	✓	✓	✓	✓
Tracebility	✓	✓	-	-	-
Adoption level (**H**igh, **M**oderate, **L**ow)	H	H	M	M	H
Certifications & examinations	✓	✓	✓	✓	✓
Translated in other languages	✓	✓	✓	✓	✓

Based on the review of the leading project management best practices, the most appropriate combination of elements from both PRINCE2 and PMBOK will be used to construct the PMM. PRINCE2 and PMBOK both have their own certification-based examinations and are globally recognised. Based on a long history of evolution and acceptance, both are proven project management practices with a huge amount of literature to provide empirical evidence for further studies.

Although PRINCE2 is not as comprehensive as PMBOK, it is based on the principles of PMBOK (Yeong, 2007). Furthermore though PRINCE2 components and processes are consistent with PMBOK, it does not include all the knowledge common to the other practices reviewed. Based on the above discussion, PRINCE2 focuses on the processes would be a critical consideration for the management of UIC projects, while PMBOK focuses on the knowledge and competencies of the project manager and will thus be complimentary (see Table 2.7).

Table 2.7 Comparison of PMBOK knowledge area and PRINCE2 components

PMBOK knowledge area	**Comparable PRINCE2 components**
Integration	Combined processes and components, change control
Scope, time, cost	Plans, business case
Quality	Quality, configuration management
Risk	Risk
Communications	Control
Human resources	Organisation (limited)
Procurement	Not covered

Though there are various differences between PMBOK and PRINCE2 approaches to managing projects, many agree that the best methodology is one which takes the strengths from both (Siegelaub, 2004, Yeong, 2007, AIPM, 2002).

To combine the strengths of both approaches, PRINCE2's major strengths lie in its focus on processes and documentation. However it lacks focus on communications, human resources management and procurement management. Conversely, the strength of PMBOK lies in its communication processes in its detailed and structured plans. PMBOK covers procurement management and administrative closure. On the contrary, PMBOK is weak in the business directional path where the business case approach in PRINCE2 will complement by focusing the entire scope of change to the business that is affected by the project (Siegelaub, 2004).

Another significant strength of PRINCE2 is its concept of the Project Board. In PMBOK the majority of this role is taken on by the project sponsors. However, in PRINCE2, the role of the Project Board is more specifically defined and it provides insight and support to help ensure commitment in getting work completed. In

PRINCE2, the Project Board owns the project and grants authority to the project manager by explicitly committing resources as the project progresses.

On the other hand, PMBOK spends extensive time focusing on quality control and a number of tools and techniques to accomplish it. PRINCE2 tends to provide an excellent set of tested techniques for quality control known as the quality review. Quality review provides the steps and resources needed to assess the conformance of deliverables and provides guidance on handling challenging or complex quality situations. There are also PMBOK's work breakdown structure which can be complemented with PRINCE2's product breakdown structure, product descriptions and product flow diagrams. The combination of these documentations in the project plan will outline clearer and robust deliverables of the project (Yeong, 2007).

PRINCE2 offers a more process oriented approach than PMBOK in identifying the necessary techniques. However it still cannot be directly applied to the management of projects. By nature, L1 methodologies (as discussed in section 2.3.1) are the most expensive and time consuming to develop although they have evolved over many years and incorporate contributions from a wide cross-section of leading thinkers across the various fields as well as a tremendous amount of historical know-how. Each approach has its own strengths and weaknesses, thus the combination of the most appropriate elements of both approaches would be a distinct action in designing a PMM for managing UIC research projects.

2.5 Reviewing Project Management Methodology

Following the review and discussion of the leading project management practices in the market; this section presents a comparative analysis of existing PMM adopted by university, industry and government.

PMM have been popularised for use in various industrial sector for over 30 years (Goff, 2007, Johnston and Wierschem, 2005). Numerous professional bodies have developed a wide range of methods and techniques to aid the management of projects. Today, PMM boast tighter project controls, improved approaches and leverage on tremendous experiences, however many projects still fail (Delisle and

Olson, 2004). For instance, the acceptance of PMM may not be the same in the academic institutions compared to industry mainly because generally university researchers lack the skills in managing and planning research projects (Johnston and Wierschem, 2005). Furthermore academicians tend to disregard the importance of project management elements and functions in the management of collaborative projects (Gist and Langley, 2007). In addition to that, there are also a number of reports discussing differences in project management knowledge, practices, project types, phases and even tools between industries, countries and application areas (Crawford, 2001, Besner and Hobbs, 2008, , 2006, , 2007).

In section 2.3, PMM were classified into 5 levels where L3 is known as organisation specific customised methodologies (Chin and Spowage, 2010). The objective in this section is to discuss L3 methodologies in detail by comparing the existing PMM available in the market from three sectors namely industry, academic institution and governmental. Each of the PMM will be compared and discussed using a list of elements to elicit a set of common components/requirements in the design of a generic PMM for use by UIC research project. The elements used are based on discussion in section 2.4 and Table 2.6:

- Project phases
- Project processes
- Project types
- Inputs/activities
- Outputs/deliverables
- Tools and techniques
- Available templates
- Checklists
- Hints and tips
- Terms and definition
- Frequency of update
- Structured approach
- Ease of application
- Flexible and scalable
- Country of origin

- Project management practices adopted

In order to critically review and compare the various PMM in the market, a total of 34 organisation's customised PMM were identified, examined and categorised into academic institutions methodologies; industry methodologies and governmental methodologies in this study. Each of these methodologies were obtained from the organisation's website which was freely accessible for the purpose of analysis. Majority of the PMM examined were created from the year 2000 to 2008. The analysis of each organisation specific methodology will be discussed individually in the following section. All the PMM identified were compared using the same list of elements to give a balanced view of the discussion.

2.5.1 Academic institution project management methodologies

A total of 15 academic institution methodologies were examined as shown in Table 2.8. These academic institutions varied between countries and adopted different project management practices in their design. A majority of the PMM were consistent with the PMI PMBOK guidelines. However, UK academic institutions showed a preference for alignment with APMBOK and PRINCE2.

Surprisingly a majority of the academic institutions designed their PMM for use in managing information technology (IT) and information system (IS) projects that are operated within their institutions. Although PMM were applied to mainly IT projects, it was also easily applicable and scalable for other project types and sizes. A majority of the examined PMM from academic institutions were organised in a structured approach complete with unique project phases, processes, inputs, activities, deliverables, tools and techniques for project applications.

Though the PMM were adequate for facilitation, a handful of the methodologies did not contain sample of templates, checklists and more importantly hints or tips to guide project managers. Furthermore, a number of PMM did not include a common set of references terms and acronyms used by the methodology (see Table 2.8). These are important components to be included in a typical PMM since many academicians' lack project management knowledge and skills in managing their research projects (Gist and Langley, 2007).

Whilst these PMMs are complete with other elements, a handful were not updated or revised to be consistent with its adopted project management practices or changes in L1 methodologies from which they were constructed. Amongst the 15 PMM investigated in this category, it was found that only two academic institutions (U11 and U15) have near complete coverage of all the identified elements and U11 methodology is the only of many PMM examined that is web-integrated.

Table 2.8 Comparison between academic institutions PMM

Comparison elements	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	U11	U12	U13	U14	U15
Project phases	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Project processes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Project types	IT	IT		IT	IT	IT		IT		IT	IT		IS		IT
Inputs /Activities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Outputs/ Deliverables		✓	✓	✓	✓		✓	✓			✓				✓
Tools & techniques	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Available templates	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓
Checklists	✓			✓						✓	✓	✓			✓
Hints and tips									✓					✓	
Terms & definition		✓	✓			✓	✓				✓	✓	✓	✓	
Frequent update	✓		✓	✓			✓								
Structured approach	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ease of application	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓
Flexible & scalable	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓
Country	Australia	Australia	Australia	Australia	US	UK	Australia	US	US	US	US	UK	UK	US	US
PM practices	PMBOK	Thomsett Organization 3rd wave PM		PMBOK		PRINCE2	PMBOK	PMBOK	IPS Assoc		PMBOK	APMBOK	PRINCE	MSF	Knapp & Moore
*Note: U - university															

2.5.2 Industry project management methodologies

Analysis in Table 2.9 indicated that the majority of industrial organisations have developed the PMM for use in managing IT related projects as was the case for those methodologies applied in the academic institutions. Many of the PMM were designed internally by the organisation's information service departments. The PMM were commonly considered to be mandatory guides that had to be followed when managing IT projects. These findings are apparently similar in academic institutions and government linked organisations perhaps due to the influence of project management in the IT sector (Betts and Lansley, 1995, Crawford et al., 2006a, Themistocleous and Wearne, 2000).

A review of these PMM found that some methodologies lacked the elements identified as essential to the effective management of projects. The common missing elements included templates, checklists, hints, and definitions which are not incorporated in the methodology. Furthermore, there are also questions raised of the PMM versions, some had not been recently updated to integrate current best practice. Amongst all the PMMs, only one industry player (I10) adopted the PROPS approach that had been popularised for managing product development projects by Ericsson (Mulder, 1997). Another industry player (I5) developed their PMM based on the IBM RUP model which focuses on agile methods. On the whole many industry players appear more comfortable with the adoption of PMI's PMBOK, the industrial de facto standard, when they designed their own PMM (see Table 2.9).

Table 2.9 Comparison between industries PMM

Comparison elements	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11
Project phases	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Project processes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Project types	All	All	All		IT	IT	IS	All	IS	All	All
Inputs /Activities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Outputs/ Deliverables		✓	✓	✓		✓	✓	✓	✓	✓	✓
Tools & techniques	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Available templates	✓	✓			✓	✓				✓	✓
Checklists	✓		✓					✓		✓	
Hints and tips									✓		
Terms & definition	✓	✓				✓		✓		✓	✓
Frequent update		✓						✓	✓		✓
Structured approach	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ease of application	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Flexible & scalable	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Country	US	US	US		US	US	US	US	US	Sweden	US
PM practices	PMBOK		PMBOK		IBM RUP	PMBOK		PMBOK	PMBOK	PROPS	PMBOK
*Note: I - industry											

2.5.3 Governmental project management methodologies

In reviewing PMM designed for implementation within the government sector it was found that the majority were designed in alignment with PMI's PMBOK as shown in Table 2.10. Almost all of the PMM established could be applied to all types of project inclusive of IT projects. Similarly, most methodologies consist of unique project phases and processes. Each of the reviewed PMM was largely complete with appropriate activities, deliverables and suggestion of selective tools and techniques for project manager's guidance. The majority of the PMM reviewed in this category were well structured, organised and presented in a comprehensive guidebook style for example, G3's PMM was designed and compiled into a 353 page booklet (see Table 2.10).

Although these PMMs were comprehensive, the lack of templates and necessary hints and tips to assist the project manager limits the value of these methodologies. This was also a concern identified from the review of the academic PMM (see section 2.5.1). Another matter of concern was whether the PMM adopted were updated on a regular basis because it was common that the version of the PMI PMBOK guide (or similar) used to build the methodology was not cited. Each PMM was uniquely standardised and regulated by an independent project management unit. This highlights the importance of establishing a project management unit to guide, monitor and regulate the use of PMM in an organisation.

Table 2.10 Comparison between governments PMM

Comparison elements	G1	G2	G3	G4	G5	G6	G7	G8
Project phases	✓	✓	✓	✓	✓	✓	✓	✓
Project processes	✓	✓	✓	✓	✓	✓	✓	✓
Project types	All	All	ITS		IT	All	All	All
Inputs /Activities	✓	✓	✓	✓	✓	✓	✓	✓
Outputs/ Deliverables			✓	✓	✓	✓	✓	✓
Tools & techniques	✓	✓	✓	✓	✓	✓	✓	✓
Available templates	✓	✓		✓		✓	✓	✓
Checklists	✓	✓	✓	✓	✓			
Hints and tips					✓	✓		
Terms & definition	✓	✓				✓	✓	✓
Frequent update			✓				✓	✓
Structured approach	✓	✓	✓	✓	✓	✓	✓	✓
Ease of application	✓	✓	✓	✓	✓	✓	✓	✓
Flexible & scalable	✓	✓	✓	✓	✓	✓	✓	✓
Country	US	US	US	Canada	Australia	US	US	Australia
PM practices	PMBOK	PMBOK		PMBOK			PMBOK	PMBOK
*Note: G – government								

2.5.4 Requirements of a project management methodology

Analysis of the PMMs reviewed indicated that the most popular L1 best practice used to build the L3 organisation specific customised methodologies was the PMI PMBOK followed by PRINCE2; whilst others customised the methodology based on APMBOK and PROPS.

It was evident that the use of project processes varies across organisations. Although the majority of processes integrated into a PMM are based on the PMI PMBOK guide, organisations recognise the importance of being unique in the market. Therefore it is common to customise PMM process groups to suit their organisation's practice. For example, Table 2.11 shows a list of the varied project management process group terms used across the three sector specific PMM. It was found that the highest and most frequently used process groups in PMM were initiation, planning and closing processes.

Table 2.11 Process group occurrences across organisation sectors

Process group	**Number of occurrences**
Initiation/ Definition	20
Planning	25
Executing / Do it	16
Controlling / monitoring / track /manage	18
Closing /closeout/exit/ finalise / completion closedown / conclusion /finalise	25

Based on the review, only a few organisations integrate technology elements into their customised PMM. For example, U5 is outstanding in this regard as it embeds technical applications such as analysis tool, mathematical analysis, simulation, project management software, project management information system (PMIS), change control systems and a project tracking database into the methodology. In addition, with an increasing demand and accessibility of the information highway many organisations have set up web based PMM for ease of use, especially when they are in a distributed project organisational environment. This popular technology tool was practiced by U11, U12, U15, G5 and I11.

Another component common to the majority of PMM examined was the various types of tools, techniques and templates embedded in the methodology. Table 2.12 shows the toolkits and templates which are utilised in different process groups in all three organisation sectors reviewed. Across the PMM, the project proposal was one of the most frequently used toolkits and commonly placed in the initiation process. In the planning process; risk plans, communication plans and work breakdown structures were the three toolkits frequently used in a majority of the PMM examined. In the execution and controlling process, change request plan seems to be a favourable toolkit. In the closing process, only a few organisations utilised the lesson learned reports and end project reports to finalise the end of the project.

Table 2.12 Usage of PMM toolkit and templates by organisation sectors

Process group	**PMM toolkit and templates**	**Number of occurrences**
Initiation	Project proposal	5
	Project initiation document	3
	Kickoff meeting	3
Planning	WBS	12
	Responsibility assignment matrix	3
	Scheduling	7
	Resource plan	7
	Budgetary plan	7
	Risk plan	19
	Risk log	8
	Stakeholder analysis	6
	Communication plan	18
	Quality plan	10
Execution & controlling	Change request plan	10
	Change request log	9
Closing	Lesson learned report	6
	End project report	7
	Acceptance signoff	5

The objective of this section was to compare and discuss specific customised PMM across three sectors to elicit a common set of requirements. Although the organisation specific PMMs differ, many have some commonality in terms of processes, procedures, tools and deliverables. These commonalities have been compiled and combined with the literature investigations and earlier studies (Chin and Spowage, 2008b, , 2008c) as follows:

1. It should facilitate the identification and management of risks and opportunities.
2. It should facilitate the clarification of goals and scope of the project by incorporating the best practices of project management group processes (MSF, 2002, Kroll and Royce, 2005), tools, techniques (Charvat, 2003, Bolles, 2002, Murch, 2001) and templates to effectively plan and manage research projects.
3. It should create a project board to oversee, monitor and assess the research project progression.

4. It should be scalable and adaptable to project sizes; where it should be specific to the organisation but customisable to individual projects (Charvat, 2003, Cockburn, 2000, Chemma and Shahid, 2005, MSF, 2002).
5. It should leverage on the best practices of the specific environment/discipline to minimise obstacles and failure rate.
6. It must be in place to promote organisational learning (MSF, 2002).
7. It should be based on organisation, governmental and sector specific standards and regulations (Wideman, 2006, Turbit, 2005, Pitagorsky, 2003, Josler and Burger, 2005, Charvat, 2003).
8. It should model the work flow of typical project (Charvat, 2003, Turbit, 2005, Bolles, 2002, Murch, 2001).

2.6 Chapter Summary

This chapter began by focusing on defining PMM and as a result of the literature reviewed, the PMM were classified into five levels; best practices, guidelines and principles (L1) to develop a sector specific project methodologies (L2), integrated into specific organisation (L3), customising PMM into project specific needs (L4) and individual specific methodologies (L5). Finally, this chapter presented a review of the five groups of leading project management practices in the market followed by a comparative analysis of the three organisation sector specific methodologies from academic institutions, industry and government for analysis. Appropriate information has been distilled and extracted from these three organisation specific customised methodologies to extract a list of requirements and components to be placed on a generic PMM for use in the UIC research environment. The key findings from the research literature will be used to assist the development of the PMM in chapter 6. The completion of this chapter provides a foundation for the development of a PMM for use in each level of research environment.

The next chapter discusses the UIC research environment in the context of its driving factors, challenges, best practices and processes.

CHAPTER 3 LITERATURE REVIEW ON UNIVERSITY-INDUSTRY COLLABORATIVE ENVIRONMENT

3.1. Introduction

The objective of this study is to develop a PMM for use in the university-industry collaborative (UIC) research environment. The purpose of this chapter is to present a rigorous analysis of UIC related literature to define, understand the driving factors, the concerns and challenges anticipated by experienced actors and to compile relevant best practices. In the first section, the UIC environment is reviewed and discussed from the perspectives of university researchers and industrial players. In order to generate the level of understanding required in designing an appropriate generic PMM for UIC application, this chapter also includes a descriptive discussion of the UIC life cycle and a view on the UIC research environment in Malaysia.

3.2. Defining University-Industry Collaborative Research

University-industry strategic partnerships are not a new phenomenon. Despite of the growing body of academic, industrial and governmental literature, a wide range of definitions and terminology are used to describe as partnership or alliance (Huxham and Vangen, 2001, Winer and Ray, 1994). To avoid confusion, the term alliance and collaboration will be used interchangeably in this study when discussing generic concepts. However, the term collaboration will be used consistently to represent the idea and concepts specifically associated with UIC.

A great number of different perspectives have been established to define the meaning of collaboration and to appreciate the complex implications. Collaboration is a business relationship that can take a variety of forms ranging from a simple single project contract to the establishment of a joint venture company and sophisticated licensing agreements (Wahyuni, 2003). It can also be loosely defined as researchers working together to achieve a common goal of producing new scientific knowledge (Katz and Martin, 1997). In the scientific definition, collaboration is an action in pursuit for peer recognition which strongly emphasises the discipline of scientists and engineers (Belkhodja and Landry, 2007). It can take various forms from offering general advices e.g. consultancy, services or to proactive research work (Katz and Martin, 1997). From the industrial actors' perspectives, collaboration is often associated with merging, acquisition and joint venture as such collaborations are common between two or more partners who complement each other's skills, resources or equipment (Wahyuni, 2003). Collaboration can also be viewed as a smart synergistic partnership which integrates the core competencies of different actors with a single mission of generating a win-win solution (Lasker et al., 2001, Junaini et al., 2008).

Based on these characteristics, collaborations are formed when organisations partially combine their skills and resources to achieve goals that cannot be attained independently (Wahyuni, 2003). It is a mutually beneficial and well-defined relationship entered into by two or more organisations to achieve results that they are more likely to achieve together than in isolation (Winer and Ray, 1994, Mattessich and Monsey, 1992). Above all the various definitions, this study defines collaboration as a shift in paradigm from competing to consenting by complementing resources and strengths. It is a relationship built on trust that is jointly shared with a balance of responsibility, authority and accountability for success that needs to be planned, managed and measured for a sustainable relationship.

The trend towards such smart partnership between universities and industries are almost inevitable in today's highly competitive environment as the probability that a single organisation could possess all the capabilities required to deliver a complex piece of innovative applied research is increasingly diminishing as the level of sophistication increases (Katz and Martin, 1997). Collaboration then becomes the synergy which helps to balance each partner's limitations and leverages on their respective strengths (Overby, 2006).

In addition, collaboration increases the opportunities of blending the academic rigidity of theoretical perspectives with the industry's relevance and ever-changing needs. Such blending of resources both in knowledge and technology serves two primary roles in the society; (1) to serve public good through the production and dissemination of scientific and technical knowledge and (2) to enhance productivity through the development and transfer of technologies (Welsh et al., 2008).

3.2.1 University-Industry collaborative modes

Collaboration can be established in a formal or informal manner (Wu, 2000). Two examples of a well established long term UIC partnership would be the collaboration between Rolls-Royce and the University of Nottingham, with the university currently hosting two of Rolls-Royce University Technology Centres; a second example is the University of Sheffield’s Advanced Manufacturing Research Centre (AMRC) which has several industrial partners includes Boeing. The sustainability factor of these partnerships lies in its prior relationship based on trust, mutual interest, exchange of expertise, skills and resources all of which have contributed heavily to the success of the partnership. In the open literature, various UIC approaches and mode of collaboration have been studied. In this work, the findings of the leading researchers on the various forms of UICs have been compiled as shown in Table 3.1.

Based on Table 3.1, the various forms of UIC have been classified and described as follow (Zakariah et al., 2004, Katz and Martin, 1997, Bacila and Gica, 2005, Wu, 2000, IIyas, 2004):

1. Research support representing the contribution of either monetary or equipment to the university. These contributions are highly valuable to the university because they typically allow significant flexibility and value both tangible and intangible outputs.
2. Cooperative research centre is the unit that facilitates the research cooperation between the university and a company in the form of institutional agreements, groups’ arrangements, the use of institutional facilities and informal interactions (Santoro, 2000). This class includes a diverse and widespread range of UIC (Gray, 1998). This is commonly located at the university and its roles includes providing assistance for research contracts and consulting activities, developing and sustaining relation with industry partners and overseeing, albeit at a high level, the non-technical management of projects.
3. Government funded projects take the form of monetary support for a university, research institutes or independent researcher to engage in R&D. The funds may

vary in terms of the requirements placed on the actors as well as the nature and size of the project. The project outcome may have commercialisation potential at later period or may be more upstream. For example in Malaysia, the Ministry of Science, Technology and Innovation (MOSTI) allocate funds periodically to university, private and public sector to conduct different categorical research that is selectively approved (MOSTI, n.d.-a, , n.d.-b, MOSTI, 2008c). Similarly the research councils in the UK provide this type of funding as well as a range of other types of support (RCUK, 2010).

4. Knowledge transfer and technology transfer are two varying approaches. Knowledge sharing focuses on human interactions, cooperative education and personnel changes (Bacila and Gica, 2005). For example internship, placement or exchange of personnel from industry to the academic environment and vice versa. These activities are promoted as they stimulate research interaction between partners. Technology transfer in this context aims to apply research findings into the development and commercialise of new technologies (Santoro, 2000). Activities in technology transfer include providing technical expertise to address research problems, the development of new products or processes from existing knowledge, assisting entrepreneurs start-up to protect and exploit IPR and to arrange licensing contacts (Santoro, 2000, Bacila and Gica, 2005).
5. Contract research involves a contractual agreement between the university and an industrial player. In a formal contractual agreement, the university academic is usually supported by postgraduates research students (PGRs) who perform the majority of the research under the guidance of a supervisor (Low, 1983). In a more preferred environment, industry researchers are placed in the university to encourage direct interaction with the postgraduates. Such placements help promote direct exposure of PGRs to industrial needs and work practices. However funding of this type of contractual research needs to be reviewed on periodic basis accordance to the agreed terms as it is commonly subject to discontinuity (Wu, 2000). The contract research between UIC is the selected sample and parameter for this research investigation. The selection of cases and sample of study will be discussed in chapter 4.

Table 3.1 University - industry collaborative mode

Citations	Types of collaborative mode
(Low, 1983)	Consulting Research grants and contracts Major contracts Affiliate programs University consortia Industry cooperatives Exchange of people Incubators and research parks
(Katz and Martin, 1997)	Intra-alliance (internal between individual, group, departments, institution, sector, nation) Inter (national)-alliance (external between individual, group, departments, institution, sector, nation)
(Wu, 2000)	General support Contract research Research centre & institutes Research consortia Industrial associates New business incubators
(Zakariah et al., 2004)	General research support Informal research alliances Contract research Knowledge transfer & training scheme Government funded Research consortia Cooperative research centre
(IIyas, 2004)	R&D project involving faculty/graduates Joint research proposal (federal & other source) Customised education/training courses for industry employees Employment opportunity & consultancy Internship & cooperative opportunity for graduates
(Bacila and Gica, 2005) (Dooley and Kirk, 2007) (Santoro, 2000)	Research support Cooperative research Knowledge transfer Technology transfer

In Zinger's work, six other collaborative relationship were identified (Matthew and Norgaard, 1984). These collaborative relationships are termed contributions, procurement, linkages, exchanges, cooperative and joint ventures. Contributions in UICs are an important source of support for research works especially when there are no restrictions on the given contributions. These contributions vary from monetary support, use of equipments and many other forms. Secondly, procurement is also another form of collaborative relationship where the industry procures from the university in the form of consultancy work and services, advisory, testing and training courses. Likewise universities too procure facilities or services and seek specialist training from industrial partners. The above could be map across to the identified work in Table 3.1.

3.2.2 University-Industry collaborative drivers

In a globally applicable research context, collaborative initiatives in R&D appear to have been driven by numerous factors such as the demands for new technological development and the pressures of the competitive global market. It is said that the only constant is change and industrial players must learn to embrace this condition to sustain their market share by constantly developing or applying new R&D to reposition their product portfolios. Additionally, industrial players recognise their weaknesses in terms of expertise and skills to anticipate the need of their product pipelines to handle intense global competition. Due to these changes, industry needs to outsource a proportion of the R&D activities in order to focus on its core competencies commonly product development, manufacturing, marketing and distribution. To access the latest knowledge and technological experts, industry players may need to rely on collaborative partnership with universities as a channel for knowledge and technology transfer.

Collaboration were portrayed vividly as a symbol of partnership in both industry and university contextual environment as shown in Table 3.2. Alongside the technological and market challenges, universities are faced with a greater demand to increase collaboration as an ‘access door’ to improve and widen student’s exposure (Bacila and Gica, 2005). The drawback of such trend is the lack of university academicians which possess both the academic and industrial experience needed to appropriately train the younger generations of graduates (Matthew and Norgaard, 1984).

Table 3.2 Varying perspectives from university and industry on R&D collaboration

University's view	Industry's view
• They are 'non-profit' institutions existing primarily to teach and educate students and undertake pure and fundamental research • Research is an open activity where staffs are valued by their publication record; research is motivated by promotion and tenure and requires maximum publicity. The motto is 'publish or perish' • Research is to look for and extend new knowledge in an absolute way. Acquisition of knowledge itself is valuable • For faculty & staff, research is a part-time activity • No emphasis on urgency, research workers are more relaxed and scholarly • Function as professional training, develop student's self-confidence, mental capabilities and latent abilities to produce creative individual capable of independent thought and mature judgment.	• Sole objective is to make profit by producing marketable products or useful service • Research is a closed activity and new developments require protection through patents. Thus communication and publication are restricted • Knowledge is valuable only if it can be exploited in products. Research is pointless unless investment in it can be justified by turning discoveries into products leading to wealth creation • In an industrial research laboratory, research is a full-time activity • Industry's goals are short term • University faculty lack of industrial experience. Thus, mismatch between industry's expectation and type of education provided by the university • University faculty tend to be patronising

Source: (Zaky and El-Faham, 1998)

Despite its drawback, collaboration is a resolution in extracting each party's core competencies and strength to form a stronger entity and balanced partnership. The numerous motivational factors are dependent upon which aspect and perspectives being considered (Keil, 2000, SBIR, n.d., Dyer et al., 2006). These objectives and driving factors have been compiled and classified from the perspective of university and industry as shown in Table 3.3.

Table 3.3 Objectives and driving factors of the university and industry leading to the establishment of UIC

Citation	University	Industry
(Klawe, n.d.)	• Technology transfer • Enrichment of graduates with real-world experiences • Understand the applicability of knowledge in the industry • Changes in the industry research • Shift in skills for research students	N/A
(Casey, 2004)	• Graduates receive workforce training • Technical opportunities exists • Availability of materials from industry • Research funding provided by industry	• Access work demands from graduates • Attain novel to 'high' technology areas • Cost effective to outsource to university
(Owen, 2003)	• Knowledge and education dissemination	• Competitiveness • Growth • Products to market • Wealth creation
(Herman and Castiaux, 2007) (Herman, 2007)	• Knowledge creation • Growth of human resources, education and educational achievement • Translation and technology transfer	N/A
(Severson, 2005)	• Develop products/services that benefit the public	• Generate income to support further research & education in the university
(Butcher and Jeffery, 2007)	N/A	• Access to wider range of ideas, facilities & expertise
(Parnami and Bandyopadhyay, 2008)	• Encouragement of funding resources • Learning ability & opportunities	• Distribution of labour • Utilisation of skills & expertise • Sharing resources • Lower risks

Note: Compiled from (Parnami and Bandyopadhyay, 2008, Butcher and Jeffery, 2007, Owen, 2003, SBIR, n.d., Casey, 2004, Klawe, n.d., Severson, 2005)

It is important to examine all the factors in Table 3.3 if a full prospective of the motivations and expectations of the stakeholders are to be appreciated. The following text outlines a number of the key factors.

Technology transfer for competitive opportunities

Davenport et al. indicated that collaborative projects are formed primarily on the principle of 'technology transfer' (Davenport et al., 1999). However, as shown in Table 3.3 the real motivational factors are more diverse and complex. From the industrial perspective, collaborations are largely driven by increasing international competition, accelerating the pace of technological changes, expanding technical barriers, the costs of retaining broad technological skills base and acceleration of the product development cycles driven by globalisation (SBIR, n.d., El-Hesnawi, 2003). Industry foresees UIC as a partnership towards attaining novelty in 'high' and 'new' technology areas and to access ideas, facilities and expertise (Butcher and Jeffery, 2007, Casey, 2004). Through collaboration, industry could strengthen their strategic position by leveraging on the core competencies of their partners, gain access to complementary skills set and resources; expand their innovation networks and lowering the cost of developing physical infrastructure. The formation of collaborations allows industry to access these benefits which in turn allows them to get new and technically demanding products to the market faster than they could on their own while simultaneously lowering research costs (Dyer et al., 2006, Barnes et al., 2000). It also gives the universities a direct mobility to get their invention or technologies into the market that would generate income to support further research (Severson, 2005).

Accessibility to technology and exposure

The driving factors leading research focused organisations (such as universities) to engage in collaboration are quite different from those of commercial organisations. Universities primarily look to enhance their prestige though the publication of results, access to industrially relevant needs/trends and projects (Klawe, n.d.). By accessing real technological issues it creates a new learning environment enriching and preparing students for the real-world (Parnami and Bandyopadhyay, 2008, Casey, 2004). With the changes in the industry, there is a need to shift research students' skills to fit the needs of industry by encouraging strong links to produce graduates with skills set more in tune with the needs of industry (Klawe, n.d.).

Commensurate the level of R&D project risk

According to an IPR expert, P.Kandiah, universities begin to realise the increasing need to work with industries because risk taking are more equitably shared in the project (Tan, 2010). In addition UIC helps to commensurate the level of risk by diverging and alleviating inherent project risk allowing partners to operate in a safer environment while they compete with rivals (Brouthers et al., 1995).

Commercialisation of application opportunities

Collaborative projects are also encouraged by more progressive governments as they create a 'symbiotic relationship' which results in commercialising the research output (Casey, 2004). Developed nations have long recognised the importance of research capabilities which are seen as attractive inducements to multinational corporations to bring new manufacturing capacity to their shores. The activities of Singaporean government are perhaps the most successful example of intentionally building R&D capacity in strategic areas with this aim in mind. Although potential benefits from UIC research projects are widely acknowledged and embraced, there remains a wide range of issues which are not encountered in more conventional projects which will be covered in the following section.

3.2.3 University-Industry collaborative challenges

Many academic leaders agree that UIC have expanded significantly in recent years. Encouragement of such partnership is a bridging stone for universities to step forward into the reality of economic and societal needs. It helps university to conceptualise theoretical knowledge into product development. This driving factor is the rescue approach to shift academic mentality to become contributor to the nation's technological and economical development (Bollag, 1990).

In fact the academic literature indicates a wide range of issues may arise in the management of UIC (Rohrbeck and Arnold, 2006, Ghani, 1991, Davenport et al., 1999, Llyod and Simpson, 2005, Harris, 2007). In this work, these issues have been compiled and classified into a number of common themes as presented in Table 3.4. Each of the themes has been categorised according to internal and external determinants. Internal determinants range from a collective group of issues abstracted from both partners such as sharing of authority, lack of trust leading to hidden agenda between partners, the level of support and the degree of involvement to be negotiated and agreed before the partnership is initiated. Apart from internal determinants, the success of collaborative projects is also affected by the external environment. There are also political pressures from governmental bodies that drive universities to generate new technologies and knowledge to increase their contribution to the society.

Table 3.4 Factors which reduces the probability of success of UIC R&D projects

<table>
<tr><th>Category</th><th colspan="2">Factors / barriers to collaboration</th></tr>
<tr><td rowspan="2">Internal determinants</td><td>Collective</td><td>• Fear factor (Casey, 2004)
• Hidden agenda (Barnes et al., 2002)
• Sharing of authority (Davenport et al., 1999)
• IPR & publication novelty (Dyer et al., 2006, Casey, 2004, Saunders, 2003, Parnami and Bandyopadhyay, 2008)
• Confidentiality and privacy (Parnami and Bandyopadhyay, 2008)
• Level of support & involvement (Ghani, 1991, Harris, 2007)
• Selection of university-industry partner (Barnes et al., 2006, , 2000)
• Conflicting interest (Casey, 2004, Ghani, 1991, Rohrbeck and Arnold, 2006, Harris, 2007)</td></tr>
<tr><td>Project management</td><td>• Unclear requirements (Barnes et al., 2002, , 2000)
• Project planning & progress monitoring (Ghani, 1991)
• Ineffective communication channel (Casey, 2004)
• Unclear roles & responsibilities of team members (Llyod and Simpson, 2005)
• Unclear role of project manager/lead researcher (Barnes et al., 2000)
• Degree of commitment & motivation (Ghani, 1991, Harris, 2007)
• Project manager selection (Barnes et al., 2000)
• Collaboration agreement not clearly written & agreed (Ghani, 1991)
• Management process & use of tools</td></tr>
</table>

Table 3.4 Factors which reduces the probability of success of UIC R&D projects (cont)

Category		Factors / barriers to collaboration
Internal determinants	Cultural	• Distrust, lack of honesty and openness (Casey, 2004, Davenport et al., 1999) • Differing project objectives (Parnami and Bandyopadhyay, 2008) • Different nature of work (Rohrbeck and Arnold, 2006, Huljenic et al., 2005) • Structures for incentives & reward varies
External determinants	Environmental	• Technology transfer & applications (Parnami and Bandyopadhyay, 2008) • Ever-growing forces of competitiveness (Rohrbeck and Arnold, 2006) • Increase in technological choices to the market (Rohrbeck and Arnold, 2006) • Deregulation of policies (Rohrbeck and Arnold, 2006) • Political pressure in universities as knowledge contributors (Rohrbeck and Arnold, 2006) • Higher demand of innovation by market • Corporate stability & continuity • Industry specific R&D interest

The following outlines several factors which reduces the probability of success of UIC R&D projects at large:

Project management obstacles

The various project management related obstacles are due to unclear requirement, poor project planning and monitoring through the project cycle and where roles and responsibilities are not clearly defined or delegated. Many of these obstacles can be traced due to inappropriate selection of project managers (Harrigan, 1986). In the management of projects, communication frequently breaks down due to unclear requirements, poor planning and unclear roles and responsibilities. These issues are more excessive when the project involves multiple organisations with widely differing perceptions (Huljenic et al., 2005). Therefore, the creation of trust, respect, openness and honesty in a collaborative partnership are an important element for successful UIC but are highly sensitive and difficult to manage (Barnes et al., 2002, Davenport et al., 1999). There are also numerous issues related to the way projects are managed which have been identified from the literature as shown in Table 3.4.

Nature of environment

Davenport et al. (1999) identified that trust and honesty between partners are difficult to accomplish due to differing nature of work, style and objectives of each organisation which eventually creates a dual project control phenomenon (Davenport et al., 1999). This dual phenomenon leads to conflict of interest, clashes in management style and consequently allowing cultural differences to dominate in the project environment. These effects are greater if the expectations of different partners are not aligned. An example of project management perspectives (see Table 3.4), conventional university based research projects are more fundamental or abstract having loosely defined scope or requirements and typically require longer periods of investigation after which tangible products becomes the exception rather than the rule. However, commercial imperatives on the other hand force industry to strive for shorter product development cycles and are lead by well defined profit oriented objectives. Many of the issues identified are related to the dynamically different nature of a typical work environment in commercial and research driven organisations.

Differences in expectations

Next, the difference in what organisations perceived as success criteria also differs dramatically. Universities regard the advancement of knowledge and reputation as their primary element of success, while industry view success only if their end products achieve acceptance in the marketplace and accrue a significant return on investment. The differences in the financial expectations of project work have also caused issues of contention as identified in Table 3.4. Universities need to charge overhead costs to projects and by convention are given upfront grants (or more likely these days staged payments) rather than payment on delivery as the usual mode of commercial organisations. An additional challenge in the partnerships are the issues involving the ownership of IPR (Bammer, 2008). These issues are considered of such importance that even the Lambert commission structured its model agreements around IPR ownership (Department of Innovation Universities & Skills, 2008).

Other factors

Other obstacles in a collaborative partnership relate to the importance of corporate stability and continuity of personnel. These concerns are particularly important to the university which collaborates with small to medium size organisations that are more vulnerable to financial constraints, poor personnel management, downsizing, restructuring, acquisition by other organisations or even possible unexpected closure, all of which can be potential threats to the success of the collaboration (Barnes et al., 2002). As a result, universities need to consider these factors when selecting partners to ensure sufficient commitment and ability to sustain the partnership throughout the project life span.

To a certain extent, UIC R&D projects are one of the key mechanisms in fostering national competitiveness as they facilitate the development and application of national innovation potential. Yet R&D projects are inherently uncertain and therefore carry a relatively large risk of overwhelming performance or absolute failure (Quelin, 2000, Erno-Kjolhede, 2000, Gokhale and Bhatia, 1997, El-Hesnawi, 2003). As a consequence of the risk quotient and the other numerous issues discussed above, successful management of R&D collaborative projects is a challenging endeavour.

3.2.4 Best practices in university-industry collaborative management

As discussed in section 3.2.2, the nature of the relationship within a UIC is significantly different from those in other project environments. Establishing a UIC partnership requires more involvement from various actors (Koech, 1995, Matthew and Norgaard, 1984).

Although many UIC fail to deliver their potential, there are success stories from which best practices can be distilled. An exemplary case is the University of Warwick Manufacturing Group (WMG), which is noted as one of the most successful European university in developing industrial contracts (Bollag, 1990). According to its founder and director, Lord Bhattacharyya, WMG’s blueprint for success lies on its autonomous department which is independent from its home university. WMG's success was based on the university's streamlined decision making structure which works in designing both open and bespoke company-specific programmes. This involves academics agreeing not to publish the resulting research after an agreed embargo associated with commercial confidentiality. Additionally, WMG's ultimate proof of success is in the mentality of university and industry both of which accept the concept of innovative ability as a win-win situation (Jump, 2011).

The academic literature contains a wide range of studies which have attempted to identify practices that enhance the probability of success. These factors have been compiled in Table 3.5 where the best practices were categorised into internal and external determinants in a similar manner to the UIC challenges discussed in section 3.2.3, Table 3.4. For example, Roherbeck and Arnold (2006) studies a number of successful collaborative partnerships and identified a number of best practices (Rohrbeck and Arnold, 2006):

- create a mutually shared mission and goals between partners
- creation of an environment of trust and transparency
- clear publication policy and IPR
- clear division of labour and management with different key performance indicators
- creating a shared and open office system

One of the most influential studies was done by The National Council of University Research Administrators (NCURA) and the Industrial Research Institute. Based on the findings they were able to define three guiding principles aimed at improving the success of collaborations (Dyer et al., 2006). The first of these principles is to develop a solid ground for consensus of a shared mission statement, vision and goals for the mutual benefit of both partners. The second principle involves fostering and maintaining a sustainable long term relationship that aims to extend innovation and economic development. The last principle is to encourage the establishment of a framework to measure the value of the collaboration, the most appropriate results and quality measures to help correct inefficiencies for the benefit of each partner. These three principles will be applied in the design of the PMM.

Table 3.5 Best practices for successful management of UIC

Category	Best practices for UIC success	
Internal determinants	Collective	• Create shared mutual mission & goals (Davenport et al., 1999, Quelin, 2000, Rohrbeck and Arnold, 2006) • Clear level of control & authority (Rohrbeck and Arnold, 2006) • Clear policy on IPR & publications (Quelin, 2000, Rohrbeck and Arnold, 2006, Saunders, 2003) • Top management involvement & commitment (Davenport et al., 1999, Ghani, 1991) • Complementary knowledge based partners (Weck, 2006, Davenport et al., 1999)
	Project management	• Clear roles & responsibilities (Weck, 2006, Llyod and Simpson, 2005) • Frequent & effective communication channels (Ghani, 1991, Quelin, 2000) • Organise joint meeting periodically (Weck, 2006) • Recruitment of competent project manager (Barnes et al., 2002) • Selection and evaluation of partner (Holmberg and Cummings, 2009, Bierly III and Gallagher, 2007) • Use of PMM (Weck, 2006, Davenport et al., 1999, Ghani, 1991, Rohrbeck and Arnold, 2006) • Good documentation and archive project experiences (Weck, 2006) • Well defined research proposal & research contract (Weck, 2006, Ghani, 1991, Quelin, 2000) • Encourage & motivate through team building
	Cultural	• Establish trust, honesty, openness & transparency (Davenport et al., 1999) • Mutual respects of differences (Ghani, 1991)
External determinants	Environmental	• Increase awareness of the exposure to new technologies (Industrial Research Institute, 1997) • Enhance stature, recognition in academia & industry (Industrial Research Institute, 1997) • Government promotion in R&D research for all industries (Industrial Research Institute, 1997)

In the management of UIC R&D projects, the recruitment and selection of a high calibre project managers are crucial to support the success of collaborative projects (Barnes et al., 2002). The management of the project is often made more difficult due to cultural differences, unclear objectives, differing missions and drivers between the various collaborative partners. Therefore the role of the project manager is the key to support creative thinking, motivating, fostering commitment and innovation within the project team. To be fully effective the competency of the project manager not only lies in planning, monitoring and coordinating the project but it must also extend to the management of knowledge workers and the new knowledge generated (Huljenic et al., 2005). The project manager needs to promote effective communications channels to build and establish trust, honesty and openness. These measures of conduct create a more effective management of interaction between the team members from the different organisations.

In addition to the importance of selecting an appropriate project manager the effectiveness of the project team is crucial to the success of the collaboration. It is essential that the project team has a clear understanding of its roles, responsibilities and reporting lines (Llyod and Simpson, 2005). This is of course best practice for all projects; however in a research environment it is common for team members to be unfamiliar with project management practices. Though it is common for researchers to have under developed team skills as they often work individually or in small groups, it is important to recognise the importance of the lead researchers skills set which may not include project management expertise (Barnes et al., 2002). It is for this reason the proposed PMM recognises a separation of responsibilities between technical and management leads, which is one of the most important principles of project management. This enables a project manager, who is equipped with the appropriate skills to handle the administrative and management activities in a professional manner and leaves the highly qualified researchers free to concentrate on running the technical aspects of the project. It is also important for the project manager to clearly define the roles and responsibilities of the lead researchers and to recognise the importance of their individual roles and the contributing organisations.

Though all team members in collaborative project are empowered with other work commitment, it is often an overlooked consideration. For example the lead researcher will typically be an experienced academic and expected to simultaneously run lectures, lab classes, tutorials, mark course works, supervises research students and a multitude of other activities. To address these aspects the PMM will contain an integrated team commitment agreement which should be well understood by every team member during the initiation process of the project (Harris, 2007). Without such a plan accurate activity planning and team commitment cannot be achieved effectively.

Such balance in a UIC is the key for a successful partnership. Both university and industry need to accept the importance in complementing each other's needs and wants. In a situational behaviour condition, collaboration could be due to the force of the market pressuring organisations aggressive search for partners without proper consideration, evaluation and selection processes (Holmberg and Cummings, 2009, Lee, 2000). Consequentially resulting in poor understanding of each partner's strategic desire in alliance, poor collaborative management and failure with early termination or withdrawal of partner (Matthew and Norgaard, 1984). Therefore, the importance of creating a structured process of partner selection has been raised by many researchers in the open literature. Selecting the right partner increases the assurance of a successful partnership. In view of this important requirement, it will be considered as one of the key tasks in the initiation process of the proposed PMM.

Another issue frequently cited preventing collaboration from getting off the ground are those associated with IPR. IPR forms a platform for building the recognition of success and is an important source of future revenue for both partners. Conflict frequently occurs due to differences in opinion about the ownership of patents, copyrights as well as issues surrounding licensing fees and the freedom to publish the findings of the work. Therefore, it is considered good practice to produce a clear written agreement which covers IPR, credits assignment, patents and publications prior to the commencement of the project. The Lambert agreements are an example that contain a set of excellent templates based around IPR issues (Department of Innovation Universities & Skills, 2008).

Although there is a need for formal legal documents, these are frequently difficult to read and understand creating a possibility where few project members will take the time to do so. The proposed PMM had earlier set its boundaries of the collaborative agreements involving IPR issues will be excluded in this study as it has been well covered by other authors. Even though this aspect would not be elaborated in detail in the methodology, resources extracted from Lambert collaboration agreement model for used in establishing the UIC will be used as a source of reference to university researchers' and industry practitioners.

Finally, success in R&D projects not only lies in the hands of industry and the research institutions but the importance of governments role in promoting awareness of new technologies, stimulating innovation and making connections. Therefore the proposed PMM will consider the need to source external funds from funding bodies such as government to support the UIC research projects.

3.3 University-Industry Collaborative Life Cycle

The progress of UIC does not follow a single generic path (Sherwood et al., 2004). Rather they tends to evolve hence despite numerous studies there is no consensus on the stages that alliances go through (Jiang et al., 2008). An interesting study of alliance life cycle by Spekman et al (1998) illustrated seven main managerial activities involved in the management of alliances as summarised below (Spekman et al., 1998):

1. Anticipating is the preliminary stage in which an organisation envisions the possibilities, ideas and dreams for the alliance. At this point, managers begin to articulate strategic intent for an alliance and begin to form the requisite criteria for a potential partner.
2. Engaging is characterised when partners begin to sort or shape their mutual expectation for the alliance and form a steering committee. This activity is commonly considered to be the beginning of the process of converting the dream into a reality.
3. Valuing is the period where terms of business are exchanged and finalised. Partners bring in both skills and resources and each attempt to measure the relative worth of these assets.

4. Coordinating is the stage where joint work formally begins and a permanent governing structure emerges. This is the central stage for integration and coordination.
5. Investing is the hard realities of the alliance in which partners commit to the future course of alliance. Assets are formally committed and resources are dedicated to the alliance’s mission.
6. Stabilising indicates the alliances maturity and realisation of its potential. Performance is measured against objectives, financial targets and operational milestones rather than less tangible measures.

In another study, partner relationship building upon all levels were found to be the weak link resulting in the identification of a four stage sequential alliance process identified from its research effort; strategy development, partner assessment, contract negotiation and alliance operations (Pekar and Allio, 1994). A study by Wahyuni (2003) indicated that each activity in the alliance landscape is presented as a discrete event although the body of literature suggest such boundaries are not so clear in practice. Wahyuni also commented that simply enumerating a set of activities might not carry an equivalent impact to examining an alliance through the lens of a life cycle perspective (Wahyuni, 2003). With many works examining the interaction of activities, people, and processes between the understanding of alliance formation and management, from a generic perspective it is not possible to clearly identify where one activity begins and the other ends (Wahyuni, 2003, Spekman et al., 1998). Table 3.6 below compares the different perspectives from existing literature on the various alliance development stages.

Table 3.6 Comparison of different perspectives on alliance development

Stages/processes	Description of each stage	Citation
1. Strategy development 2. Partner assessment 3. Contract negotiation 4. Alliance operations	1. Studies alliance's feasibility, objectives & rationale 2. Analyse partner's strengths, weaknesses & selection criteria 3. Define partner's contribution, rewards & proprietary information & penalties for poor performance 4. Address management's commitment, budgets, resources, priorities & performance	(Pekar and Allio, 1994)
1. Courtship 2. Engagement 3. Newly partnered companies 4. Bridging differences 5. Old married	1. Meeting point, interest & compatibility 2. Drawing up plans & close the deal 3. Discussion on different ideas on business operation 4. Devise mechanism to bridge differences 5. Discovery of ongoing collaboration based on results	(Kanter, 1994)
1. Envision results by working individual to individual 2. Empower ourselves by working individual to organisation 3. Ensure success by working organisation to organisation 4. Endow continuity by working collaboration to community	1. Bringing people together, enhance trust, vision and specify the desired results 2. Confirm organisational roles, conflicts, organise effort & support members 3. Manage work, create joint systems, evaluate results & renew effort 4. Create visibility, involve community, change system & end collaboration	(Winer and Ray, 1994)
1. Rethinking the business 2. Crafting an alliance strategy 3. Structuring alliances 4. Evaluating alliances	1. Strategic reassessment, establishing a role for alliances 2. Evaluating firms value chain activities, leverage resources, create fall-back positions 3. Importance of structures, framework, role of bargaining 4. Assess alliance, learning and rethinking alliance strategy	(Yoshino and Rangan, 1995)

Table 3.6 Comparison of different perspectives on alliance development (cont)

Stages/processes	Description of each stage	Citation
1. Alliance business case 2. Partner assessment & selection 3. Alliance negotiation & governance 4. Alliance management 5. Assessment & termination	1. Value chain analysis form, needs-analysis checklist 2. Partner screening, cultural fit 3. Negotiations matrix, alliance contract, structure, metrics framework 4. Problem tracking	(Dyer et al., 2001)
1. Partner selection 2. Negotiation/structuring 3. Implementation 4. Performance evaluation	1. Matching partners based on choices & decision e.g. reputation, experience, capabilities etc 2. Decide appropriate governance forms, scope of activities, division of labour etc 3. Carry out the agreement, put cooperation into operation 4. Examine the partner's objectives are met based on cost & benefits	(Jiang et al., 2008)

One of the most effective areas of UIC lies in the realm between basic research that catered for exploration and discovery of ideas and the technology derived from the knowledge explored, a region (shaded) known as innovation illustrated in Figure 3.1 (Matthew and Norgaard, 1984).

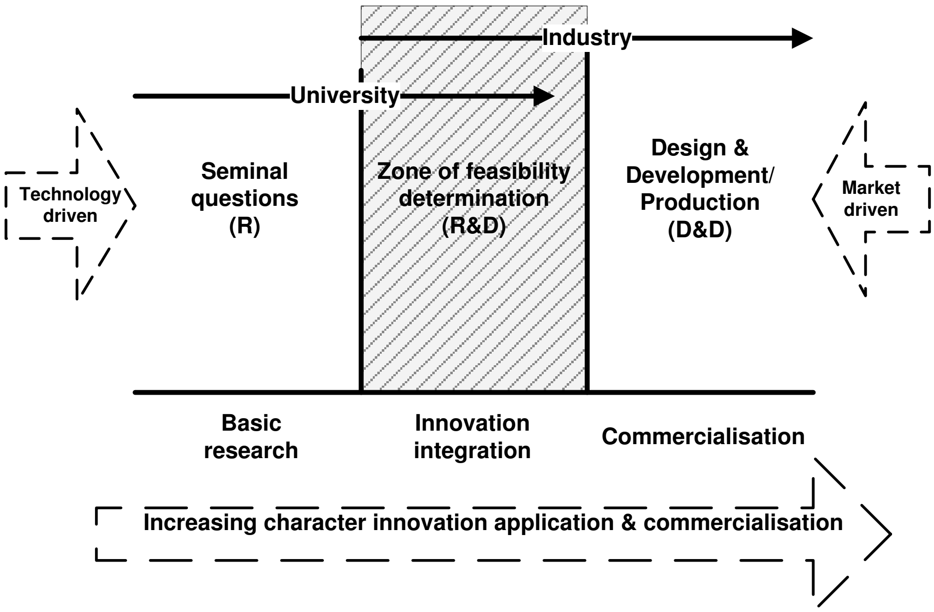


Figure 3.1 Model of UIC

Source: (Matthew and Norgaard, 1984) and research analysis

In Figure 3.1 the shaded area overlapping both industry and universities is the most pertinent zone in the collaboration process. It contains the greatest range of ideas and inventions. The challenge is to integrate the organisations and their associated capitals to deliver an effective collaboration. Each partner is motivated driven by different factors (as discussed in section 3.2.2). The university is driven by a desire to generate new ideas, technology and make discoveries which is different from those factors which drive commercially driven organisations. It is this shaded area that is the most unmanageable but perversely holds the most potential (Matthew and Norgaard, 1984). In other words, this shaded area is the common ground established for collaboration, it may yield the most fruit but it is an uncharted territory for many.

This investigation lays the foundations and understanding of the workflow and process model of UIC which will be extracted for integration into the PMM framework. Based on the literature, three main stages in the UIC life cycle have been defined; establishment, operational and evaluation which will be discussed in the following sub-sections.

3.3.1 Establishment stage

UIC are initiated for various reasons and follow different approaches. It has become a compulsory option for universities and is increasingly recognised as essential by more companies if they are to remain competitive. Based on literature reviewed, this study has identified the following essential components encapsulated in the establishment of UIC.

1. Partner selection and assessment

Significant importance is given to partner selection in the literature and it has been identified as a critical factor (Brouthers et al., 1995, Kale and Zollo, 2006, Holmberg and Cummings, 2009, Porter and Baker, 2005, Bierly III and Gallagher, 2007, Hipkin and Naudé, 2006). It has been identified as the foremost process for firms to assure successful partnership yet it remains as one of the key obstacles in most collaborations (Holmberg and Cummings, 2009, Bierly III and Gallagher, 2007), perhaps because the level of trust and vested interest are at their lowest at this stage.

When the decision to collaborate has been made, the next crucial question involves whom it wants to partner with. Partnership is similar to any form of relationship where compatibility is essential for an effective relationship. Similarly an organisation's indication of compatibility to enter into a partnership is closely linked to the choice, availability, compatibility of characteristic (Geringer, 1991) and even congruence of business goals, mission and strategy (Holmberg and Cummings, 2009).

Due to technological developments and changes in demands and competitiveness, firms tend to jump into collaborative partnership to achieve faster results. By saying that, firms collaborate due to top management relationship without proper understanding and measurement of the partner's compatibility of skills, resources and goals (Carboni, 1992). Alternatively, the management holds the sole decision in opting for the selected partners without prior review with other project stakeholders. The above example illustrates that there are potentially many implicit condition arising in the collaborative environment either academically structured or industrial condition. This restraint firms from identifying the appropriate and compatible partners prior to collaboration formation. Thus determining the partners will need to be linked to the overall project objectives, mission, compatible skills, complementing resources, corporate culture, risks, opportunities etc. These had been discussed earlier in section 3.2.4.

In a recent report by Eden et al (2007), partner selection is heavily influenced by external factors such as firms' hesitation due to knowledge transfer and leakage, the result of which is that firms aim to protect themselves by limiting the collaborative partnership. As a result, partner selection is identified only as an alternative and given the necessity to access specific competitive edge-cutting resources, skills or technologies. Eden et.al also identified three categories of alliance partner's compatibility elements in the selection process; friends, acquaintance or strangers. They recommended organisation to select 'friends' as partner for new R&D alliances and avoid 'acquaintances' when they do not have adequate information to predict future behaviour (Eden et al., 2007).

It is important that due consideration is given to the assessment approach for partner selection (Gulati, 2004, Kale and Zollo, 2006). Most firms however have the tendency to jump into collaboration and learn their lesson the hard way. Despite the emphasis on partner selection in the literature, this area still lacks specific research attention and practically even current best practices that are not always known or implementable.

Many scholars have recommended firms to synergise specific criteria for use in assessing potential partners and to avoid collaboration unless they have insufficient resources (Brouthers et al., 1995). An evaluative criterion of classification comprising of complementary skills, compatible goals, cooperative culture and commensurate level of risk were identified as the four Cs of strategic collaboration in a study by Ma and Li (2006). In their work, they also commented on the importance of understanding cultural differences, business matching, trust and location of partners as the foundation for successful cooperative relationships in UIC partner selection (Ma and Li, 2006). Bierly and Gallagher (2007) uses a strategic expediency in partner selection decision making. Wu et al (2009) developed five sets of major criteria with sub-criterion to guide firms in the selection of the best partners as shown in Table 3.7.

Table 3.7 Categorisation of criteria for selecting partner

Categorisation criteria for selecting alliance partner	Citations
Four Cs of strategic alliances; complementary skills, compatible goals, cooperative culture, commensurate level of risk	(Brouthers et al., 1995)
Strategic fit, trust and strategic expediency	(Bierly III and Gallagher, 2007)
Characteristics of the partner, marketing knowledge capability, intangible assets, complimentary capabilities, degree of fitness	(Wu, 2000, Wu et al., 2009);
Firm status (human resources, financial status, management, marketing, R&D capacity, production capacity) Cooperative relationship (location, trust, business matching, culture difference) Cooperation record (cooperation networks, cooperation credit, cooperation quality)	(Ma and Li, 2006)
Humility, leadership, trust, reciprocity, balances resources, expertise, political connections, past experiences	(Porter and Baker, 2005)
Historical past experiences	(Kale and Zollo, 2006)
Strategic interdependence, social and structural embeddedness	(Gulati, 2004)
Strongest complementary resources (physical equipment, reputational assets), strong resource endowment, social interdependence (priorities), goal congruence/strategic goal converge	(Overby, 2006)
Prior successful partnership, adequacy of information, willingness (repeatable engagement for opportunism)	(Eden et al., 2007)

The criteria in Table 3.7 are seemingly important as they feed the analytical evaluative strategy for selecting collaborative partners. This is because partners are selected only when they can balance, complement and give political strengths, resources and credibility needed to get the job done (Porter and Baker, 2005). Although many essential factors influence the selection of collaborative partners, at times selection of partners have been overly based on systematic judgement and the collective discussions of cross-functional groups including competent, motivated professionals as well as academic consultants (Carboni, 1992).

Through understanding the above literature, this study aimed to categorise the criteria used for partner selection in the PMM framework. It will be designed as a template to guide organisations in the selection of potential collaborative partners.

The categorisation criteria will be identified as the 7Cs of partner selection scheme in this work and will be further discussed in chapter 7.

2. Partnership arrangement

Each new collaboration employs a new arrangement for the partnership, as it was formed for a unique need to address a specific problem or opportunity (Matthew and Norgaard, 1984). Hence, there will not be a single generic approach to structuring and managing this type of partnership, rather arrangement on the formation should be relevant to gain mutual advantage and to suit the situation. Therefore the collaboration mode is an issue which should be closely related to the goals and its reasons for its establishment (Wahyuni, 2003). This important aspect of UIC establishment will be incorporated in to the design of the PMM.

3. *Understanding each partner's roles, needs and interest*

For UIC success, partners need to comprehend the rationale for the collaboration by recognising the strategic vision and fears that each partner brings to the partnership. Carboni (1992) put forward that UIC research alliances would be most effective by initially assessing university skills and facilities and coordinating this with industries strengths and activities to achieve a common goal. The process could begin by understanding the technical objectives, analysing internal strengths, limitations and needs. Assessment of such will help the university to focus its capabilities in the partnering process (Carboni, 1992).

4. Partnership dynamism – attitudinal restructuring

The central importance to structuring and management of the partnership is the willingness of each partner to embrace an attitude of cooperation to achieve a common solution. Partnership attitudinal restructuring involves confronting differences by shifting towards solution rather than being problem oriented; encouraging the flow of new ideas with an open mind, delineate differences in opinion and to be coherent on the mutual contribution and benefits from the effort.

One of the crucial elements is the willingness from each partner to identify a need to create a conducive environment to support the dissemination and exchange of information as well as movement of personnel in the collaborative project structure.

To accomplish this goodwill, partners need to convene regular scheduled meetings to promote awareness of resources, opportunities and personnel exchange programs.

5. Management environment

The level of dynamism in UIC partnership is influenced by three basic issues; assessment of needs and matching resources, management role and the organisational structure (Matthew and Norgaard, 1984). UIC partners need to conduct a clear and realistic assessment on the needs, capabilities, benefits and risk that the partnership may encounter. Such awareness level is needed to tap the new resources that meet each partner’s needs. One of the means in evaluating partner’s capabilities starts by assessing the current research programme being studied and to assess the magnitude of these needs for use both in the present and the future. By doing this, each partner will be able to understand their own environment as a step in strategic planning process to better match the needs with business partner in assuring greater partnership success (Arranz and Fdez. de Arroyabe, 2008).

6. Top management role and leadership

The partnership environment needs to be supported with a high degree of involvement and interest from the top management. Active involvement by top management increases the likelihood of a successful collaboration. Involvement from the most senior level e.g. the vice chancellor of the university and the chief executive officer of the company is recommended to optimise the probability of a successful collaboration (Matthew and Norgaard, 1984).

At a lower level, management needs to encompass the coordination of physical and human resources to foster innovative collaboration (Porter and Baker, 2005). Human resource management is a difficult task, it tends to be even more difficult and complicated when it involves different organisational cultures (Matthew and Norgaard, 1984). In such situations, the resolving mode is patience, compromise and willingness in the negotiation process with a determination to establish an effective collaboration. This expectation needs to be derived from both parties where every differences and expectation are discussed and negotiated at the outset of the project.

7. Organisational culture and structural support

Although the cultural divide between university and industry in negotiating research agreements is real and considerable, there are ways to bridge the gap (Burnside and Witkin, 2008). For example, partners should recognise and be respectful towards each organisational culture differences in terms of policies, personnel, structure or practices (Geringer, 1991). Although the provision of strong management leadership helps to facilitate a better understanding of the collaborative environment, yet in order to fit into an innovative and strategic environment, partners must also learn to acclimatise.

Bridging the gap between UIC partners also entails the development of some aspect of structural support. Whilst structures may reflect some degree of bureaucracy, it is seen as a necessary pillar of support. Every UIC structure is unique, yet it should be influenced by a list of factors for example whether UIC had any prior partnership experiences, prior structure established, whether the objective of engagement in the collaboration is a long term or short term plan, the mode of partnership, length of collaboration and the degree of intimacy (as negotiated and agreed in the contractual agreement) (Matthew and Norgaard, 1984).

According to the literature, the organisational structures which house each partner's competitive niche need to establish its own policies and procedures which must be transparent and visible. To minimise the degree of conflict, every distinct set of policies and procedures needs to be rationalised and understood by all individuals involved. In addition, an advisory board must also be established to oversee, evaluate, monitor and approve the decision making process of project related activities (Matthew and Norgaard, 1984).

8. Negotiation and managing contracts

In the case where both parties discuss the collaborative arrangement and expectation with a common objective in mind, the negotiation process and contract agreement should be mutually satisfactory. Yet, the above scenario may not occur in every situation because partners have to address their actual needs, source and share resources; all issues whether it is common or specific to one partner need to be raised. At times the negotiation process can be both the most challenging and lengthy period of the whole establishment stage.

The literature suggests that both parties need to facilitate each other irrespective of the collaborative mode in mind and that they are not in competition rather both should gain from the collaboration (Matthew and Norgaard, 1984). Though subjective, contractual negotiation should reach some degree of consensus in the following areas; activities, duration, roles and work delegation as the first priority. Secondly, the distribution of IPR, results of publications, patents and licensing (Brannock and Denny, 1998) need to be considered. The third set of factors for negotiation include financial agreement and management which address both direct and indirect costs when additional activities incurred in the course of project rework. Fourthly, the contract needs to clearly specify the definite accomplishment which will signify the end of the project and the partnership. Finally, negotiation of contract should be considered to be a review gate system. To safeguard the project the advisory board monitors and controls everything that could potentially cause problems.

3.3.2 Operational stage

Although significant effort has been invested in the project at the start of the operation stage, the relationship may still change significantly and the probability for termination still exists. The collective strength of partners may also take a downturn towards the end of the operation stage as exhaustion of resources and deadlines for commitments approach. According to Das and Teng (2002), there is also the possibility that the initial match between the partners is no longer relevant which may result in termination or reformation. For the collaboration to proceed efficiently in the operation stage, conflict of interest between partners needs to be curbed (Das and Teng, 2002). The following variables have been identified as important components for the development of the PMM to manage UIC in the operational stage.

1. Collaborative agent or boundary spanner

Collaborations should be managed as a hybrid organisation in which each partner cooperates in sharing investment costs and risks but remains independent with different motivations and objectives (Wahyuni, 2003). Besides that, collaboration often fail because the operating or project managers do not work well together and not because the contract were poorly written (Harrigan, 1986). Both Huxham and Vangen (2001) noted the importance of management as a central, continuous and inherently difficult aspect of collaborative practice. In their study, the best approach to help with collaborative practice is the organisation of a structured team and the assignment of an alliance manager (Matthew and Norgaard, 1984).

Though the UIC partnership exists as one they are often represented and facilitated by separate individuals within the two organisations. These individuals are the social tie builders that bridge the organisation. There are many terms used to describe these individuals such as boundary spanner (Walker et al., 2009, Gerardi and Wolff, 2008, Sherwood et al., 2004), alliance manager (Huxham and Vangen, 2001, Yoshino and Rangan, 1995), academic project manager (Carboni, 1992) or collaboration agent (Philbin, 2008).

The boundary spanners must be in a position that if the partner’s contributions are found to be insufficient they can take appropriate corrective action (Yoshino and Rangan, 1995). The roles of boundary spanner as gate keeper is to bring diverse groups of people together to collaborate across organisational boundaries (Gerardi and Wolff, 2008). It is also through such social exchange and experiences that an environment of trust and support in collaborative research is formed.

Groman (2006) indicated that an ‘on the board’ project manager is the best practice for adoption in collaborative research projects (Groman, 2006). As such the university must commit a trained academic project manager to facilitate the collaborative partnership so as to lower the dependency on the industrial partner for project management (Carboni, 1992). The appointment of an academic project manager also allows the tailoring of the needs and organisation (industry/university) culture (Cooke-Davies and Arzymanow, 2003). The academic project manager needs to be flexible, adoptable, a quick learner and a good communicator (Barber, 2004) whilst embracing the essential skills of an effective project manager (Schwalbe, 2002) and yet still hold academic credibility.

2. Communication planning

Another important variable in the operational stage is communication planning (Huxham and Vangen, 2001, Yee et al., 2009a, Newby, 1997, Dodourova, 2009, Mattessich and Monsey, 1992, Winer and Ray, 1994). The importance of open and casual communication on a day to day basis can counteract mistrust and suspicion.

Secondly, in building effective communication channel, partners need to establish informal and formal links and to communicate openly and frequently (Winer and Ray, 1994). Formal communication includes involvement in the decision making, creating written agreements on structure and roles. As such communication planning requires time and effort to produce and distribute. Informal communications are established based on personal connection but above all partners need to be taught on how to ‘listen’ to each other as they communicate (Covey, 1990). Thirdly, written reports can be an important means for conveying status. However they represent one way transmission of information and do not create a culture of open and transparent communication (Carboni, 1992).

3. Control and coordination mechanism

Control can be viewed to have negative connotation particularly by academic researchers. It tends to suggest restrictions, criticism, lack of confidence and authoritarianism (Carboni, 1992). Yet the much suggested view is regarded as a critical issue for successful management and performance of the collaboration. Traditionally control is intended to monitor and appraise the progress of the research so appropriate action can be considered to minimise deviations from its original objective (Carboni, 1992). However difficulties tend to arise from the nature of the assessments and the nature of research works itself. The project manager hence becomes an essential person and needs to have the ability to operate effectively by being able to maintain progress and team moral in the face of uncertainty (Cicmil, 2006).

Insufficient control over the collaborative management may also lead to lack of cohesion and unity thus threatening the performance and the ultimate outcome. Therefore proper management of control is necessary (Wahyuni, 2003) but should not be restricted to blind adherence to plans as the dynamics and the uncertain nature of research means that the plan may quickly become irrelevant. Rather it should provide the flexibility to researchers to follow what they believe is the best course of action to achieve the project goals (Carboni, 1992).

3.3.3 Evaluation stage

Measurement of the performance of a collaboration is a complex and controversial topic because partners do not necessarily have the same expectations or performance criteria (Wahyuni, 2003). However the body of literature view evaluation as an essential element to ensure successful and sustainable collaborations (Yee et al., 2009a). It is difficult to assess and measure because academic research deals with new concepts and explorations in new and uncharted areas (Matthew and Norgaard, 1984). Furthermore research measurement becomes even more overwhelming when it involves UIC activities. There are differences in criteria, values and standards in each sector to judge the performance and productivity of the research (Carboni, 1992). In such a condition many authors have differing views on performance measurement. The following discussion elaborates on several scholars' views of collaborative performance measurement in the evaluation stage of UIC.

Das and Teng (2002) have identified four possible outcomes from this stage – stabilisation, reformation, decline and termination. In the stabilisation condition, the collaborative effort becomes mature and able to fit into the environment on a continuous basis and stabilised patterns of interdependencies and collective strength developed. Such outcomes are perfected when a real synergy of two entities are further developed which subsequently influences future collaboration. A possible combination outcome is also predictable such as termination after reformation which may not necessarily signal failure, whilst deterioration in a collaborative environment may lead to a declining outcome.

HellstrOm and Jacob (1999) identified six parameters of collaborative performance measurement based on dynamic network management of UIC effort. Firstly, research performance can be evaluated based on the fertility of its network through its productivity in producing spin-offs leading to new research projects. Secondly, by structuring and connecting networks the collaboration has achieved to address issues such as the diversity of the partners created to allow knowledge sharing. Thirdly, indication of the collaborative efforts financial success is a measurement of the relationship. Indicators such as royalties accrued by the university as a result of the collaborative activity, market share, cost and also duration taken to achieve its overall objectives are financial indicators. Next, measurement by educational outcome such as the generation of graduates from the collaboration, funding of lectureships and equipment obtained (HellstrOm and Jacob, 1999).

Fifth, the number of publication produced from the network is perhaps of greatest value and importance to the university. It is the primary achievement criterion based on the scientific exploration as it reflects the visibility and honour of the university and academic researchers (Carboni, 1992, HellstrOm and Jacob, 1999). Finally, the numbers of patents produced from the research network is also highly prized but this importance varies depending on the organisation. However it follows that with a high rate of patenting there tend to be a decline in the publications, justifying a shift in favour of knowledge dissemination to knowledge protection in the long run (Fulop and Couchman, 2006). Yet in recent years the increase in commercial interests of universities has raised the value of patents and royalties from leveraging deals associated with the collaborative effort and has become an important source of additional income. In addition these interests are becoming one of the favourable factor to develop a long-term relationship with industrial partners (Carboni, 1992). Whilst other scholars believed that the ability to learn is one of the most intangible assets generated from the collaborative effort (Wahyuni, 2003), the knowledge obtained can also result in organisational learning (Kale and Zollo, 2006).

In designing a scalable methodology for use in a UIC research environment, it is crucial to have a thorough appreciation of the R&D life cycle in order to integrate and map it to the methodology. The above discussion on the UIC life cycle thus provides a better understanding of the importance of the requirements, components, processes and issues that need to be addressed. Based on the discussion in this section, the design of the PMM would need to incorporate aspects of partner selection and assessment to provide a systematic process in the decision making. A list of criteria will be created for use in the PMM for partner selection.

Effective collaboration also needs to be supported by the top management, a favourable management environment, the willingness of attitudinal restructuring by conducting the collaboration with an open mind irrespective of the collaborative mode or types of contractual agreements to minimise partners' differences. For effective operation of UIC, scholars have suggested the assignment of an on board project manager from each partner is crucial and they need the skills to act as a social tie builder between organisations to promote better communication channels, as well as in coordinating the UIC project environment. At the close of the UIC, evaluation of collaborative performance becomes a key measurement between partners mainly because each partner has different levels of expectations and performance criteria.

The proposed PMM framework would integrate a toolkit identified as project balanced scorecard which allows partners to view collaborative project performance from four perspectives; financial, customer, internal, innovation and learning. It would aid partners to have a balanced view to understand the many interrelationships in collaboration thus leading to improved decision making and problem solving in the UIC. These elements will be further discussed in chapter 7 and detailed in the PMM guidebook.

3.4. University-Industry Collaborative Research in Malaysia

Based on the previous discussion of UIC literature, this section aims to examine and understand the significant growth and need for UIC in the Malaysian research environment. Although the introduction of UIC over the years is believed to be beneficial, the establishment of UIC's in Malaysia are still visibly lacking. The research objective for this study is to bridge the visibility gap by providing a new insight to the adoption of PMM as a strategy to improve the management of UIC and subsequently increases UIC research outputs for the nation.

Malaysia is a growing nation currently going through rapid industrialisation whilst emerging as a major global producer and exporter of technological sophisticated high value-added products in a number of limited sectors (Malairaja and Zawdie, 2008). Yet, UIC is still a new phenomenon in Malaysia (Yee et al., 2009a, Aslan, 2006) compared to other Asian nations. In the recent World Bank 2007 and Ninth Malaysian Plan (9MP) reports, a strong indication on the need to strengthen Malaysia's National Innovation System (NIS) through establishing greater linkages and contacts between university and industry was seen as essential as the nation strives to become a knowledge-based economy (The Economic Planning Unit, 2006). To achieve this Malaysia will need to strengthen its policies and innovation system to encourage and cultivate the collaborative culture of UIC R&D in order to generate greater skills and human capital development plus technological sophistication to mitigate the issues associated with the lack of information technology (IT) and technological competence skills (The World Bank, 2007).

In the Ninth Malaysian Plan (9MP), it was acknowledged that there is more need to strengthen the NIS (The Economic Planning Unit, 2006). One of the elements indicated in the innovation system is creating and establishing closer link between universities and industry and to increase R&D funding allocation under both National Plans. Without the incentives of research grants, the level of interactions would be much lower (Malairaja and Zawdie, 2008). This fact was clearly acknowledged by the Eight Malaysia Plan (8MP) (The Economic Planning Unit, 2001).

According to the World Bank (2007), the linkages between university and electronic firms in Malaysia are weak despite government support for R&D. Furthermore, Malaysia is lacking in certain skills and competencies (MOSTI, 2008a, , 2008b). Although this may be mitigated by forging closer links between universities and industry, the challenge lies in sourcing for skilled, diverse and new form of management and leaderships as the enabler for innovative thinking (Jackson, 2009).

In view of this changing environmental trends and demands, the government realised the need for more development in its human capital which is a significant input to the growth of the nation. However, due to differing expectations and requirements provided by institutions of higher learning to supplement industrials needs, Malaysia need to review alternative strategies to mitigate these barricades.

3.4.1 Competitiveness ranking

Today, other Asian countries, for example India and China, are producing more technological scientists than Western nations (Jackson, 2009). This achievement is being associated to the merging of industrial outsourcing with research institutions or universities. However, Malaysia in comparison has fallen short of this level of technological advancement (even when corrected for the difference in population sizes) which is perhaps a reflection to its maturity in forming UIC (Malairaja and Zawdie, 2008). Although collaboration between university and industry is nothing new and has been commonly agreed as an important source of knowledge for industry (Agrawal, 2001). Malaysia’s weaknesses in bridging the gap are still visible to date (Abdul Rahim and Mohd Said, 2006, Malairaja and Zawdie, 2008, Gomez, 2009).

In the report by Malairaja and Zawdie (2008) it is a significant implication that Malaysia is lagging behind technologically compared to other countries whilst its competitiveness ranking dropped from 16 in year 2005 to 37 in year 2007 (MOSTI, 2008b). In response to this situation, the government adopted the NIS framework to review existing science and technology (S&T) policies and various mechanisms in place to strengthen the country’s S&T capabilities.

Industrialisation is not the only emphasis, with the increasing number of universities which is attributed to the demand for tertiary education and government’s liberalisation policies is making Malaysia as an educational hub and centre of excellence for higher education (Malairaja and Zawdie, 2008). The government also foresees the crucial synergies accrued between UIC. These links between UIC can stimulate innovation and entrepreneurship creating a more well structured mechanism to facilitate the creation of new product innovations and human capabilities (Gomez, 2009).

3.4.2 Significance of study

In regards to the above emerging trends facilitating the needs for closer links between universities and industry in Malaysia, there is still a lack of empirical studies on the best practices to supports and cultivates UIC. A number of reports identified the rising need for collaborative effort yet the key determinants in opposing this notion lies in the cultural mindset of the universities and industry (Abdul Rahim and Mohd Said, 2006, Malairaja and Zawdie, 2008, Zakariah et al., 2004). Although Western nations have been able to bridge the knowledge gap between these two parties, Malaysia is still at its infancy stage of establishing and promoting this effort to the market (Abdul Razak, n.d., Zahedi et al., 2000).

The gaps between university and industry were found to be more significant than expected hence more empirical work needs to be carried out to identify the impediments to produce more effective practices and thereby cultivate UIC (Abdul Razak, n.d., Abdul Rahim and Mohd Said, 2006). Furthermore, in the recent 9MP's NIS framework, a variety of complementary policy reforms are recommended to encourage innovation within the university sector itself to strengthen UIC linkages for example funding research competitively and selectively, establishing professionally managed technology commercialisation offices in selected universities, involving universities in regional development efforts and aligning university culture with the business culture (The World Bank, 2007). However, such productive partnership needs to be led by competent leaders and abilities to develop new technologies in order to nurture UIC linkages.

In response to the condition, the Prime Minister recently announced that Malaysian universities should be given more autonomy as a way to promote a climate of free and critical thinking in the university. With such autonomy, universities have the freedom to vet and approve R&D proposals and thus to decide on how to upgrade technology that may lead to novel industrial products (Gomez, 2009). With the new policy, it will tighten the closure of UIC in innovation and entrepreneurship among graduates which may foster the rise of university spin-off.

The investigation and discussion from this section identified that UIC in Malaysia need for more research effort especially in relation to relationship management and encouragement of the collaborative effort.

3.5 Chapter Summary

In summary, this chapter provides an overview on the environment of UIC definition, motivational driver, and challenges surrounding it. The literature investigated on the process collaboration development was also discussed from a dyadic perspective. The key uniqueness identified between UIC partners' are their different aims and objectives as well as the importance of appreciating the different working environment and cultures.

This chapter divided UIC development into three stages: establishment, operation and evaluation, each stage being a stepping stone to get to the other. It is viewed as a crossroad and inter-junction because successful management of the collaboration will subsequently influence its ability to operate and sustain for future cooperation. Being in a partnership, both need to understand, synergise their strengths and reduce conflicts in order to build a stronger relationship to lead for better performance in the collaboration. By understanding the cycle of UIC, it will allow the mapping of work flow into the proposed PMM framework.

The final section discusses UIC in the Malaysia environment, its growth and anticipated challenges perceived by industry, university and government. Although incentives have been provided by the government as a strategy to encourage and build better linkages between the industry and university, it is still lacking as in any assistance on how to manage such collaboration. Malaysia will still need to strengthen its policy on innovation to encourage and cultivate R&D collaborative effort. Synergising their unique strengths and opportunities has become an effort that many have strived to achieve with much difficulty especially in Malaysia.

The research approach and design of this study will be discussed next in the following chapter.

CHAPTER 4 RESEARCH APPROACH

4.1 Introduction

This chapter discusses the research approach used in this study and outlines the rationale for its adoption. Explanation of the cases selected for assessment, selective unit of analysis, data collection techniques and methods of data analysis will be examined. Further, the techniques used to test the reliability and validity of results obtained will be reviewed. This chapter aims to provide an adequate but not exhaustive description of the research process and methods used in this study so other researchers may replicate the work in the future. It does not attempt to present an exhaustive review of the research methods as these can be found elsewhere in the literature. The research will be carried out on a step by step approach based on the case study protocol.

4.2 Research Workflow

The aim of this study is to develop a PMM for use in the UIC research environment. The development of such a generic methodology which can be tailored and customised requires an understanding of the research environment and the requirements placed on such a methodology. Prior to this study, investigations were conducted by the author and the project and engineering management group at the University of Nottingham's Malaysia Campus (UNMC). This work focused on the development of a PMM for three distinct related project environments, namely; undergraduates (Chin and Spowage, 2008b), doctoral research projects (Chin et al., 2011) and collaborative research (Chin and Spowage, 2008c). In each research environment, further investigations were carried out to understand the requirements, the challenges and best project management practices in each environment. As a result, the research designed and implemented two L3 PMMs, suitable for undergraduate and doctoral level research environments. These two PMM were successfully tested and iteratively form the backbone of the PMM under development in this work which is intended for use in a Malaysian UIC research environment.

The following section describes the research workflow in this study which has been divided into three phases as illustrated in Figure 4.1. Phase 4 would be included in the future work of this study and is intended to test the effectiveness of the designed PMM in real UIC cases. This will be discussed in chapter 8.

4.2.1 Phase 1 - Literature review, assessment and benchmarking

Phase 1 of this study involved a rigorous review of the literature related to the three research environments; undergraduates, doctoral and university-industry (see Figure 4.1). Each environment was investigated to extract the salient points for the development of L3 UIC PMM in this study.

The investigation focused on understanding the research work flow, the challenges anticipated, current practices applied, motivations and best practices used in each of the research environments. The information extracted allowed the creation of a mapping strategy to integrate the project management components to develop a generic yet customised methodology for use in the UIC research environment. This phase was carried out in Year 1 of this study and the findings of each environment were successfully published (Chin and Spowage, 2008a, Chin, 2009, , 2008, Chin and Spowage, 2008b, , 2008c, Chin et al., 2011) and will not be reviewed in this work.

4.2.2 Phase 2 – Develop and evaluate two L3 PMM

Despite the relative simplicity of undergraduate research projects they still commonly contain many elements of commercial projects e.g. they have stakeholders, specific deliverables, interaction with both internal and external stakeholders and they also need to operate within and interaction with the organisation's operational systems. In addition, there are many challenging issues which arise as the project progresses, thus an appropriately designed PMM can help handle these issues and manage the progress of the project work (Chin and Spowage, 2008b). In comparison, the processes involved in a doctoral research are significantly more extensive than those associated with undergraduate works. Doctoral research projects aim to explore, and develop rational explanations (Richardson, 2005) which often leads to the development of theoretical understanding and the discovery of new findings or knowledge and commonly focus on answering the research questions. Although the research condition between undergraduates and doctoral students differ from those in collaborative research projects, many organisations still treat all projects the same way.

As emphasised by Llyod & Simpson (2005), due to the different level of complexities and drivers in traditional commercial development and academic based research projects; the use of project management techniques may not always be appropriate for all projects. Yet, the generation of one generic model would lead to unwieldy use of different possibilities of project management styles. To compromise and balance, a one-best-model should be tailored for each project.

Therefore in this phase, the PMM were conceptualised based upon the extracted literature from Phase 1. The PMM developed for use in each of the research environments was designed and iteratively refined. This phase consisted of a detailed examination of two research environments associated with UIC projects, namely the undergraduates' and doctoral research project environment. This work has resulted in the development of PMM designed specifically for each environment. These PMMs were tested and evaluated with the relevant target groups to assess their effectiveness and to improve the PMM for future implementation as shown in Figure 4.1.

An internal assessment at UNMC was also carried out to validate the PMM developed for use in the undergraduate research environment. The output of the assessment was used to design the PMM developed for the doctoral research project PMM which was similarly validated. The completion of both PMM formed a concrete foundation for the development of PMM for UIC in this research project which constitutes Phase 3 and is the focus of this work.

It should be noted at this point that these two environments are directly related to the UIC project environment since the majority of UIC projects share much of the same physical infrastructure and actors. For example in a majority of UIC projects, university researchers are often assisted by doctoral students in the project execution utilising similar project management tools and techniques in the planning and monitoring of a UIC project.

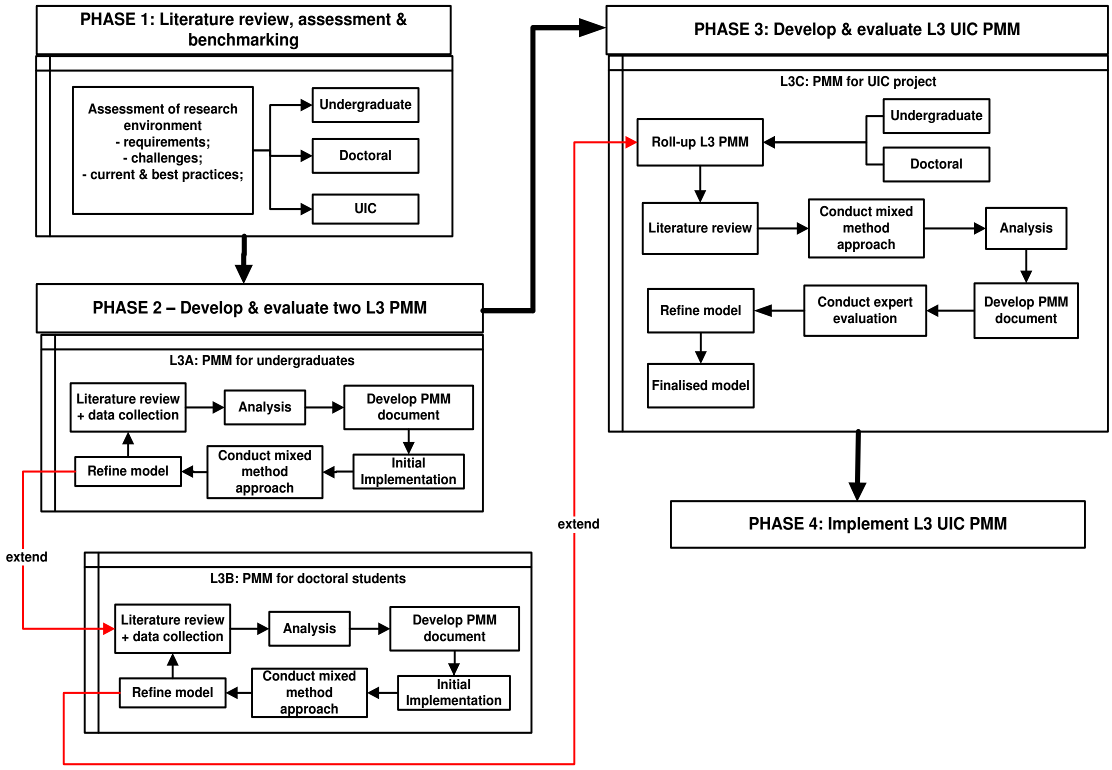


Figure 4.1 Research workflow

4.2.3 Phase 3 – Develop and evaluate L3 UIC PMM

This phase aimed to develop a comprehensive L3 UIC PMM. Both PMM designed for undergraduates and doctoral research environment were rolled up, consolidated and expanded to include the necessary requirements and components suitable for the UIC research environment. Before embarking on the design of the PMM, detailed investigations were carried out via secondary and primary sources. Literature review and the results obtained from Phase 2 were essential to define the unique project management components, tools, techniques and processes which are required for customisation of an organisation specific methodology. The significant results obtained from Phase 2 will be needed for the development of the L3 UIC PMM. Data was collected via a mixed method approach and analysed prior to developing the PMM. The PMM was then sent for expert evaluation to assess its feasibility, usability and usefulness. Results were analysed to further improve the developed PMM then finalised as the primary output of this study. It should be noted that it was not possible to implement the PMM within the scope of this project as UIC project durations typically exceed the duration permitted for this work, see Phase 4.

4.2.4 Phase 4 – Implement L3 UIC PMM

This phase is not included in this study and will be carried out as future research. In this phase the completed and improved version of L3 UIC PMM developed in Phase 3 will be deployed in targeted universities to assess its effectiveness in practice. The targeted respondents of this study will include university researchers and industry players involved in UIC projects. The objectives of this phase is to create awareness of the use of PMM in a collaborative research environment and guide first time researchers on how to better plan and manage UIC projects.

4.3 Research Paradigm

Most modern research works relevant to this study tend not to fit clearly into either qualitative or quantitative methods. The best approach will be a combination of qualitative and quantitative methods – known as mixed method or mixed model approach (Thomas, 2003, Law and McLeod, 2004). This will be the approach used in this study.

The literature focusing on the relevant research methods was polarised between researchers who favoured qualitative over quantitative approaches and vice versa. In the 1980s, discussion between researchers were biased towards a stronger appreciation of research paradigms namely objective or positive-quantitative, interpretive-qualitative and critical-theoretical paradigm (Law and McLeod, 2004). Modern day researchers view qualitative and quantitative approaches as complementary rather than antagonistic (Thomas, 2003).

Quantitative methods are designed to control bias so that facts are easier to understand in an objective way. This leads us to the objective or positivist paradigm viewing the world in a measurable and observable manner (Glesne and Peshkin, 1992, Thomas, 2003). In contrast, qualitative approaches strive to understand the perspective, looking at first hand experience to provide meaningful data (Law and McLeod, 2004). This portrays reality in a socially constructed, complex and ever-changing world as defined by the interpretivist paradigm. On the other hand, quantitative research is designed to identify and isolate specific variables within the context of searching for relationships, correlation and causality (Law and McLeod, 2004). Whereas, qualitative design is more focused on the holistic and naturalistic view of what was being studied for example via documentations, historical events, observations and interviews. Many supported these findings by clearly distinguishing these two research paradigms as natural science and human science (Zuber-Skerritt, 1992) (Law and McLeod, 2004). A list of terminologies is clearly classified under these two paradigms as shown in Table 4.1.

Table 4.1 Paradigm of research

Paradigm 1–Natural Science	**Paradigm 2-Human Science**
Traditional	Alternative
Experimental	Naturalistic
Prescriptive	Descriptive
Reductionist	Holistic
External	Internal
Nomothetic	Ideographic
Normative	Interpretive
Positivist	Non-positivist

Source: (Zuber-Skerritt, 1992)

Although a combination of methods increases the validity and reliability of findings, the use of qualitative methods offers more ways to explore and investigate obscure problems and to generate testable theories. In this study, the interpretive-qualitative paradigm is utilised. The normative model shown in Table 4.1 was based on human behaviour that were rule-governed and investigated through methods of natural science (Zuber-Skerritt, 1992). In contrast the interpretive paradigm is characterised by concern for individual and human behaviour. Given the different assumptions of positivist and interpretivist paradigm, they both require different instruments and procedures suited for data gathering.

Based on the interpretive-qualitative paradigm, this study seeks to describe and explain a dyad perspectives of UIC involved in R&D projects. The study has chosen a qualitative paradigm using semi-structured interviews and quantitative self-administered questionnaire surveys in the mixed methods using a case study approach to develop the PMM, which will then be evaluated by an expert review panel in a quantitative manner. The selected approach and cases will be described in the following sections.

4.4 Research Strategy- the Case Study Approach

Research approach is an inquiry from a particular philosophical stance or worldview which determines the purpose, design and methods used in their interpretation of results (Blunt, 1994). According to many (Cooper and Schindler, 2001, Law and McLeod, 2004), research design is the blueprint for fulfilling objectives and answering questions. However, selecting a design may be complicated by the availability of a large variety of methods, techniques, procedures, protocols and sampling plans. Hancock (1998) emphasises the need to find the answers to questions which begin with: why? how? and in what way? to decide the appropriate research approach. Based on the suggestions given, the differences between qualitative and quantitative research methods were reviewed and examined as shown in Table 4.2.

The research strategy adopted for this study is the exploratory case study. It is important to note that case study strategy should not be confused with qualitative research. Instead it can be based on any mix of quantitative and qualitative evidence.
Based on the technical definition by Yin (1994), a case study is an empirical inquiry to investigate a contemporary phenomenon within its real life context especially when the boundaries between phenomenon and context are not clearly evident. In this study, the case to be studied is the UIC research environment in Malaysia. As a result it needs to rely on multiple sources of evidences with data to benefit the development of theoretical propositions in the data collection and analysis.

Table 4.2 Comparison between qualitative and quantitative research

Qualitative research	**Quantitative research**
• Concerned with the opinions, experiences and feelings of individuals producing subjective data • Describes social phenomena as they occur naturally • Understanding of a situation through a holistic perspective • Using inductive approach to the development of theory • Data are collected through direct encounters with individuals' example by interviews or observation • Data collection is time consuming • Different criteria used to assess reliability and validity • Different terms used compared to quantitative research	• Depends on the ability to identify a set of variables • Deductive approach in that it tests theories which have already been proposed • Sampling seeks to demonstrate representativeness of findings through random selection of subjects.

Source: (Hancock, 1998)

It has been speculated that theories developed from case study research are likely to have important strengths like novelty, testability and empirical validity, which arise from the intimate linkage with empirical evidence. Second, given the strengths of this approach and its independence from prior literature or past empirical observation, it is particularly well-suited to a new research area or those in which existing theories seem inadequate (Eisenhardt, 1989). The use of case studies ideally permit the researcher to reveal multiple factors interacting to produce the unique character of the subject (Thomas, 2003).

The case study approach is selected because it allows an in-depth investigation of the UIC activities based on respondents that had participated in such partnerships. This is aligned with the definition given by Eisenhardt (1989) as UIC is a new phenomenon in Malaysia which is only recently being explored by a handful of Malaysian researchers. Further posits the choice of a case study approach as the main research strategy. This approach requires consideration of the following points (Yin, 1994, Eisenhardt, 1989, Wahyuni, 2003, Merriam, 1998) namely:

1. Type of research questions
2. Degree of control over the events/ depth of analysis
3. Degree of focus to historical events/ process perspective
4. Identification of bounded system in the focus of investigations

Firstly, the type of research questions can be categorised as a scheme series of 'who', 'what', 'where', 'how' and 'why' (Yin, 1994). In the case of 'what', 'who' and 'where' questions, survey strategies or archival strategies are likely to be favoured as it aims to describe predictive outcomes from the events. But when 'how' and 'why' questions are present this lead to more explanatory investigations, the use of case study method is the preferred research strategy. The case study is in line with the research questions that focus on how to develop a PMM by consolidating the best practices of UIC. As for subsequent questions relating to the research it also emphasises the 'how' and 'why' questions as discussed in section 1.2. This is the first reason to select the case study approach as the preferred research strategy.

Secondly, in the adoption of a case study approach, the investigator has virtually no access or degree of control over actual behavioural events. This is because case studies serve as a research inquiry emphasising the processes involved rather than the outcomes of an inquisitive discovery. In other words when little is known about the subject, setting questions and defining answers are not possible. Then theory building rather than theory testing becomes the aim of this study. One of the key strength of case study approach is its ability to deal with a full variety of evidences; documents, observations, interviews, archival records, participatory role and artefacts (Merriam, 1998, Yin, 1994). The use of these sources allows the investigators to address a broader range of behavioural and attitudinal issues relative to the studied cases. In conceptualising the PMM, four aspects are investigated to discover its co-relation and interdependency contributing to the methodology design. The integration of these aspects may be less common in the UIC research environment. Therefore, there is a need to build a theory by setting up propositions to link the data to be collected with the research questions.

The use of grounded theory will be adopted to further describe and explores what is actually happening in the selected case environments (Corbin and Strauss, 2008). As best defined, grounded theory is a qualitative research approach based on a systematic set of procedures used to derive grounded theories from the phenomenon. Therefore, a qualitative semi-structured interview was chosen to obtain rich data and in-depth understanding of the cases to build the theories in this study.

Thirdly, case studies are selected largely for the reason to study a particular or multiple cases to further understand why certain situations occurred and how the people, group or organisation succeeded. Evaluation of the phenomenon leads to descriptions of historical events that happen in the distant past. This fits this study as the historical materials from these cases can then be used to understand the relationship of project management in a UIC partnership. Such evidence may be difficult to extract with the use of a quantitative approaches.

Finally, in using case studies as an instrumental way of investigation, the most essential element is the identification of the case itself (Merriam, 1998). In designing and selecting cases, there must be a '*bounded system'* as the focus of the investigation (Creswell, 2003). Here, the investigator needs to identify the particular features inside-out of the system. In such a case there is an added need to delimit the objects of study, time and place. Some of the common bounded elements in case studies are for example the number of individuals or organisation involved and the features or properties to be investigated. In aligning with this principle, this study delimits and limits the number of aspects to obtain descriptive data from the respondents. These are explained in section 1.5 and will further be elaborated in the unit of analysis of the selected cases in section 4.6 of this chapter.

Like other methods, this approach had some drawbacks that must be taken into consideration. By comparison, methods for quantitative research are well understood and widely taught and consequently appear to be increasingly influential in the development of theory and practice (Cutler, 2004). In other words, case studies are, in certain quarters, viewed as a lesser form of inquiry compared to experimentation or techniques such as survey based studies. According to Yin (1994), the greatest concern with the approaches adopted in this work is its potential lack of rigor. This occurs when the investigator lack skills in the case assessment which may lead to biased views that influence the direction of the findings and conclusions. Secondly, case studies are not statistically valid; considering the large number of variables and examination of different aspects from its subject (Wahyuni, 2003). Thus it provides little basis for scientific generalisation as compared to experimentation. In general, case studies are unlike experimental investigations as they do not represent a sample. Instead it is the investigator's aim to expand and generalise theoretical propositions (analytical generalisation) and not to the population (statistical generalisation) (Yin, 1994). And the third concern comes in terms of its long documentation that investigators note throughout the cases studied. As quoted 'case studies are among the hardest type of research to do' (Yin, 1994). Hence, the investigator needs to have good understanding and appreciation of the processes involved in the case study approach. Despite these common drawbacks, investigators should not be put off from the adoption of a case study approach as the quality of outputs obtained can be of the highest quality.

The following sections will describe the selected data gathering techniques. Another aspect in relation to the depth of analysis in this study is that it enables the researcher to build a closer relationship with the respondents. This allows greater access to confidential information thus enables a deeper understanding of the actual context of study, relationship between UIC partnerships, perspectives and complexities involved.

4.5 Data Collection Method

This section discusses the types of data collection method that will be engaged in this study. The use of qualitative and quantitative approach is considered for this study as described in the following sections. This strategy is also known as mixed method approach (Creswell, 2009). In this design, data is collected in both forms concurrently and information is interpreted as the overall results. A set of principles are adhered to in the data collection strategy, namely; the use of interview guides (King, 2005, Saunders et al., 2000, Kvale, 1996, Gillham, 2005) and case study protocols (Eisenhardt and Graebner, 2007, Yin, 1994, Eisenhardt, 1989). Following the discussion, this section also presents the design of each data collection method selected in this study.

4.5.1 Qualitative research – semi-structured interview

In the attempt to understand the world from the subject's point of view and to unfold meaning from a respondent's experiences to scientific explanations, qualitative research interviews were conducted. It is a mean of interchange of views (Inter Views) between two people (interviewee and interviewer) conversing about a theme of mutual interest (Kvale, 1996). Clearly, in qualitative research, the interview is perceived as a purposeful discussion between two or more people (Kahn and Cannell, 1957). But it needs to be of real scientific value if it needs to serve more purpose than that. Saunders et al (2000) describes it as a means of gathering valid and reliable data relevant to the research question(s) and objectives of a study. Based on a number of researchers' descriptions of qualitative interviews, they can be categorised into several typologies depending on its level of formality and structure as shown in Table 4.3.

Table 4.3 Interviews types/typology

Citation	Typologies of interview
(Saunders et al., 2000, Sekaran, 2000)	• Structured interviews; • Semi-structured interviews • Unstructured interviews
(Healey and Rawlinson, 1994, Healey, 1991)	• Standardised interviews; • Non-standardised interviews
(Powney and Watts, 1987)	• Respondent interviews; • Informant interviews.

Source: (Saunders et al., 2000)

Each types of interview serve a different purpose. Structured or standardised interviews are used in survey research, while semi-structured and in-depth or non-standardised interviews are used to conduct exploratory situations (Saunders et al., 2000). In exploratory studies, semi-structured or in-depth interviews can be helpful to 'find out what is happening and to seek new insights' (Powney and Watts, 1987). In descriptive studies, structured interviews can be used and in explanatory studies, semi-structured interviews are used to understand relationships between variables (see Table 4.4).

Table 4.4 Uses of different types of interview in each of the main research categories

	Exploratory	**Descriptive**	**Explanatory**
Structured		✓✓	✓
Semi-structured	✓		✓✓
In-depth	✓✓		

✓✓ = more frequent, ✓ = less frequent

Source: (Saunders et al., 2000)

In this exploratory case study, a semi-structured interview is adopted in order to understand and explore the revolving issues associated with the management of UIC research projects. The use of semi-structured interviews allows an exploratory discussion to understand the 'what' and the 'who' but also emphasise exploring on the 'why' questions in the selected case study approach (Saunders et al., 2000).

Despite its limitations, it is the most important way of conducting research interviews due to its flexibility which is balanced by a defined structure which allows acquiring quality data (Gillham, 2005, Zorn, n.d.). In this study, the choice of conducting semi-structured interviews were influenced by four conditions namely; the nature of the approach to research; the significance of establishing personal contacts; the nature of data collection questions and the length of time required for completeness of the process (Saunders et al., 2000).

Firstly, based on the nature of this research which is an exploratory case study, the use of semi-structured interviews provides the means and opportunity to describe, explain and build on interviewee's responses. This is an important approach when a phenomenological study is conducted. The idea of adopting this approach is to address the research questions and objectives set for this study. Then formulate and build theories based on interviewee's responses. This process is described as theory grounded from data (Corbin and Strauss, 2008).

Secondly, the interviews provide the opportunity for interviewer and interviewees to establish and build closer relationships throughout the process. Furthermore, it provides the interviewees an opportunity to reflect on events. Saunders et al argued that given the options, managers prefer to be interviewed than to complete a questionnaire survey. Thus the earlier technique was preferred because the interview itself stimulates interest and sparks new ideas (Saunders et al., 2000). In comparison with the questionnaire survey, some consider that questionnaire surveys introduce bias as respondents either complete it reluctantly providing untruthful answers due to sensitive information or are reluctant to spend the time needed to fully appreciate the questions.

Third, the goal of the interview was to see the research topic from the perspectives of the interviewee and to understand how and why they adopt such approaches. To achieve this goal, Kvale (1996) identified the need to have low degree of structure imposed on the interviewee and open questions which focus on 'specific situations and action sequences in the world of the interviewee'.

From the compilation of the available literature, there are three situations that are likely to result in rich data from an interview process namely; where there are large number of questions to be answered; questions are open-ended and ordered and that the logic of questioning needs to be varied (Saunders et al., 2000). Finally, in the event, where the objective remains to obtain answers for all questions asked, it will require a significant length of time to obtain the required data from the interviewees. Therefore, this study will adhere to a set of protocols (Gillham, 2005, Yin, 1994, Kvale, 1996, King, 2005) to guide through the interview process as shown in Figure 4.2.

4.5.2 Design of semi-structured interview questions

Easterby-Smith et al (1991) reported that in in-depth interview, if the interviewees are encouraged to talk freely throughout the session it is more likely to lead to discussion and discovery of important concerns relevant to the research topic. In order to achieve success at the end of the interview, devising relevant interview themes such as formulating appropriate questions styles aid the interview process.

Saunders et al. (2000) found that designing the right types of question is critical for interview success. The questioning styles that are commonly used in semi-structured and in-depth interviews are open questions, probing questions and closed (specific) questions. Open questions allow respondents to define and describe a situation or event, they encourage the interviewee to provide extensive and developmental answer that may be used to reveal attitudes or to obtain facts (Grummitt, 1980). An open question is likely to start with or include one of the following words: ‘what’, ‘how’ or ‘why’ (Saunders et al., 2000, Easterby-Smith et al., 1991).

Probing questions are used to explore responses of significance to the research topic. It is used to seek an explanation when the interviewer may not understand the meaning or response. Questions to probe interviewee’s response may include, ‘Tell me more about …’ (Saunders et al., 2000). Whenever an open question does not reveal a relevant response, the interviewer may probe the area of interest using supplementary questions as a way of rephrasing the original question. Patton (2002) describes six kinds of questions that respondents can be asked; (1) experience/behaviour questions, (2) opinion/value questions, (3) feeling questions, (4) knowledge questions, (5) sensory questions and (6) background/demographic questions (Patton, 2002).

In this study, the interview questions were designed based on open questions and probing questions in order to elicit more opinions from the respondents on their collaborative experiences. Hence, a combination of questions described by Patton will be used in designing the interview questions for this study. The interview questions aimed to accomplish research objective no.2 (see section 1.2).

To accomplish the research objective and its sub-objectives, 6 sections were designed in the interview protocol; namely (1) Driving factors (DRIV-F), (2) Barriers (BARR), (3) Best Practices (BT-PRAC), (4) Development processes (DEV), (5) Project management (PROJ-MG) and (6) Future views (FUT) shown in Table 4.5. Each section consists of one or more open-ended question which aimed to investigate the UIC research environment in Malaysia.

In the process of interviewing, ‘the respondent must do 90% of the talking. If this is not happening, either the questions are poor or the respondent is antagonistic to the research’ (PRA Inc, n.d.). Healey and Rawlinson (1994) suggested that it is usually best to leave sensitive questions until near the end of an interview because this allows greater time for the respondent to build up trust and confidence in the interviewer (Healey and Rawlinson, 1994). Thus, a number of probing questions in regards to the future view of UIC in Malaysia were listed at the end of the interview to attain more opinions, recommendations and suggestion from the respondents. The questions developed in line with the above best practices are shown in Table 4.5

Table 4.5 Questions designed for semi-structured interview

Theory Question	Category Code	Interview Questions
What are the driving factors in UIC?	DRIV-F	• Why collaboration?
What problems are faced in UIC partnership?	BARR	• What are the problems that tend to occur in the collaboration?
What are the best practices to be adopted by UIC in managing the partnership?	BT-PRAC	• What are the basic practices/success elements to better manage collaboration?
What is the significant relationship between the establishment, project management and outcome evaluations of a UIC?	DEV	• Describe the processes of establishing UIC? • How the performance of collaboration measured?
What are the requirements in a UIC PMM?	PROJ-MG	• What key elements are needed in the planning process? • Do you/institution adopt a PMM to manage UIC? • If there is a PMM, what should be included in it?
How are UIC in your organisation being managed? Is there any structured approach to the project management?		• What structures are created/adopted to coordinate the collaboration? • Who are the key people involved in the project management? Is there a project manager from each partner? If yes, how has it benefited the collaboration? If not, why? • How is the progress of the collaboration progress monitored and controlled?
What are the future views of UIC in Malaysia?	FUT	• What are the sustainability criteria for UIC growth in Malaysia? • University researchers should be equipped with industrial experience. What is your view? • Do you think project management skill is a contributing element to collaboration success? Why?

4.5.3 Design of questionnaire survey

In this study, the purpose of designing the questionnaire survey is to validate the literature findings discussed in chapters 2 and 3. This is particularly important in this work as many of the findings from the literature were from project environments outside of Malaysia. Although the perspectives will certainly be different the questionnaire surveys were identical for both university and industry in order to address the same issues. In addition, both classes of respondents are or have recently been involved in UIC projects.

The questionnaire surveys consists of 64 items which are distributed into three main sections; Section A on UIC anticipated challenges or barriers, Section B on the best practices in successful UIC and Section C to identify the requirements for UIC PMM development. In each section, respondents are asked to indicate their level of agreement on each item identified as important for a successful UIC partnership. The questionnaire survey was conducted at the end of each interview session; hence it was possible to give a verbal briefing to the respondents. Questionnaire surveys were also conducted in a different manner to suit respondents', whereby it was either self-administered and collected at the end of the interview session or distributed with a self-addressed and stamped envelope. As a general rule of questionnaire survey design they should be as brief as possible including only essential questions in less than 6 pages (Zikmund, 2003). Therefore, all items were designed in a concise and precise manner. In terms of measurement, the Likert 5 point scale was anchored with statements like 'strongly disagree' to 'strongly agree' to measured each items in the questionnaire survey.

Although the items were based on relevant literature, the factual properties from university and industry respondents were unknown. Therefore, it was necessary to pre-test the instrument to determine the potential flaws in the questions designed, data collection and analysis. The pre-test was useful to determine the understandability of each items listed in the questionnaire survey. Any ambiguities with the questions based on pilot sample respondents were improved before finalising the questionnaire survey for full distribution. The questionnaire survey items listed in the three sections are presented in the following Table 4.6, Table 4.7 and Table 4.8.

Table 4.6 Section A items

Category	Contributing barriers to UIC success
A.1. Collective	A1.1. Fear factor
	A1.2. Partner(s) with hidden agenda
	A1.3. Sharing of authority
	A1.4. Ownership of intellectual property rights (IPR) & publication
	A1.5. Loss of confidentiality and privacy of information
	A1.6. Lack of support and involvement from management
	A1.7 .Poor selection of partner(s) (university/industry)
	A1.8. Conflicting/differing interest and objectives
A.2. Project management	A.2.1. Unclear requirements
	A.2.2. Project planning & progress monitoring
	A.2.3. Ineffective communication channel
	A.2.4. Unclear roles & responsibilities
	A.2.5. Unclear role of project manager/lead researchers
	A.2.6. Degree of commitment & motivation level
	A.2.7. Project manager selection
	A.2.8. Collaboration agreement not clearly written & agreed
	A.2.9. Poor management processes & use of tools, templates
	A.2.10. No proper project organisation structures
	A.2.11. Lack of project policies and procedures
A.3. Cultural	A.3.1. Distrust, lack of honesty and openness
	A.3.2. Different nature of work
	A.3.3. Structures for incentives & reward varies
A.4. Environmental	A.4.1. Technology transfer & knowledge transfer
	A.4.2. Competitive forces
	A.4.3. Increase of technological choices in market
	A.4.4. Changes in the regulation/government policies
	A.4.5. Political pressures to university and industries
	A.4.6. Industry specific R&D interest
	A.4.7. Partner(s) instability & continuity
	A.4.8. Higher demand of innovation by market

Table 4.7 Section B items

Category	**Best practices for UIC success**
B.1. Collective	B.1.1. Create shared mutual mission & goals
	B.1.2. Clear level of control & authority
	B.1.3. Clear policy on IP rights & publications
	B.1.4. Top management involvement & commitment
	B.1.5. Complementary knowledge based partners
B.2. Project management	B.2.1. Clear roles & responsibilities
	B.2.2. Frequent & effective communication channels
	B.2.3. Organise joint periodic meetings
	B.2.4. Recruit competent project manager (each for industry & university)
	B.2.5. Good documentation and lesson learned archive
	B.2.6. Well defined and agreed research contract
	B.2.7. Encouragement, motivation through team building
	B.2.8. Incentives & rewards structures
	B.2.9. Design project organisation structures
	B.2.10. Use of project management methodology
B.3. Cultural	B.3.1. Compromise during negotiation process
	B.3.2. Establish trust, honesty, openness & transparency
	B.3.3. Mutual respect of differences
	B.3.4. Understanding
B.4. Environmental	B.4.1. Increase awareness of new technologies
	B.4.2.Enhance stature, recognition in academia & industry
	B.4.3. Promotion in research for all industries areas

Table 4.8 Section C items

List of requirements for UIC PMM
C.1. It should integrate the principles, processes, guidelines and practices of both UIC and project management concepts
C.2. It should include some decision analysis or tools in guiding organisation on the formation of a university-industry partnership
C.3. It should facilitates the identification and management of risks and opportunity
C.4. It should facilitate the clarification of goals and scope of the project by incorporating the best practices of project management group processes, tools and techniques to effectively plan and manage research projects
C.5. It should create a project board/committee to oversees, monitor and assess the research project progression
C.6. It should identify to the organisation which collaborative mode are more suited for the particular type of projects
C.7. It should include a structural sample of collaborative agreement for ease of negotiation
C.8. It should be scalable and adaptable to project sizes; where it should be specific to the organisation but customisable to individual projects
C.9. It should involve technology elements which are integrative and neutral to the organisation's existing system
C.10. It should model the work flow of typical project
C.11. It should leverage the best practices of collaborative research environment to minimise the obstacles & failure rate
C.12. The methodology must be in place to promote organisational learning

A pre-test and revision of the questionnaire survey was conducted in August to September 2009 with a small sample of the targeted population, consisting of 7 respondents from three universities, three industry players and one from a research agency. In this study, an undeclared pre-test (Czaja, 1998) was conducted in the same manner as intended for the main study.

4.5.4 Evaluation method

The concepts of evaluation had been widely contested in the literature. Several definitions on evaluation had been identified. It can be defined as a 'study designed and conducted to assist some audience to assess an object's merit and worth (Stufflebeam, 2001). It is also 'a systematic study of a particular programme or set of events over a period of time in order to assess effectiveness' (Hitchcock and Hughes, 1989).

There are two significant types of evaluation; formative and summative (Van Tiem et al., 2004, Morrison et al., 2001, Scriven, 1996). According to Van Tiem et al (2004), formative evaluation is developmental and continuous that begins during the analysis stage and continues through the selection and design of intervention and even early implementation. Formative evaluation method involves gathering feedback from users and other relevant groups during the development and implementation process. Morrison states that formative evaluation is most valuable when conducted during the development because it aims to identify problems so improvement and adjustment can be made during or before the final implementation (Morrison et al., 2001). Its main objective is to give importance to the available strengths and provide an opportunity to convert weaknesses into strength. Thus, conducting formative evaluation requires determining the needs, formulations, process implementation etc (Rampur, 2009).

Summative evaluation is directed towards measuring the degree to which the major outcomes are attained by the end of the program (Morrison et al., 2001). It provides information on the product's ability to do what it was designed to do. Summative evaluation is typically in quantitative form to assess concrete achievement as part of process acknowledgement (CeTAL, n.d.) and to aid organisations in determining if the purpose of imparting knowledge was fulfilled. Summative evaluation plans comprises final result assessment, effectiveness evaluation, cost to benefit comparison etc. Contradictory to formative evaluation, summative evaluation is carried out at the end (Rampur, 2009).

The above definition and discussion of formative evaluation and summative evaluation are summarised in Table 4.9. Rampur (2009) also noted that when it comes to selecting either type of evaluation method, the main criteria in determining the decisions are the aims of the implementation, time and when the evaluation technique could be implemented.

Table 4.9 Formative vs. Summative Evaluation

Formative	**Summative**
Primarily prospective	Primarily retrospective
Analyse strengths and weaknesses towards improving	Document achievement
Develop habits	Document habits
Shape direction of professional development	Show results of such forays
Opportunity to reflect on meaning of past achievements?	Evidence of regular formative evaluation?
Feedback	Evidence

Source: (CeTAL, n.d.)

‘An evaluation model not only provides the overall framework for evaluation but also gives shape to the research questions, organises and focuses the evaluation and informs the process of inquiry’ (Conrad and Wilson, 1985). Thus, a critical aspect of programme evaluation is designing an evaluation model (Ruhland, 2003). In general according to Hansen (2005), evaluation models fall into six categories namely result models, explanatory process models, system models, economic models, actor models and programme theory models. The results models or summative evaluations focus on the results of a given performance, programme or organisation. The model which involves knowing the unintended as well as the intended outcomes of the project defined by Scriven (1973) is also known as the goal-free evaluation model. The principle of this type of evaluation is the effects and not the goals. Process models focuses on the ongoing processes and effort while system models are system perspectives analysing the input, structure, process and outcomes. The economic models focuses on the cost efficiency and benefits from the system perspectives. Then the actor models focuses on the actor's own criteria for assessment. Finally the programme theory models assess the validity of the programme theory which the organisation builds (Hansen, 2005).

Stufflebeam (2001) further identified 22 different approaches often used to evaluate programmes. One of the best and most applicable programme evaluation approaches is client-centred/responsive. This classic approach requires evaluators to work with the clients to support, develop, administer or directly operate the programmes under study and seek or need evaluators' counsel and advice in understanding, judging and improving programmes. It is a process of continuous exchange between evaluator and clients via continuous communication for the purpose of discovering, investigating and addressing a programme's issue. Worthen et al (1997) organises programme evaluation into six models; objectives-oriented, management-oriented, consumer-oriented, expertise-oriented, adversary-oriented and participant-oriented evaluation from various individuals who have written about the model, primary uses of each model and the benefits and limitations of each evaluation model (Ruhland, 2003, Worthen et al., 1997).

In this study, formative evaluation and expert panel review (Evalsed, 2009) will be utilised. The terminology 'expert panel review', will be used in this work although it is termed differently by many authors; actor model (Hansen, 2005), client-centred/responsive approach (Stufflebeam, 2001), expertise oriented approach (Worthen et al., 1997) or expert-judgment focused method (De Jong and Schellens, 2000).

The expert panel review is one of the oldest and most widely used evaluation approach (Worthen et al., 1997). This approach constitutes of a group of experts to judge a programme and make recommendations based on their perception (Hogan, 2007). These experts are usually independent specialists in the field/discipline related to the evaluated program. The experts are chosen to represent all points of view in a balanced and impartial manner (Evalsed, 2009).

According to Worthen et.al (1997), the review process can either be in a formal or informal. A formal review system will have a structure or organisation established to conduct periodic reviews; published standards, pre-specified review schedules, with a combination of several experts to judge its overall value and with an impact depending on the outcome of the evaluation (p.121). Other evaluations which lack either one of these components are considered an informal review system (Hogan, 2007).

The expert panel review is a generic tool mainly used to assess small and simple programmes which do not warrant many resources because it is relatively easy to implement (Worthen et al., 1997) and inexpensive (Evalsed, 2009). Furthermore, it is also flexible allowing expert panels to intervene either at the beginning or end of the evaluation in combination with other data collected or analysis tools to provide interpretation and development of findings from the evaluation work (Evalsed, 2009). The apparent limitation of the expert panel review approach is the central role of the expert judges, mainly because this approach is the only one that puts much stock in professional expertise makes it more prone to personal bias than other programme evaluation approaches. Moreover because of the use of expert judges, it permits evaluators to make judgment that is personally biased. However, the expert review approach have caused and been considered by some to be inherently conservative and not based on programme objectives (Worthen et al., 1997, Hogan, 2007).

By default the experts must have extensive relevant experience in the field; however this carries with it the risk bias. Moreover the comparison of views may lead to under evaluation of minority perspectives. Participants with lower level of education can also be useful in the assessment because their perspectives can bridge gaps in the review (De Jong and Schellens, 2000). On the other hand, highly educated participants may provide more exhaustive and rich feedback on documents or programme. Potential weaknesses of expert panels can be avoided by employing several techniques. For example having broader range of interests, to represent and limit work to only a part of the evaluation in order to ensure clearer focus so that its significance will be recognised (Evalsed, 2009).

4.5.5 Designing the evaluation questionnaire survey

A questionnaire survey was chosen as the appropriate method for collecting quantitative data for the evaluation model designed in this study. The objective of this questionnaire survey was aimed at evaluating the developed PMM in Phase 3 (see Figure 4.1) by seeking expert panel judgment and suggestions to improve the PMM. The purpose of the expert panel evaluation is to measure the following evaluation criteria:

- Feasibility - could the methodology be easily followed?
- Usability – is the methodology workable? Are the steps, tools and techniques easy to use and apply?
- Usefulness – is the methodology worth following? Will the methodology help researchers to produce better results in project management?
- To identify areas of improvement for the methodology

The evaluation criteria needs to be as practical as possible and successful tests of any practical methodology should constitute; feasibility, usability and usefulness evaluation (Platts, 1990). The feasibility evaluation examines if each step in the methodology was followed consistently as designed. Factors include intensiveness of activities laid down, consistency, clarity and completeness. The second assessment criteria evaluates the usability level on whether the methodology is workable to project researchers in UIC, whether the steps, tools and techniques are relatively simple and user friendly. The factors considered are templates simplicity, practical, comprehensible and problems faced in using the PMM. Comment boxes were designed in the questionnaire survey aimed at probing expert panels' opinions.

Finally, the last criteria aimed at evaluating PMM's usefulness. In assessing this criterion, the experts need to consider whether the PMM would help project researchers in UIC research environment to produce better results in managing their project. Experts are requested to evaluate if the methodology would produce better outputs compared to the present work. The overall usefulness of the developed PMM was assessed in terms of its benefits, structure, perception of value, adoption level, effectiveness and satisfaction. Without user satisfaction, a methodology would be less likely to be used and to produce beneficial results to the organisation (Adesola, 2002). The questions designed for the expert panel review are shown in Table 4.10, Table 4.11 and Table 4.12.

Table 4.10 Questions to assess PMM feasibility

Feasibility - could the methodology be easily followed?	
A1	Do you find the activities in the methodology easy to follow?
A2	Do you find the activities in each phase labour intensive?
A3	Is the methodology described adequate and transparent?
A4	Is the methodology internally consistent? If not, highlight which sections are inconsistent.
A5	Were all the activities developed necessary to be followed in a collaborative research project? If not, which activity or phase is redundant and why?
A6	Could the methodology be followed with minimal facilitation (e.g. training)?
A7	Would you have any difficulty communicating the methodology to your project team?
A8	Do you consider the methodology as a guide to better assist your project management? Why?
A9	Is the methodology appropriate for use in a collaborative research project environment?
A10	Do you think the methodology should be put forward for adoption in your research group/organisation? Why?
A11	How do you think it should be carried out (implementation strategy)?

Table 4.11 Questions to assess PMM usability

Usability – Is the methodology workable? Are the steps, tools and techniques easy to use and apply?	
B1	Do you find the methodology usable in practice?
B2	Do you find the toolkits, templates and forms easy to be filled?
B3	Do you encounter any problem following the activities?
B4	Which tools or templates do you foresee as unnecessary/redundant? Why?
B5	Any other tools or techniques that should be included in the methodology? Why?
B6	Has the methodology addressed all the necessary tools required for use in a collaborative research environment?
B7	Can the methodology be a supplement to existing practice in your organisation? If no, why?
B8	Do you think the methodology is easily comprehensible in layman term?
B9	What factors would help you to use this methodology?

Table 4.12 Questions to assess PMM usefulness

Usefulness – Will the methodology help to produce better results in project management?	
C1	Do you think the methodology will consume excessive amount of time and resources?
C2	Do you think the methodology will help researchers to better manage their projects?
C3	Is the structure of the methodology in each activity useful e.g. ‘Inputs’; ‘Tasks’; ‘Toolkits’, ‘Output’ and ‘Hints’?
C4	Do you think the methodology is credible for application in the market?
C5	Would you consider using the methodology?
C6	Do you think there are some activities or modules that can be exempted or merged? If yes, highlight these activities or the module.
C7	Were any of the terms unfamiliar to you?
C8	Overall were you satisfied with the contents and structure of the methodology?
C9	What do you consider to be the strength of this methodology?
C10	What makes this methodology different from other methodologies?

4.6 Selection of Cases – Unit of Analysis/Sample

Crouch (1984) defined sample as ‘limited number taken from a large group for testing and analysis of the assumption that the sample can be taken as representative of the whole group’ (Crouch, 1984). Sampling techniques provide a range of methods that enable researchers to reduce the amount of data needed to draw valid conclusions about a given population (Saunders et al., 2000).

Saunder et al (2000) further added that sampling also provides a valid alternative to consensus when it is impractical to survey the entire population due to budgetary or time constraints. The determination of sample size is important from a statistical and economic perspective. A large sample is better than a small sample from statistical point of view but inherently more expensive to conduct. Determining the right sample size also depends on the variability within the population and its ability to differentiate different parameters. However, it is a complicated task thus a compromise is often necessary (Ghauri et al., 1995).

Lincoln and Guba (1985) discussed the differences between purposive sampling and conventional sampling. They stated, ‘It (purposive sampling) is based on informational, not statistical considerations’. Its purpose is to maximise information, not facilitate generalisations. This is aligned with the adopted case study definition explained by Yin (1994). Associated data collection procedures are strikingly different and depend on the particular fade and flow of information as the study is carried out rather than on a prioritised consideration. There are further comments that by using purposive or theoretical sampling, the researcher increases the scope or range of the data as well as the likelihood that multiple realities will be uncovered (Lincoln and Guba, 1985). Compared to conventional sampling, it is responsive to data, leading it as a collection method based on concepts derived from data (Corbin and Strauss, 2008). Thus, the use of common characteristics inherent in sampling types utilising ‘theoretical sampling’ commonly adopted in qualitative studies will be applied in this study.

Theoretical research sample is about looking for indicators of concepts that might examine the data to discover how it varies under different conditions (Corbin and Strauss, 2008). Hence, in applying theoretical sampling, this study has chosen 20 public higher education institutions (PHEI) in Malaysia that are engaged in engineering based UIC R&D collaborations. From each of these PHEI, a project leader and their industry partner were identified and approached for a semi-structured interview and questionnaire survey in July to September 2009.

The study aims to explore what essential requirements are needed to support the development of a PMM for use in a UIC research project environment. Thus, the targeted and sample respondents were selected based on their previous and present involvement in UIC projects. Hence, the ideal respondents would have been involved in all aspects of initiating, planning and managing the collaborative project. To ensure the respondents are representative of the population, interviews from all PHEIs in Malaysia were selected. The conduct of this will give a complete picture of the UIC phenomena in Malaysia and from the university and the industry perspectives which would provide dyadic view simultaneously cross-checking perspectives from each team.

4.6.1 Sample selection and justification

Malaysia has 20 full-fledged public universities, 21 polytechnics and 37 community colleges at the time the study methodology was developed. In addition there are 32 private universities and university colleges, 4 branch campuses of international university and 485 colleges offering a range of academic and vocational courses under the Ministry of Higher Education's control (MOHE, 2007a). The public universities can be divided into Apex university (1 institution), research focused (3 institution), comprehensive (4 institution) and focused universities (12 institutions) illustrated in Table 4.13.

Among these 20 public universities, three universities were not actively involved in academic research (MOHE, 2008). However almost 55% of Malaysia's total number of researchers are from public universities (Thiruchelvam and Ng, 2009). Furthermore, research universities in Malaysia are established to focus on research and innovation activities. Thus, these university are encouraged to generate 45% income to finance their own operating cost and another 25% in development expenditure (MOHE, 2007b). Malaysia also targets commercialisation of 5% and 10% from all its R&D outcomes by year 2010 and 2020 respectively (MOHE, 2007a, , 2007b). However, this situation is not promising at present as less than 5% of total research funding of university are derived from non-government sources (in other words industry) (Thiruchelvam and Ng, 2009). These factors strongly focus on the importance of public universities as contributors to the nation's knowledge economy quest and further validation for the importance of this study.

The primary limitation applied to this study is the need to balance the validity, reliability and rigor against the time and resources available. It is impractical to estimate or assume that this study can or should identify all possible issues relating to the historical archival of UIC. The sample size for this study may be considered small, however the real scale of UIC in Malaysia is relatively small. Collecting data from fewer cases will enable more detailed information to be collected (Saunders et al., 2000). In addition the number of subjects necessary depends on the study's purpose (Kvale, 1996). Questions arise, if samples are too small, then it is not possible to make statistical generalisations. Similarly, if subject is too large, it is then not possible to make analytical interpretation within the constraints of limited time and resources. Warren (cited in (Bryman and Bell, 2003)) made an interesting note on the minimum number of interviews required for valid publications; stating that it is between 20 and 30 respondents. In this case study qualitative interviews are not presented for statistical generalisation (Yin, 1994). Therefore there may be limitation in the selection of appropriate sample size that is able to support the overall convincing conclusion.

4.6.2 Experimental design of qualitative and quantitative approach

Data collection from case studies relies on many sources of evidences (Yin, 1994). Thus, in this study, data will be collected via face to face interviews, telephone interviews, email interviews, questionnaire survey, project documentations, websites and information previously collected and compiled from the literature. The face to face interview will use a semi-structured approach as discussed in Table 4.3 and Table 4.5.

However, due to geographical distance, some of the respondents were interviewed via telephone using Skype application (Fitzgerald, 2009) or email interviews (Bampton and Cowton, 2002, Meho, 2006). Telephone interviews (Bonnel and Le Nir, 1998) had been a survey technique in the market since the 1970s. In the pervasive evolution of Internet during the 1990s, email became an alternative communication system in almost every organisations and household.

Despite the differences between the interview methods, both require consideration of professionalism and ethical conduct (Gillham, 2005, Lowndes, 2005). Hence, in this study, respondents are identified; informed of the nature of the research with acknowledgment and full consent obtained and documented prior to the interview. Both telephone and email interviews will be conducted only when face to face meetings are not possible due to geographical, time or cost constraints. A set of protocols for each type of interview were developed and presented in Figure 4.2 is a schematic flow chart of the sample selection and interview process.

Table 4.13 Selected case sample for data collection

University type	List of universities	Corporate website	Characteristics
Apex	1. University Sains Malaysia	www.usm.my	- Research focused
Research focused	2. Universiti Malaya	www.um.edu.my	- Competitive enrollment
	3. Universiti Kebangsaan Malaysia	www.ukm.my	- Quality academicians
	4. Universiti Putra Malaysia	www.upm.edu.my	- 50/50 undergraduates/postgraduates
Comprehensive	5. Universiti Teknologi MARA	www.uitm.edu.my	- Multidisciplinary studies
	6. Universiti Islam Antarabangsa Malaysia	www.iiu.edu.my	- Competitive enrollment
	7. Universiti Malaysia Sarawak	www.unimas.my	- Quality academicians
	8. Universiti Malaysia Sabah	www.ums.edu.my	- 70/30 undergraduates/postgraduates
Focused	9. Universiti Teknologi Malaysia	www.utm.my	- Focus studies
	10. Universiti Utara Malaysia	www.uum.edu.my	- Competitive enrollment
	11. Universiti Pendidikan Sultan Idris	www.upsi.edu.my	- Quality academicians
	12. Universiti Sains Islam Malaysia	www.usim.edu.my	- 70/30/ undergraduates/postgraduates
	13. Universiti Darul Imam Malaysia	www.udm.edu.my	
	14. Universiti Malaysia Terengganu	www.umt.edu.my	
	15. Universiti Tun Hussein Onn Malaysia	www.uthm.edu.my	
	16. Universiti Teknikal Malaysia Melaka	www.utem.edu.my	
	17. Universiti Malaysia Perlis	www.unimap.edu.my	
	18. Universiti Malaysia Pahang	www.ump.edu.my	
	19. Universiti Malaysia Kelantan	www.umk.edu.my	
	20. Universiti Pertahanan Nasional Malaysia	www.upnm.edu.my	

Source: (MOHE, 2007a, , 2007b)

The second source of information in the case study will be gathered from various documentations namely project proposal, project plan, memorandum of understanding (MoU), progress reports and lesson learned from past completed projects. These administrative documentations are important to use in corroborating and augment evidence (Yin, 1994), as means to cross-check data collected from interviews. In all, websites and archival records from project leaders and university will be useful records in studying and analysing the cases. It should be noted that certain respondents may not be willing or able to provide complete documentation. This is an inevitable reality in a research environment such as this; however, every effort will be taken to obtain a complete set of corroborating documentation for research analysis purpose.

The interview sample contains several features which need to be considered in the analysis. Firstly, the investigated UIC R&D projects are focused on engineering based research projects. Thus, there are a few parameters identified below to build the boundary for the cases studied and in the identification of research projects from PHEIs:

- R&D projects involving UIC in a greater or lesser extent (e.g. contract research or joint contract)
- engineering based research projects (e.g. civil, mechanical, chemical etc)
- small to medium sized projects (budget range from RM50k to maximum RM500k only)
- project status are in progress, completed and those which have made significant progress
- UIC projects are funded or supported by industry players rather than government bodies

In summation the experimental design in this study is both qualitative and quantitative with compiled information from various sources of evidence obtained including interviewing the identified 20 PHEI university researchers in collaboration with industry. The investigation will provide a broader and dyadic view simultaneously data triangulation will be used in each of the case studies to increase reliability and validity of data.

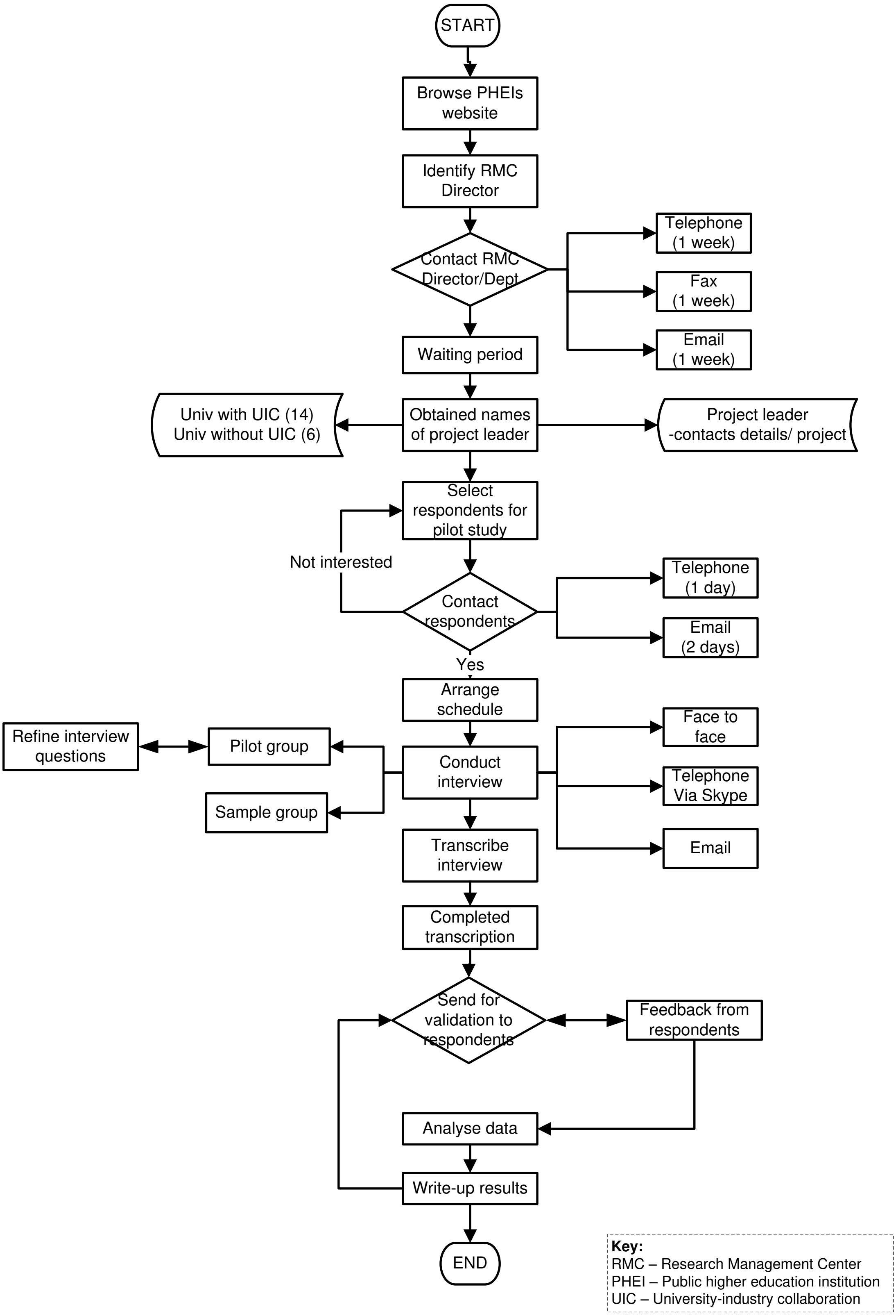


Figure 4.2 Experimental design of qualitative and quantitative approach

4.6.3 Experimental design of evaluation approach

The use of expert panel review is an effective approach which is widely accepted for identifying problems, formulation of ideas, development of strategies and policy making. However, attention must be paid to its procedural issues and problems as these may affect the success of expert panel review (Seskin et al., 2002).

Successful expert panel evaluation involves several processes. Colin's (2004) identified four phases for proper deployment of expert panels; (1) define problem scope, (2) create expert panel, (3) develop expert panel process and (4) document results. Seskin et.al (2002) discusses six steps for successful expert panel process; (1) know the big picture, (2) design the process, (3) create the panel, (4) final preparations, (5) manage the process and (6) document the results. Other steps in expert panel reviews involved identification of a list of potential experts, selection and mandating of the experts, investigations and synthesising (Evalsed, 2009). According to Seskin et al (2002) there is no single 'right' way to conduct an expert panel. Rather, the specific format of each panel will need to be customised based on the objectives of the research and project-related constraints. Therefore, the evaluation approach designed for this study will be based on Colin (2004) four phases of expert panel review as shown in Table 4.14.

The first step involves defining the aims and objective of the evaluation process which aimed at evaluating the developed PMM in Phase 3 (see Figure 4.1). Three assessment criteria was determine for expert panel evaluation; feasibility, usability, usefulness and improvements for the developed PMM.

Step two involves creating the expert panel for evaluation. The members of the panel need to be specialist or experienced in the field concerned. Furthermore, where appropriate, experts from university, industry and research agency must be willing to become involved in the evaluation. These experts are selected from the previous sample group carried out in the semi-structured interview and survey namely from university, industry, research agency and project management experts.

Generally the panel should compose of between 6 to 12 members belonging to different fields of expertise which helps to broaden the range of interest and diversity of views (Evalsed, 2009). As a result, through various means of request, a total of 10 experts were identified whom were willing to be involved in the evaluation process. A pre-test and revision of the evaluation questionnaire survey was conducted in July 2010 with a small sample of the targeted expert panel. To collate more experts for the evaluation, some experts were requested to identify at least one or two other experts relevant to volunteer for the evaluation in order to gain more validity and reliability of the PMM evaluation process. As a result a total of 3 additional experts were nominated and obtained from sampled respondents.

Table 4.14 Expert panel phases

1. Define the project/problem scope • Ensure clear understanding of the nature, aim, and extent of project/problem • Determine clear objectives and tasks • Recognise any limitations or restrictions
2. Create Expert Panel • Locate, contact, recruit potential experts and supporting staff • Composition and balance in panel profile • Roles of panel chair, technical writer, etc. • Determine experts from potential pool
3. Develop Expert Panel Process • Determine expert interaction • Establish how information will be provided • Select strategy/model of analysis • Determine focus of evaluation • Convergence and form consensus of opinion
4. Document Results • Typically recommendations or findings are presented in a formal written report • Could be for public use or only disseminated to appropriate persons

Source: (Colin et al., 2004)

The evaluation was carried out quantitatively with the use of a questionnaire survey and distributed via email to each expert. In the interaction process, experts were initially briefed on the material they are required to evaluate. The developed PMM were disseminated to the expert panels for review once clarification was achieved supplemented with a cover letter stating the objectives and instructions of the evaluation conduct (see Appendix 8 and Appendix 9).

A recommended reply period of one week was given however due to the majority of experts' tight schedule and work commitment the period was extended to two to three weeks. Face to face discussion was deemed inappropriate in this evaluation process because majority of experts were not based locally. Therefore, communication was maintained consistently via email and telephone conversation to verify any doubts related to the evaluation questionnaire survey. However, since the selected expert panel consists of overseas institutions and organisation, time zone differences and work commitment, further limits the discussion period. Thus, reminders were sent accordingly to encourage higher response rates.

Upon completion of the evaluation by the expert panel, it would be vital to identify the problems, suggestions and areas of improvement that will need to be carried out to improvise the PMM. In the final process, conclusions and recommendations that are collectively accepted will be produced into a guidebook (see PMM guidebook). In later phases of this study, the PMM will be refined and finalised for use in Phase 4 for future implementation and practical adoption in real life UIC research project environment to farther the present study (see Figure 4.1). The experimental design of the evaluation approach carried out for expert panel review model is shown in Figure 4.3.

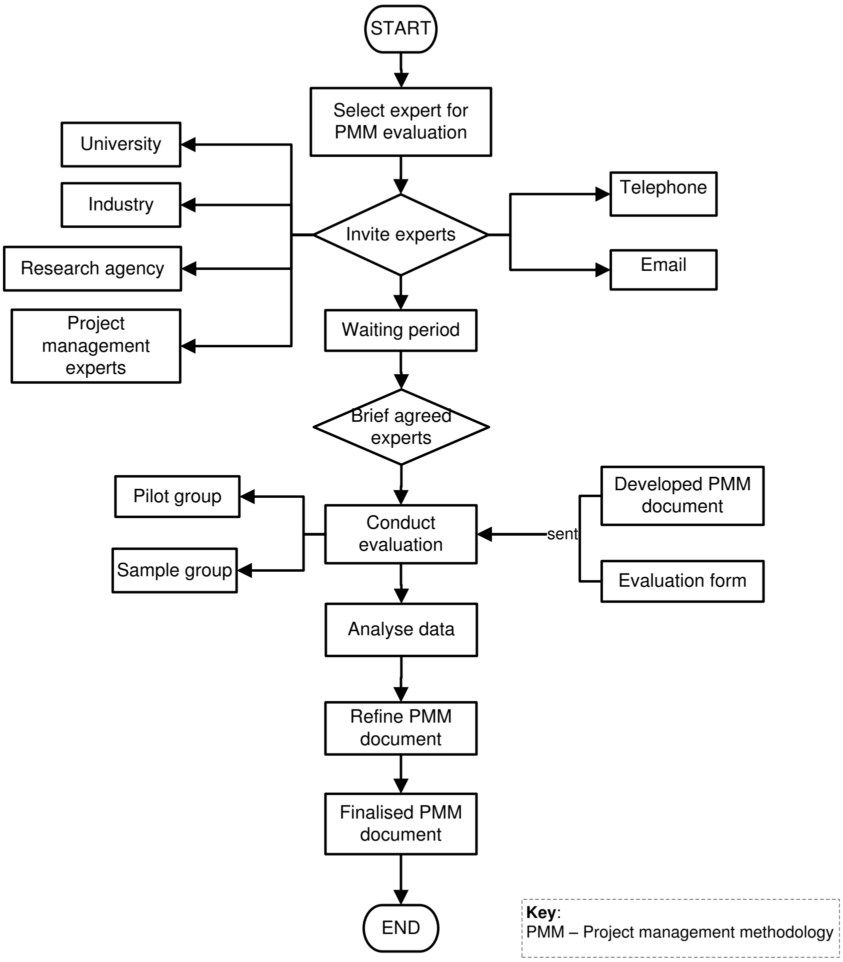


Figure 4.3 Experimental design of evaluation approach

4.7 Method of Analysis

There are a few schools of thought in the literature. Prior to consolidating the suitable qualitative analysis for this study a review of available strategies by several theorist are discussed. Two of the most influential groups of theorists are the naturalists (Miles and Huberman, 1994) and grounded theory (Glaser and Strauss, 1967). In this section, several data analysis methods are compared (see Table 4.15) which help to derive a suitable strategy for data analysis in this study. Based on the grounded theory, collection and analysis of data obtained needs to go in hand as theories and themes will then emerged during the investigation (Glaser and Strauss, 1967). This is the strength of grounded theory development.

Table 4.15 Qualitative data analysis model – a comparison

Citation	(Glaser and Strauss, 1967)	(Miles and Huberman, 1994)	(Kvale, 1996)	(Baker, 1999)	(Bryman, 2004)	(Gillham, 2005)
Model	Grounded theory	Qualitative data analysis	Interview data analysis	Qualitative data analysis	Interview data analysis	Interview data analysis
Process/ Stages	Collect data Note taking Coding Memoing Categorising/ sorting- Saturate data Writing report	Data reduction Data display Conclusion & verification	Condensation Structuring/ Narrative Interpretation Ad-hoc	Condense data (coding & memoing) Display data (themes, patterns) Develop & test conclusion	Code Read Re-read Review codes Theoretical ideas Slice data	Transcribe Categorical analysis Derive category (coding) Write report Combine with other sources

Source: Research analysis compilation

When all the relevant information has been collected from both semi-structured interviews and multiple sources of documents, the next stage involves analysing the data. In Wahyuni’s (2003) study, the author argued that qualitative interviews capture richness and complexity of subject matter that needs to be explained in a comprehensive manner. Apparently, the adoption of interviews as research methods involves challenges as well. It is not merely new method as it yields qualitative text rather than quantitative data (Kvale, 1996) but tools of research to gather facts (Gillham, 2005). But the ‘facts’ do not speak for themselves however they are obtained. All raw data requires interpretations which involved analysis (Corbin and Strauss, 2008). However, it can almost never be a finish process. As there is always a need to extend, amend and reinterpret when new insights or situations arise. Therefore, analysis is a process of generating, developing and verifying concepts, that are built up over time and with the acquisition of data (Corbin and Strauss, 2008).

Reviewing the various strategies of data analysis in Table 4.15 had provided a clearer insight into the process of data analysis. In the next few paragraphs the steps taken for this research will be presented.

Data analysis can be broken down into several actions as illustrated in Figure 4.4. First, after all data is collected from each respondent in the case study. The interviewed data will be transcribed using Express Scribe (NCH), a computer assisted transcription software to generate a written interview report from each respondent. Then, when all the information has been gathered, each interview report is read, re-read iteratively to derive meaningful categorical analysis through the coding technique. According to Glaser and Strauss (1967) coding is one of the most central processes in grounded theory. At this first step, open coding is the initial step used to break down, examine, compare and later group into categories (Glaser and Strauss, 1967, Bryman, 2004). In open coding, the researcher is immersed into the data through line by line analysis, coding as much data as possible and writing memos about the conceptual and theoretical ideas that may emerge during the analysis process. The process is completed when the researcher begins to see the possibility of a theory that embraces all the data (Walker and Myrick, 2006).

Second, once categories of themes are developed, the second phase of coding known as axial coding (Glaser and Strauss, 1967) is done in each of the identified themes in the report. This action brings forth sub-codes from the original codes. It helps the researcher to further derive immersed categories from the data. In addition, it helps to break down, conceptualise and put back data into new meanings, an action in building theories from data (Wahyuni, 2003). The process will be an iterative cycle until all data are saturated and no new theories are derived.

Third, after immersed categories are derived through coding, the data needs to be presented and displayed with the use of some inventive method. According to Miles and Huberman (1994), data display goes beyond data reduction providing a more organised, compressed assembly of information that permits conclusion drawing. It can be in an extended piece of text, chart, matrix or diagram to elaborate the ideas that had been developed (Baker, 1999, Miles and Huberman, 1994).

Hence, at this stage a computer assisted qualitative data analysis software (CAQDAS) NVivo 8 (QSR, 2007) will be utilised to assist the development of an appropriate diagrammatic form to display the data and make extrapolations. The use of this application will help to discern systematic patterns and relationships that will help derive an interpretative analysis in the last stage.

Fourth, the process of cross-checking the analysed data and adherence to the principles of best practice case studies methodology as described in section 4.4 were carried out. The examination of multiple sources of evidences from the case studied is carried out in this stage. At this stage, a process of cross-checking findings derived from secondary sources such as project documentations obtained from respondents are conducted, a process also known as triangulation (Bryman, 2004). Triangulating is a mean to understand the historical context within events such as company documents that increases the validity of findings in reflection to the theory postulated (Stavros and Westberg, 2009). Finally, upon consolidating all the themes, a diagrammatic representation of codes and interrelationships of each category is derived.

The next stage involves writing a report of the analysis. Completed reports of analysis and summary of the recommendations will be sent to all key respondents (both university and industry). The intention is to provide an opportunity for key respondents to review, validate any mistakes in the supplied information and for respondents to provide recommendations and suggestions in their perspectives on the proposed practices and methodology. Steps of qualitative data analysis adopted in this study are summarised in Figure 4.4.

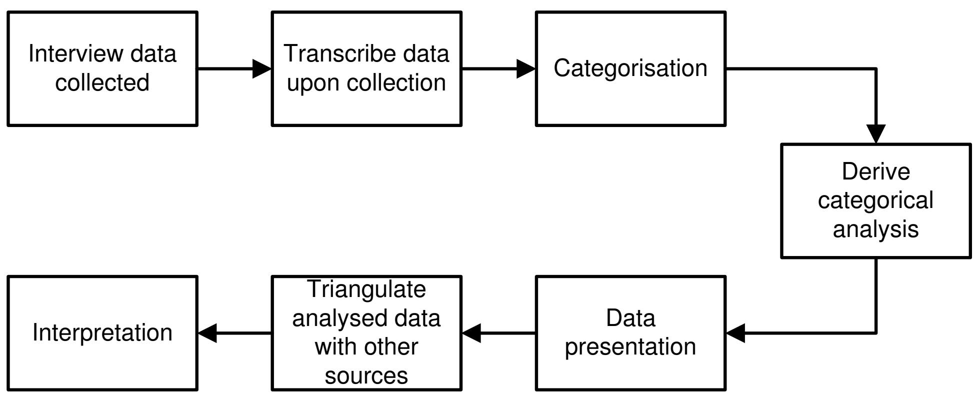


Figure 4.4 Model of qualitative data analysis

Source: (Miles and Huberman, 1994, Glaser and Strauss, 1967, Gillham, 2005, Bryman, 2004)

4.8 Validity and Reliability Concern

Often researchers are questioned on how their research can be convincing, precise and practical if it is to be repeated by another researcher (Drucker-Godard et al., 2001). Validity and reliability 'measures' are commonly used to judge the quality of quantitative research. However in a qualitative interpretive research paradigm these questions are debateable and frequently used to critique or dispute the findings of such research work. Qualitative studies involving investigations into the 'real-world setting' aim to unfold areas of new phenomenological interest (Patton, 2002). Thus any kind of research findings produced through understanding or observations of the natural situation are derived from the researcher's own perception. Therefore, in comparison with quantitative research which depends on the instruments construction; in qualitative research it is the researcher who is the instrument (Patton, 2002). As a result it is largely the researcher's credibility and due diligence in developing the methodology which acts as an indicator or to validate the reliability of the data. The following sections attempt to provide additional information on the measures employed to ensure the validity and reliability of this study.

4.8.1 Validity

The term validity always comes with reliability in both qualitative and quantitative studies. As demonstrated by the numerous definitions of validity, this concept is by no means universal nor static (Golafshani, 2003). From the qualitative research perspective, some perceive that validity is not an applicable term as no single method is universally justifiable (Drucker-Godard et al., 2001). Thus it is recognised that researchers should select an appropriate test to overcome the validation assumptions inherent in this type of research. The extensive reviews by scholars (Miles and Huberman, 1994, Yin, 1994, Eisenhardt, 1989), have led to the development of two distinct validity testing techniques; internal validity and external validity, both of which will be used in this study.

Internal validity consists of internal coherence and pertinence of results produced (Drucker-Godard et al., 2001). It concerns two aspects of qualitative research; causal links to determine whether event x led to event y; and links made between inferences (Yin, 1994). To accomplish this challenge, pilot test interviews were carried out at initial stage to get further insights into the postulated theory and to simultaneously test the appropriateness of questions for both kinds of respondents. This experiment reduced the probability of making invalid links and sought evidence to disconfirm the assumed link in the research. For example, the identified barriers in UIC research environment are categorised into two major categories and four sub-categories as discussed in Table 3.4. These categories were designed in accordance to the semi-structured interview questions, which were tested in the pilot interview. When no additional data can be retrieved from the pilot groups of respondents, the properties of interview categories are redeveloped. The final scrutinised interview questions were later conducted with another new set of respondents but from the same case grouping.

External validity refers to the degree to which findings can be generalised across settings. The question of generalisability in case studies has always been an area that received considerable criticism (Yin, 1994, Cutler, 2004). The typical question of validity is raised on how a single case or sample can be used to generalise statistical evidence.

Of course the same question can be raised in quantitative research as well; how a scientific generalisation can be based on a single experiment? For example experimental research which is based on multiple set of experiments replicated in different conditions. In short, case studies are similar to experimental studies. It is a form of evaluative research exploring situational conditional differences which may not have a clear single set of outcome (Yin, 1994). It also does not represent samples rather analytical generalisation based on the skills and credibility of the researcher.

The question of external validity in this study is assured by firstly selecting and drawing a robust sample from the population. Since the population are still in its infancy stage as discussed in section 3.4, the drawn samples described in section 4.6.1 are effectively the appropriate informants for the study based on the parameters identified, their background, nature of industry and even nature of projects. Hence by using multiple groups of people of different structural conditions it will maximise the analytical generalisability of this study.

4.8.2 Reliability

In the qualitative paradigm, Lincoln and Guba (1985) described reliability in terms of dependability. In another report, it is referred as the researcher's responsibility for ensuring the research process is logical, traceable and documented (Golafshani, 2003). Reliability addresses how effective the research methods and techniques produce (or can reproduce) data (Cano, 2000). In other words, are the results reproducible by another investigator given the same methodology and an equivalent sample? To ensure reliability is attained, transparency of the research methods used is paramount. This requires a description of the methods used in the research through the use of documented protocols (Yin, 1994). To demonstrate the degree of reliability in this study, some actions have to be implemented such as constructing protocols; getting a dyadic insight into both partner (university and industry) perspectives in natural setting; obtained feedback from respondents and the use of multiple sources of information.

Firstly, to increase the reliability of the study, scholars recommend the development of a set of protocols (Yin, 1994, Cutler, 2004). Thus, in this study, a protocol containing a list of procedures and rules to guide the research process is generated as shown in Figure 4.2. Adhering to the principles recommended, the preparation of protocols help investigators to conceptualise how the findings will be documented. It also provides readers with a structured guide on how the case study has been conducted (Yin, 1994). During the research, another process audit trail is used. This procedure establishes both dependability and confirm-ability of the research process. In all research, an audit trail of the research process should be documented for data analysis and theory generalisation (PTC, 2007). In terms of interview question development, a set of interview guidelines (Gillham, 2005, Kvale, 1996) (see Appendix 4) were followed.

Secondly, to support and strengthen evidence of research, the research gains insights in a dyadic view from both parties (university and their industry partner), thus increasing the reliability of the research. In any circumstance where the sources are inconsistent or conflicting, respondents were contacted to identify any knowledge gaps which required further investigation.

Thirdly, Wahyuni (2003) recommended that one of the most logical sources of corroboration is the respondent. The respondents are after all the key informants in the entire research. Regardless of the reason, the use of these multiple data sources can strengthen the findings while minimising the weakness of a single approach (Wahyuni, 2003). Furthermore by examining the data from a different perspective to corroborate findings increases the reliability of research. Such a data triangulation approach facilitates more reliable interpretation of data (PTC, 2007).

4.9 Ethical Considerations

In the context of this study, ethics refers to the appropriateness of the researcher's behaviour in relation to the rights of those who become the subject of the work, or are affected by it (Saunders et al., 2000). Wells (1994, p.284) defines 'ethics in terms of a code of behaviour appropriate to academics and the conduct of research' (Wells, 1994). Ethics in human sciences researches can be broadly defined as 'the proper manner of conduct'. The methods of data collection, through the various methodologies in this study, needs to respect the respondents' many rights, so that they do not suffer any physical harm, discomfort, pain, embarrassment or loss of privacy (Denzin, 1989) as a result. Ethical concerns will naturally emerged as an essential element in engineering management focused research of this nature as the study requires access to organisations and individuals to collect, analyse and report data.

Researchers need to address specific ethical issues, including aspects of disclosure, gaining respondent agreement to participate in the research, data collection and storage methods (Simon et al., 1998). However, Saunders et.al (2000, p.149) agreed that irrespective of which research methods are adopted, the following ethical principals are advisable;

- to respect intended and actual participants' right to privacy;
- to avoid deceiving participants about why the research is undertaken, its purpose and how the data collected will be used;
- maintaining the objectivity during the data collection, analysis and reporting stages;

- respecting assurances provided to organisations about the confidentiality of (certain types of) data;
- respecting assurances given to organisations and individuals about their anonymity; considering the collective interests of participants in the way the data will be use which they provide.

Privacy is also seen as the cornerstone of the ethical issues that confront those who undertake research e.g. consent, confidentiality, participant reactions, when data is analysed and reported (Saunders et al., 2000). In order to protect the privacy of participants, the following rules will be adhered throughout the process of data gathering as specified in the UNMC code of conduct (The University of Nottingham, 2007) and the best practices discussed below (Saunders et al., 2000);

- brief the participants on the objective and purpose of the research;
- privacy of possible and actual participants;
- obtain formal consent from participants in writing;
- voluntary nature of participation and the right to withdraw partially or completely from the process;
- maintenance of the confidentiality of data provided by individuals or identifiable participants and their anonymity;
- reactions of participants to the way one seek to collect data;
- effects on participants of the way in which the data is use, analysed and reported;
- behaviour and objectivity of the researcher.

In considering the research approaches used in this study, the ethical guidelines suggested by Babbie (1990) will be followed. According to Babbie (1990) a right to privacy means one has the right to refuse to be interviewed or to refuse to answer any questions in an interview. To address these rights correctly, an ethical researcher should do the following (Babbie, 1990):

- inform participants of their right to refuse to answer any questions or participate in the study;
- obtain permission to interview participants;
- schedule field and phone interviews;

- limit the time required for participation;
- restrict observation to public behaviour only.

Throughout this study, the ethical principles and considerations outlined in the above have been followed to ensure the research is in compliance with the university and best practice ethical standards.

4.10 Chapter Summary

This chapter began with an outline of the research workflow which was divided into four phases, including a description on the research paradigm and case study approach as the research strategy. To gain an inside view of the relationship and perception of UIC research environment and project management, a semi-structured interview and questionnaire survey were designed. This included a detailed discussion on the data collection method used in this study and the evaluation model for assessing the PMM. The questionnaire survey approach chosen for this study was also explained in this chapter. Sample selection of cases and units of analysis for this research were further justified and the experimental designs of each method were presented followed by explanations of the method of data analysis for this study. The data analysis method involved a combination of methods focusing on case study analysis and grounded theory. The final section elaborates on the validity and reliability issues questioning whether this study is convincing, precise and practical if it is to be repeated by other researchers. Ethical issues were also examined and guidelines were adhered to ensure privacy, consent and cooperation from respondents in this study.

The next chapter presents the results and discussion obtained from the semi-structured interview and questionnaire surveys carried out in this study.

CHAPTER 5 RESULTS AND DISCUSSION

5.1 Introduction

This chapter describes the results obtained from the study; semi-structured interview and questionnaire surveys. The interview results were recorded with respondents' permission, transcribed into word-processed format and sent to respondents to review and validate. The reviewed reports were then re-read for analysis and coding purpose as described in section 4.7. A protocol was written up as a guide to provide clear insights into the data analysis of this mixed mode research method. The completion of the coding process from the interview report identified several themes which will be used to define the requirements place on the PMM. The following section describes the questionnaire survey results distributed to the interviewed respondents. At the end of each interview session, a questionnaire survey was distributed to respondents to validate the findings elicited from discussion in the literature reviews in chapters 2 and 3 discussions. Experimental designs of the interview and questionnaire survey were presented earlier in sections 4.5 and 4.6 in chapter 4. In this chapter the results and findings are presented and discussed. A conclusion is drawn to summarise the findings of this chapter.

5.2 Sampled Respondents

This section presents the findings of a series of qualitative semi-structured interviews with respondents from the university, industry and research agency as shown in Table 5.1.

A total of 19 structured interviews were carried out with university and industry partners from September to November 2009. On average the duration of each interview lasted for 50 minutes to accommodate the respondents tight schedules (see Table 5.1). Each of the interviewees were currently or had recently been involved in UIC R&D projects in the role of project leader or lead researcher, while interviewees from the research agency and a spinoff company were obtained through the university research group social networking media and personal contacts. All interviews were carried out in a semi-structured, face to face, audio-recorded and transcribed to generate a written interview report and later sent to the respondents for validation (see Table 5.1). Codes (Glaser and Strauss, 1967, Bryman, 2004) were generated using NVivo as a analysis tool to derive meaningful categorical analysis. Following Miles and Huberman (1994), nodes were developed based on the interview reports transcribed and coded during data analysis (see Appendix 5 and Appendix 6).

Interview questions were generated based on research questions, categorised and coded for questioning purpose (see Table 5.2). The organisation types selected for this interview represented a diverse range of UIC within Malaysia meeting the research objectives. These organisations are:

1. A foreign based university established in the market for ten years which is very keen to promote and establish more partnership with the industry.
2. A research focused university established in 1962 as the first university for the nation ranked above 200 worldwide (THE, 2009).
3. A number of focused universities recently established from the year 2000 which are still at the infancy stage of generating UIC.
4. A university established in 1969, was the first educational institution in the nation to be selected and given the Accelerated Programme for Excellence (Apex) status. The university has a continuous partnership with government linked companies (GLC).
5. A number of comprehensive universities established in the 1980s and 1990s whom are interested to establish a UIC centre of excellence, yet lack the experiences and skills of collaborating extensively with industry partner on their own effort.
6. The external respondent was an ex-chairman for the Centre for Resource & Research Collaboration.
7. A spin off company from a research focused university, aiding the university from consultation services to commercialisation of innovated products.
8. A small medium enterprise involved in providing integrated engineering expertise and businesses in project management, project resources, IT, consultancy and other services.

9. An environmental biotechnology company with Bio-nexus status which had been in operation since 1980 and is in collaboration with one of the research focused university.
10. A consulting engineering company experienced in structural, engineering and designing which is specialised in buildings for the defence sector and has been in partnership with a focused university for the past two years.
11. A concrete based construction company in a successful collaboration with the focused university for over two years.

Table 5.1 Sample description of respondents' profile

No	Respondent ID	Organisation type	Role	Experience (years)	Date	Method	Duration (mins)
1	U1	Foreign university	Project research leader	>10	02/9/09	FTF	60
2	U2	Research focused university	Project research leader	>15	11/9/09	FTF	60
3	U3	Focused university	Project research leader	<5	14/9/09	FTF	40
4	U4	Research focused university	Project research leader	>10	26/10/09	TEL	64
5	U5	Research focused university	Project research leader	>5	12/11/09	FTF	60
6	U6	Focused university	Project research leader	>5	7/10/09	TEL	31
7	U7	Research focused university	Project research leader	>10	22/10/09	FTF	52
8	U8	Focused university	Project research leader	>10	27/10/09	FTF	50
9	U9	Comprehensive university	Project research leader	>5	17/10/09	FTF	50
10	U10	Focused university	Project research leader	>20	9/10/09	FTF	52
11	U11	Research focused university	Project research leader	>5	29/10/09	FTF	35
12	I1	SME	Project sponsor	>10	14/9/09	FTF	60
13	I2	SME	Project sponsor	>10	24/9/09	FTF	55
14	I3	SME	Project sponsor	>10	21/10/09	FTF	50
15	I4	SME	Project manager	<5	13/11/09	FTF	34
16	I5	SME	Project sponsor	>5	22/10/09	TEL	20
17	I6	SME	Project sponsor	>5	30/10/09	FTF	60
18	E1	Research agency	Senior management	>10	21/9/09	FTF	45
19	E2	University spin-off	Senior management	>10	16/11/09	FTF	66

Notes: University (U); Industry (I), External research agencies (E); Small Medium Enterprise (SME); Face to Face (FTF); Telephone (TEL)

5.3 Semi-Structured Interview

As discussed in sections 4.5.1 and 4.5.2, semi-structured interview questions were developed from a critical analysis of the literature, assigned with a category based variable and coded to generate the interview questions (see Table 5.2). A pilot interview was carried out with three university respondents; three industry respondents and one from a research agency. These pilot respondents were selected from the sample group which aimed to validate the reliability and validity of this research.

The following sub-sections will describe the results analysed, coded and outline the themes that emerged from the interviews. As well as conducting interviews, respondents also participated in a questionnaire survey given at the end of the session that was self-administered to validate factors and issues identified that were common in a UIC project environment. The questionnaire survey findings will be discussed in section 5.4.

Table 5.2 Theory questions for each category variable used as guide for the semi-structured interview and questionnaire survey development in relation to the identified literature review

Central Question	Theory Question	Category Code	Interview Question	Literature review: University	Literature review: Industry
How to develop a PMM for use in a UIC environment?	What are the driving factors in UIC?	DRIV-F	• Why collaboration?	• Technology transfer • Enrichment of graduates with real-world experience • Understand the applicability of knowledge to industry • Changes in the industry needs drives research planning • Shift in skills set demand for research students • Graduates receive workforce training • Technical opportunities in industry exists within academic setting • Availability of materials from industry • External, non-governmental source of research funding • Financial reward for researchers • Enhanced recognition and prestige of the university and researchers involved • Knowledge and education dissemination • Knowledge creation • Growth of human resource, education and educational achievement • Encouragement of funding resources • Learning ability & opportunities	• Access potential future employees • Attain access to novel 'high' end technologies • Cost effective to outsource to universities • Extension of innovation networks • Gaining access to governmental sources of funds • Enhance competitiveness • Enhance growth • Speeds time for products to get to market • Wealth creation • Access to wider range of ideas, facilities, expertise • Distribution of labour • Utilization of skills & expertise • Sharing resources • Lower risks

Table 5.2 Theory questions for each category variable used as guide for the semi-structured interview and questionnaire survey development in relation to the identified literature review (cont)

Central Question	Theory Question	Category Code	Interview Question	Literature review	
How to develop a PMM for use in a UIC environment?	What problems are faced by UIC partnership?	BARR	• What are the problems that tend to occur in the collaboration?	**Collective** Fear factor Hidden agenda Conflict in control & authority Ownership of IPR Low support from top management Poor selection of partners Conflicting interest & objectives	**Cultural** Distrust, lack of honesty Different nature of work Poor understanding on needs
				Project management Unclear requirements Poor planning & monitoring Ineffective communication Unclear roles & responsibilities Degree of commitment Project manager selection No project structure Lack project policies & procedures	**Environment** Competitive forces Increase technology choices Changes in regulations & policies Political pressures Industry specific R&D interest Partner instability & continuity High demand for innovations Poor technology transfer

Table 5.2 Theory questions for each category variable used as guide for the semi-structured interview and questionnaire survey development in relation to the identified literature review (cont)

Central Question	Theory Question	Category Code	Interview Question	Literature review
How to develop a PMM for use in a UIC environment?	What are the best practices to be adopted by UIC in managing the partnership?	BT-PRAC	• What are the basic practices /success element to better manage UIC?	**Collective** Shared mutual goals Level of control & authority Clear policy on IPR Top management involvement Complementary knowledge **Cultural** Compromise Trust & transparency Mutual respect Understanding **Project management** Clear roles & responsibility Frequent & effective communication Organise regular effective meetings Competent project manager Documentations Well defined contract Team building Incentives & reward Project organisation structure Use of project methodology **Environment** Awareness of new technologies Stature, recognition Promote research in all discipline

Table 5.2 Theory questions for each category variable used as guide for the semi-structured interview and questionnaire survey development in relation to the identified literature review (cont)

Central Question	**Theory Question**	**Category Code**	**Interview Question**	**Literature review**
How to develop a PMM for use in a UIC environment?	What is the significant relationship between the establishment, project management and outcome evaluations of a UIC partnership?	DEV	• Describe the processes involved in establishing UIC?	**FORMATION (COLLABORATION)** Conception of research IDEA /strategy Prepare an in-house proposal Identify organization core competencies Decision to form Identify potential alliance partners Distribute solicitation letter to interested parties/partners identified Select and identify potential partner Negotiate and plan collaborative research agreement Submit for external funding and approval Alliance project approved, sign agreement **OPERATION (PROJECT MANAGEMENT)** Launch/execute the alliance project Plan and monitor alliance project progress Take correction action review Completes project **EVALUATION & TERMINATION (TRANSFER)** Performance evaluation Transfer technology and knowledge Sustaining relationship

Table 5.2 Theory questions for each category variable used as guide for the semi-structured interview and questionnaire survey development in relation to the identified literature review (cont)

Central Question	Theory Question	Category Code	Interview Question	Literature review
How to develop a PMM for use in a UIC environment?	What is the significant <u>relationship</u> between the establishment, project management and outcome evaluations of a UIC partnership	DEV	• How the collaboration performance is measured?	**Tangible performance indicators** - potential spin-off; number of graduates generate; patents and non patentable property; list of publications in journals or conferences and financial success **Intangible performance indicators** exploration of new knowledge or findings; increase of experiences, relationship building
	What are the <u>requirements</u> in a UIC PMM?	PROJ-MG	• What key elements are needed in the planning process? • Do you/institution adopt a PMM to manage collaboration projects? If yes/no, why? • If there is a PMM, what should be included in it?	**<u>METHODOLOGY REQUIREMENTS</u>** • Principles & processes • Organizational standards/regulations • Model work flow of project • Promote organisational learning • Technology element • Tools & techniques • Specific & customizable • Scalable & adaptive • Identify risk & opportunity
	How are UIC in your organisation being managed? Is there any structured approach to the <u>project management</u>?	PROJ-MG	• What structures are created /adopted to coordinate the collaboration? • Who are the key people involved in the project management? Is there a project manager from each partner liaising in managing the project? If yes, how has it benefited the collaboration? If not, why?	**<u>OPERATION (PROJECT MANAGEMENT)</u>** Launch/execute the alliance project Plan and monitor alliance project progress Take corrective action review Completes project

Table 5.2 Theory questions for each category variable used as guide for the semi-structured interview and questionnaire survey development in relation to the identified literature review (cont)

Central Question	Theory Question	Category Code	Interview Question	Literature review
How to develop a PMM for use in a UIC environment?	How are UIC in your organisation being managed? Is there any structured approach to the project management?	PROJ-MG	• How collaboration progress is monitored and controlled?	**MONITORING & CONTROL (PROJECT MANAGEMENT)** Progress reporting, technical reporting, financial reporting, frequent communication planning
	What are the future views of UIC in Malaysia?	FUT	• What are the sustainability criteria for UIC growth in Malaysia? • University researchers should be equipped with industrial experience. What is your view? • Do you think project management skill is a contributing element to collaboration success? Why?	Complementary rewards, sharing of resources, sharing of ownership, communication, understanding, trust, relationship management, cultural differences receptiveness.

5.3.1 Development stage (DEV)

Describe the processes involved in establishing collaboration

One fifth of the university respondents indicated that they were approached by the industry due to their niche research area of expertise. This was mainly due to the fact, as noted by the industry partners, that there were no other university doing research in that specific field within Malaysia, hence restricting their options. On the other hand, a majority of respondents stated that the collaboration was more of an individually initiated effort that took place after several rounds of discussion. University partners commented that the amount of time and effort involved to convince their industry partners was very significant and the process was considered to be a ‘very challenging ordeal’. One university respondent recounted the numerous visits to the industry partner over the course of two years before eventually being given a project as a trial. In the view of university respondents, the majority agreed that there was a lack of direct involvement from their institutions to facilitate the engagement or to assist with the selection of industry partners. These following comments are reflective of the findings in this study with respect to the establishment of a UIC in Malaysia:

- Industry partners **directly approached** university researchers due to their interest in the niche area or an immediate technical problem requiring expert solutions.
- **Pre-existed relationship** (Dyer et al., 2006); initiation as a result of professional work, academic connection or mutual interest in specific areas of research.
- **Joint effort/balance contribution** (Vyas et al., 1995); whereby each partner contributed to the research via a ‘win-win’ partnership. For example as indicated by a university respondent, industry partners contribute samples and in return the university partner carries out experiments on the samples. As a consequence the collaboration became ideally beneficial, sustainable and synergistic (Barbara, 2008, Lasker et al., 2001).
- **Individual initiatives/effort**; whereby university researchers select their own partners via personal contacts without significant guidance from the university was stressed by the majority of respondents. One industry partner similarly agreed that in his view, direct contacts and involvement with the university researcher rather than university administrators was the normal practice.

Among the 19 respondents, only a few were able to provide a more descriptive response to the process involved in UIC establishment.

Based on the responses a diagrammatic representation has been developed in Figure 5.1. At initiation, collaborations were commonly established either through pre-existing relationship or individual effort initiated by either one of the partners. According to the respondents, UIC begins with an identification of a research idea by either party before a decision to collaborate is initiated. Once the relationship between partners has been established as shown in Figure 5.1, the next step involves negotiating the contractual agreement between the two parties. Once an agreement is reached, a memorandum of understanding (MOU) is signed by both parties. An industry partner identifies the importance of a MOU in the set up of the collaboration because it clearly spells out the terms and conditions of the relationship, deliverables, expectations and scope of work. The second aim involves solidifying the partners' relationship. It was noted that small to medium enterprises (SMEs) are more flexible with the contractual agreements with university researchers. This is mainly due to SMEs inadequate understanding and knowledge of UIC establishment creating greater dependency on university researchers to progress with the agreement.

Surprisingly the findings in this study indicate that the formation of UIC(s) without any contractual agreement was not uncommon. Evidence collected from both the literature (Matthew and Norgaard, 1984) and the interviews indicates that it is important to create a written agreement to optimise the probability of fulfilling the project requirements. However, one of the partnerships interviewed in this study did not consider this to be a significant success factor. In their one and half years of partnership, they commented that their collaboration set-ups were mainly based on research without commercial interest. As a result, no form of contractual agreement was utilised. However, they did indicate an interest to generate an agreement in the future to support their long term collaboration.

When sourcing for external funds from government bodies, proposals are written and submitted for application. Once the funds are approved it is a requirement that an agreement is drafted with the government body. Projects are then executed and reviewed periodically until completion. The aim of UIC differs greatly. From the government's perspective the outputs expected from the university are PhD graduates, patents and publications; while commercial value oriented products are of course the industry partners' desired outcomes.

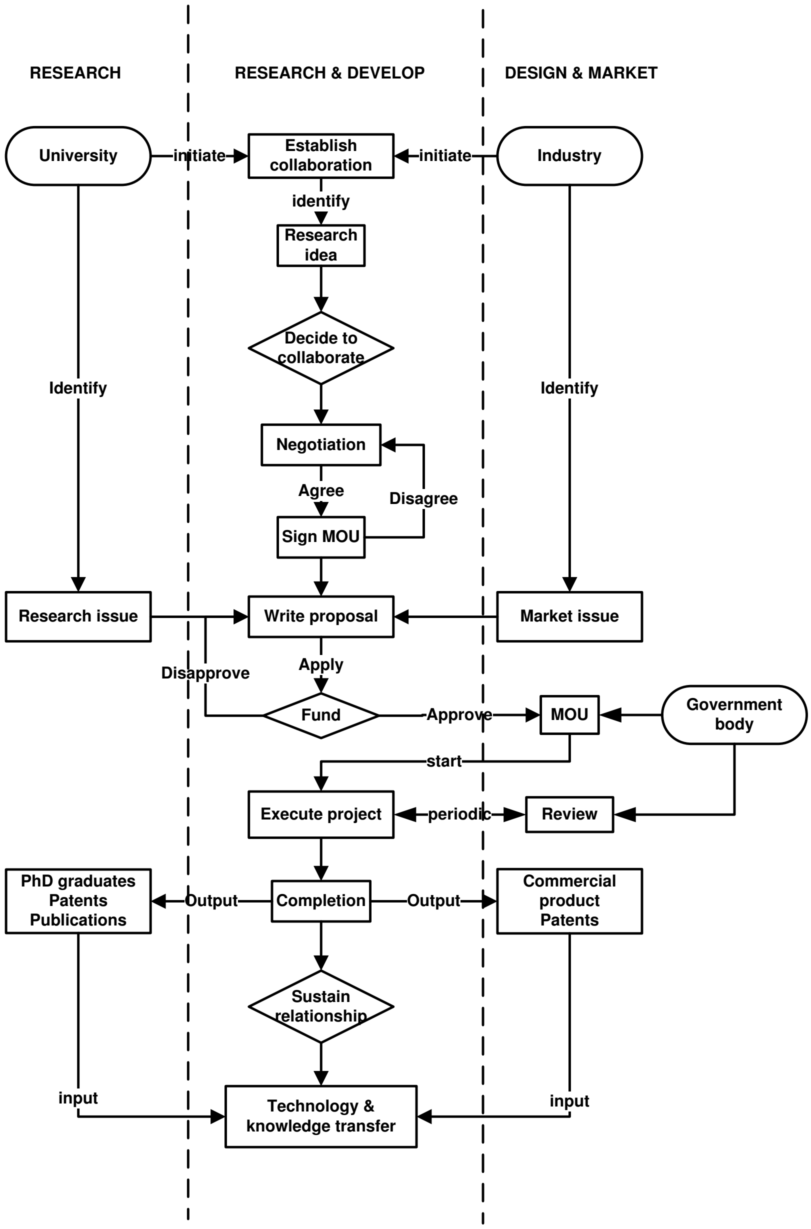


Figure 5.1 UIC establishment process as described by interviewed respondents

How collaboration performance is measured?

As a result of the collaboration, two types of outcomes were constantly expressed by both university and industry respondents as explained below:

> *"There are two types of outcome*s; financial and research outcome. In terms of research outcome it benefits the research student, university and me. As academician, solving the research issues associated with the project is our main output. Where else the company financial output is commercialis*ing the project" (U1)*

> *"In general, the project is considered successful when we manage to solve the problem and in* some cases, with the agreement of the company, I was able to publis*h the work" (U2)*

> *"…in terms of knowledge, it is significant. We have written a few papers, we gathered some* data to confirm some of our hypothesis of *our findings" (U3)*

> *"Besides commercialisation, future R&D and spin*-offs for new areas for example the *activated carbon in super capacitor material" (I1)*

> *"Outcome is our commercial benefit" (I2)*

> *"…whether universities had been able for example to churn out enough of engineering and scientific capability to meet the needs for upgrading" (E1)*

These have been grouped into tangible and intangible outcomes.

- **Tangible outcome**; such as paper publications, new findings and solutions by university researchers are the normal deliverable expected from the academicians. University researchers also view collaboration as a strategy to generate more doctoral graduates with industrial exposure to meet the market needs.
- **Intangible outcome**; such as knowledge development, validation of findings, satisfactions of research output or solution to the specific problems. Industry partners view collaboration as a means of accessing higher value technology to their product at the same time increasing their products commercial values and competitiveness in the market.

Despite the fact that collaborations are heavily emphasised by all respondents, they did not provide any specified response to this question. Findings revealed that there is no indication of performance measurement conducted by the organisation to assess its outcomes or direct involvement of institutions in measuring the performance of the collaboration outcome. This dyad view was consistently identified from the interviews. The response from this question denotes that this area is still understudied in the market (Yee et al., 2009a).

5.3.2 Driving factors (DRIV-F)

Why collaboration?

- **Complementary support**

The reason provided under this category by university researchers relates to their traditional role as knowledge contributors. Both university and industry need to accept the importance in complementing each other's needs and wants. For example industry collaborates with the university for their expertise in the particular niche area, subject matters, solutions or methodology from a theoretical perspective. In return for their effort university researchers received financial support and exposure to the industrial R&D project environment. Responses captured from the interview were consistent with this findings identified in the literature earlier (see section 3.2.2). The majority of the collaboration was established based on previous relationship and past cooperation that was successful, resulting in their second partnership in the future.

- **Common interest/ground**

Although partners in a UIC place emphasis on different aspects of the partnership, both the university and industry must comprehend the rationale for the collaboration. A number of common grounding factors for collaboration where identified as being consistent with the literature, these include:

- The UIC provides practicing engineers and other skilled professionals an opportunity to upgrade themselves through the collaboration and participation in university programmes.
- The UIC opens new windows of opportunity to industry through university research results and publications.
- The UIC generates fruitful innovation results to society.

- **Capability of facilities and expertise**

Industrial respondents from SMEs stressed that they require infrastructural support and expertise to conduct the research. This is their prime driver for collaboration. The situation is significantly different from the case of multinational companies (MNCs) R&D projects because funding for related facilities is more widely available whereby MNCs have greater capital to support the laboratories particularly in science-based researches according to industrial respondents.

- **Increase value chain of competitiveness**

In Malaysia, collaboration is viewed as both a strategy and driver for industry to move up the value chain with the primary aim of competing with companies in other developing nations. A university respondent commented that Malaysia is a nation going in the right direction but it needs more industrial experience and resources to improve its present situation. An insight from an external respondent (E1) commented;

> *"The whole idea behind UIC is university becomes more relevant to industry, universities work with industry in order to ensure that our capabilities continue to expand in the direction needed by the industry and to move up the economic value chain"* (E1)

5.3.3 Barriers (BARR)

What problems may occur in a UIC?

Although the questions specifically asked about the obstacles which occur in UIC, the majority of respondents provided a general view towards the question. Industry respondents agreed there is a need for the university to understand what industry wants and how to converge their basic research into applied research for better integration. The university respondents also shared this view. The common problems identified by respondents include:

- **Divergence of interest and expectations**

One of many issues in UIC is the differing views of partner's expected outcomes, responsibilities and authority. For instances from the universities perspective, industry expect a lot from them resulting a lot of 'hand-holding' culture and frequently a demanding approach treating the university researchers in a similar manner to conventional suppliers. This problem more commonly occurs in SMEs who with the exception of the commercial deliveries frequently lack understanding of what they want and need from the UIC. Based on interviews, conflicts are common during the formation of the UIC due to divergence of interest and expectations, thus requiring a lot of reconciliation which lengthens collaborative agreement. With such experiences, it is important to value the differences among others to achieve synergy (Covey, 1990). Although each partner purpose differs, it is also the unique key that holds to a successful balanced partnership.

- **Bureaucratic structure**

Bureaucratic structure was the most commonly cited hurdle in the formation of UIC. Industry respondents commented that processing applications to initiate collaborations with the university partner and to obtain grants from government bodies was a lengthy process. These issues were perceived as a significant deterrent to companies considering initiating UIC.

- **Partner selection**

The importance of partner selection prior to any collaboration is becoming more prominent in the reported literature (Brouthers et al., 1995, Kale and Zollo, 2006, Holmberg and Cummings, 2009, Porter and Baker, 2005, Bierly III and Gallagher, 2007). However, this was not a prominent factor in the findings from this investigation. The interview findings were not consistent with literature because technological developments, changing demands and competition cause organisations to 'jump into partnership' in order to be able to produce products faster. Further, it is likely that the more limited availability of research capabilities and the geographic issues in Malaysia make the pool of potential partners for a given technology smaller than in more developed nations where the bulk of the literature is generated.

- **Negotiation and reconciliation of opinions and interests**

Respondents reported that divergence in opinions and interest are the main hurdles in collaborative establishment and management. Being able to ensure both parties' interests are met requires extensive negotiation. Based on their experience an industry respondent commented that it is a challenge to manage academicians'.

- **Clearly defined roles and responsibilities**

The negotiation process should also clarify the roles and responsibilities of each partner and the team members involved. Both U1 and I1 respondents, who had a joint history of collaboration, felt that by doing so, many problems were circumvented as described:

> *…When the project initiated, we circumvented a lot of problems for instance in the signing of the MOU and in clarifying the roles of the university and the company"* (U1)

> *"There* are issues but with clear roles of responsibilities and obligations, the problem can be solved. These are clearly stated in the MOU*" (I1)*

- **Frequent and open communication channels**

This was considered one of the challenges yet it is also the key to managing the collaboration according to the industry respondent. Adopting a flexible and open communication channel within the team members and between the two partners establishes trust and confidence between partners. I1 also agreed communication between partners needs to be very personal in order to understand each other's needs and issues. The practice of this approach is heavily emphasised by all respondents, all agreeing with the importance of communication as the key to relationship management.

- **Simpler procedures**

Lengthy application forms, processing procedures and the approval process seem to be also one of the hurdles preventing industrial partners from collaborating with universities.

5.3.4 Project management (PROJ-MG)

The following questions aimed to answer research objective no. 2 (see section 1.2).

What key elements are needed in the planning process?

No indication of the use of a formalised PMM was given by the interview respondents. Only one industry respondent agreed that there was a need for a methodology as the key element in UIC planning. However, the remaining respondents did identify the need for several elements commonly associated with project planning and PMM. These include:

- Clearly defined project objectives or problem
- Well scheduled and planned timeframe
- Adequate amount of financial support for investment, production, technical
- Selecting the right partner and right expert manpower with sufficient capability to sustain the partnership
- Clearly defined roles and responsibilities amongst project team
- Well planned, leveraged and minimise resource utilisation
- Adoption of PMM

These observations together with the advantages associated with the use of a PMM identified in section 2.2 indicate a general lack of understanding of the benefits a PMM can bring to the collaboration. In addition, though the return on investment from the industry point of view is considered an important element in the project planning in a UIC, it was not identified by the respondents.

What structures are created/adopted to coordinate the collaboration?

The majority of industry respondents indicated their preferences not to adopt any specific approach or structure in the management of collaborative projects. It was also evident that the industry respondents were more responsive to coordinating collaborative tasks via deadlines and milestones. Furthermore, the industry partners viewed regular scheduled meetings and discussions as sufficient vehicles to coordinate the collaboration.

In comparison, the university partners indicated a more practical approach to the coordination of their collaboration through periodic documentation reporting, regular meetings and email discussions to maintain open communication between partners. These approaches appeared to be appropriate, particularly in such a dynamic project environment. Additionally, university respondents are also dependent on their university research management centre for collating documents and monitoring project progress. Based on the comments from university respondents', they are required to submit reports to the university research management centre either on monthly, half a year or yearly reports to facilitate performance management.

> *"No strategy in particular. For us, the most important is capturing information and retaining it.* Furthermore the way we monitor our project by capturing constant updates on the information for instance anything that happens in the lab. By doing so we ensure the project is running smoothly. We capture the information through daily meetings, weekly meeting and at present weekly reports in replace of the weekly meeting. *However the important thing isn't the report but the follow up on* even trivial issues in action. Documentations without follow-up are useless*" (*I1).

Who are the key people involved in the project management? Is there a project manager from each partner? If yes, how has it benefited the collaboration? If not, why?

For this question, respondents identified several individuals whom are directly involved in the collaboration. These can be classified as researchers, project leader, programme leader, industrial researchers, project sponsor, doctoral students, R&D department and senior management.

In practice, the appointment of a project manager in the UIC projects was not considered to be as an important success factor as the available literature would suggest (Groman, 2006, Matthew and Norgaard, 1984, Gerardi and Wolff, 2008) (see section 3.3.2). As such universities must commit to training an academic project manager to facilitate the collaborative partnership so to have less dependency on the industry partner (Carboni, 1992). With the appointment of an academic project manager, he/she will tailor to the needs and style of the organisation (or university) culture (Cooke-Davies and Arzymanow, 2003). With that expectation, the academic project manager is required to be flexible, adoptable, a quick learner and a good communicator (Barber, 2004) while embracing the essential skills of an effective project manager (Schwalbe, 2002).

However, findings from respondents indicated there were no physical project managers in practice rather the role is generally taken by the project leader (from university) or project sponsor (from the industry). Commonly these accidental project managers are not given any project management training. In the view of the respondents, this arrangement does not seem to affect the performance of the collaboration as stated by an industry respondent (I1). It was believed that because both partners' roles were clearly defined this would compensate the absence of formal project management training. However, as the respondents indicated several issues and barriers encountered in the collaboration (see section 5.3.3) which basic project management training and documentation could have helped a well trained project manager resolve at least in theory, enhancing the effectiveness of the collaboration.

> *"In this project, we only have one project manager who is U1. He is the one who oversees the* technical aspects. As for me, I am the project owner who manages the relationship, cash flow, and resources. In term of the contract*, both of us tried to manage it with combine effort"* (I1)

Does your UIC adopt a PMM to manage the collaboration?

After an explanation of what constitutes a PMM, all respondents agreed that no formal PMM was used to manage UIC projects. The reasons identified differed between respondents. University respondents were in general, satisfied with their present university management structure in coordinating and monitoring collaboration project. University respondents also highlighted that their industry partner prefers coordination to be carried out by respective institutions in their own management style and practice.

It is evident that industry respondents preferred to retain a degree of flexibility in the management of the collaboration so as not to overburden their own team. Interestingly, one industry respondent strongly expressed the desire to exercise a PMM in UIC projects, while another expressed his view below:

> *"There was no well defined way or methodology for us. Methodology may* be useful in general terms for projects. However project varies from one another and no one methodology fits into all project. The idea can be introduce using some aspects of project implementation methodology but not too rigid. It has to be customised depending on the relationship as there is no hard or fast rule *in managing relationship"* (I1).

If there is a PMM, what should be included in it?

It is apparent from the interview results that none of the industry or university respondents adopt or creates their own formal PMM although many elements of a

PMM are present. Responses from industry were consistent with the literature findings. The following components were suggested for inclusive in a PMM which are grouped into scalable, effective for the full range of projects (this is more a requirement than a component), partner matching, relationship management, project planning, contract management and ethical guidelines.

- **Partner matching**

This aspect has been identified as the foremost process for organisation to assure successful partnership in the literature and from the respondents but remains as one of the key obstacles in most collaborations (Holmberg and Cummings, 2009, Bierly III and Gallagher, 2007). A number of respondents agreed that for a successful collaboration it is essential to select the right partner. One university respondents commented that searching for the right partner is both subjective and intuitive. The findings indicate that presently UIC practices in Malaysia lack appropriate partner selection strategies.

- **Relationship management**

The importance of managing university-industry relationships can be established via constant communications. Respondents strongly agree that it is important to manage the soft skills side of UIC. An industry respondent states that they regularly ‘inspire each other’ as a result they are more committed in retaining their collaborative relationship. Other means of relationship management were through regular visitation from university to the organisation and vice versa. Respondents commented that regular meetings facilitate transparency, creating an environment of trust and openness which avoids misunderstandings and distrust among collaborators.

- **Project planning**

This component was highlighted by the industry respondents; resource planning was seen as an important component to ensure continuity in the collaboration. Manpower and infrastructure forms the two major resources that facilitates R&D collaborations in this work. Respondents also stressed that there must be adequate and permanent supply of manpower to ensure completion of tasks. Another critical element in every project is the issue of financial support. Industry respondents all stressed that without finance ‘there is no project to pursue’. As collaboration comprises different stakeholders, there is a need to monitor and control the spending of funds in a more transparent way.

- **Contract management**

The majority of respondents signed a contractual agreement between their partners as a formal procedure to formalise the collaboration. Respondents conformed that the agreement helps to establish and define the relationship. Results indicated that the respondents sign an agreement prior to the production of the research proposal. Only one university respondent described their collaboration as open ended without contract or commercial interest. However, despite the importance of a legal relationship binding both partners; the industry respondents indicated that they have contested the aspect of contractual agreement as merely written papers which may be easily terminated unless there is an appreciation and commitment in the collaborative relationship. This conflict with the literature findings in section 3.3.1 and results in section 5.3.1 that this is possibly a reflection of the importance placed on relationships over legal agreements in the Malaysian UIC project environment.

- **Ethical guidelines**

A university respondent reported the PMM should also constitute ethical guidance for university researchers. It was suggested that guidelines should be provided by the university administrators and should include elements such as selection of project types, researcher ethics, the conduct of work and financial management. It should however, be noted that personnel in university research management centres are not typically experts in such areas and thus the PMM should provide guidance for these actors to structure such advisories. University respondents stated that such guidelines will benefits university researchers in many ways as expressed in the statement below;

> *“Guidelines related to ethics* are needed to safeguard the reputation and image of the university for instance not to procure materials from a relative for the project. Although it may be customary in Malaysia but I do think it is best not to conduct such act. Other ethics such as conflict of interest in relation of money, manpower recruitment could be included in the guideline for university *researchers”* (U1).

How is the progress of the collaboration monitored and controlled?

Respondents agreed that in order to effectively monitor and control progress, it is important to foster open and transparent communication channels between partners. By doing so, they are kept informed of everything that takes place within the collaboration. All respondents' perceived communication should be carried out with clarity, completeness and in a concise manner in order to maintain and enhance relationships, trust and confidence between the partners.

Approximately, half of the respondents commented that their practices in producing reports such as progress report, weekly reports or even daily reports helps to keep track of the project. Others produce milestone reports, technical reports and financial reports. The majority produces reports using milestones reporting in order to receive the next payment from funding body. Although documentation are generated mainly for archiving, in reality there is less of a requirement to produce lengthy reports between partners as indicated in the literature (see sections 2.4 and 5.3.4). For instance, an industry respondent commented that it is unnecessary to produce lengthy reports as long as the project sponsor/owner is aware of project progress through regular emailing, online discussion and meetings.

5.3.5 Best practice (BT-PRAC)

What are the best practices/success elements to better manage the collaboration?

- **Create mutual understanding and objectives**

The interview findings revealed that the foremost salient elements that build the foundation for a successful and sustainable UIC is mutuality of understanding on their shared mission, goals and objectives between partners. The literature findings in section 3.2.4 support the above assertion (Dyer et al., 2006, Rohrbeck and Arnold, 2006). Respondents also indicated that in order for one partners to meet the expectations of the other, the mutual interest needs to be realistic.

- **Autonomy and flexibility in UIC management**

Despite sharing mutual goals, creating a successful and sustainable UIC needs to be supported by a flexible environment to allow collaborators to flourish (Yee et al., 2009a). From the findings, although university researchers are interested in R&D, many are bound by their other work commitments such as teaching, marking and administration. Another respondent suggested the need for flexibility in organising the researcher's role. Hence there should be a clear demarcation between academic and commercial activities to minimise conflict of interest. In the recent 10th Malaysian Plan (10MP) report, more public university which have achieved certain preconditions and level of readiness would be granted autonomy (Bernama, 2010). With such autonomy, universities have the freedom to vet the merits of R&D proposals so they can make strategic decisions to upgrade technology that may lead to novel industrial products (Gomez, 2009).

Respondents suggested university researchers should be given a degree of autonomy in all aspects of the collaboration. This comment was reflected in recent comments by the Prime Minister of Malaysia (Gomez, 2009) to give way for more autonomous decisions and freedom of the university in the management of UIC. A managing director of a university spin off commented that UIC in Malaysia is still at its learning stage:

> *"Many universities are still reviewing and lining the processes and procedures in addition to* governmental policies issues, mainly because public universities belonging to the government and *there are rules to be followed which some are not destine for UIC" (E2)*

- **Constant and transparent communication**

Instigating regular communications allows actors to be kept informed of everything that are taking place within the collaboration. All respondents agreed that communication needs to be managed with clarity, completeness and in a concise manner as this enhances the relationship, trust and confidence.

5.3.6 Future views (FUT)

The following questions were asked to gather views on the present situation of UIC in Malaysia. All respondents were very attentive and critical of this area. A number of suggestions were highlighted as a mean to sustain effective UIC linkages in Malaysia. The factors which emerged from the interview were grouped into several themes.

What are the sustainability criteria for UIC growth in Malaysia?

- **Spin-off from university**

Respondents from the industry suggested that for the benefit of the university and the researchers, either an internal or external spin-off should be one of the key goals to sustain UICs in Malaysia. Interview findings found that spin-off as a result of UIC is still at its infancy stage.

- **Incentives and structure**

The majority of researchers highlighted that there is a need to change the incentive structure for university researchers. These include:

- Recruitment of senior and experienced industrial professionals to university. This helps the university to create better connection and exposure to industry needs through the leadership of industrial professionals.
- To regulate placement or internships for university researchers to local industry on regular basis for example during sabbatical leave. This helps to create more consensus in understanding and connectivity with industry partners needs and wants.
- Support on the set up of an industry collaborative advisory board within the university in structuring curriculum that fits to industry requirements.
- Restructuring of university incentive structures emphasising researcher’s contribution in developing innovative capabilities for industry besides publication works.

- **Re–orienting research path to meet industry needs**

According to the respondents, weak collaborations are due to lack of visitation and networking and consequently deliver little commercial value. One reason is university researchers’ are too comfortable in the university environment. Several suggestions were provided by respondents to reorient researchers to meet industries needs, these include:

- Increase the level of correlation between university research by converging towards industrial and commercialisation needs

- Setting up of a coordinating mechanism/unit to assist university in reorienting their research towards industrial needs and subsequently expose graduates to some level of industrial experience.

- **Stronger government policy**

Many universities and industry respondents believe that due to loose government regulations; foreign research companies and university are sought after for consultation and expertise. This issue had created some dissatisfaction in a number of respondents. In response, they suggested that there should be enforcement regulating government linked companies (GLC) to procure services or expertise from local universities. Others suggestions to strengthen UIC linkages, included ensuring clarity in governing UIC policy, compelling universities to establish stronger links with industry and reorienting key performance indicators (KPIs) in universities to be more heavily weighted towards industrial cooperative research.

- **Centralised electronic databases**

Industry and university respondents both recommended the creation of a centralised electronic database of university researchers and industrial partners to facilitate the selection of potential collaborators. Analysis of the existing systems in place revealed that many universities do not have or are in the midst of compiling such databases and none are centralised, easily searchable or comprehensive according to U5 and I2. This highlights the need for the government to create such databases to provide efficiency in identifying potential university and industry collaborators.

University researchers should be equipped with industrial experience. What is your view?

This notion highlights the need for university researchers to be more exposed to industry so that they comprehend their needs. Industry respondents suggested a need for university researchers to be better equipped with industrial experiences in order to facilitate UIC. As commented by respondents, university researchers whom are exposed to industry are seen as more effective collaborators because they are equipped to understand what business needs particularly related to the commercial aspects. One respondent suggested a potential solution was for the university researchers to undergo attachments with companies.

Amongst all respondents, only one university respondent held the view that the universities role is only to innovate while the industry role is to commercialise. It was obvious throughout this particular interview that this partnership was not as effective as it could have been. In comparison, majority of respondents positively agreed that university researchers equipped with industrial exposure have a deeper understanding of industries needs.

Do you view project management skills contribute to collaboration success? Why?
Positive reaction was noted to this question. The majority agreed that project management skill contribute to the management of project scope, schedule, cost and even contractual agreements. Furthermore, project management aided in monitoring progress and mitigating issues. These observations are consistent with the literature findings in sections 2.4 and 3.3.2.

A university and industry respondents both commented that a project manager needs to be both a people manager and technical expert to contribute his/her interpersonal and organisational skills in managing and handling various people in the research environment. In order to carry out the tasks, a university respondent highlighted the need to design an appropriate methodology which should be acceptable to both university and industry as the key to managing UIC projects.

5.4 Questionnaire Survey

Upon completion of the interview process, questionnaire surveys were distributed to the same group of respondents (see Table 5.1) using two approaches; self-administered immediately after the interview session or by postage in a self-stamped envelope. Follow up reminder were carried out via emails and telephone calls a week after distribution of the questionnaire survey to increase the response rate, 11 respondents returned with full complete answers.

The questionnaire survey consisted of three sections based on the elicited literature findings discussed in chapter 2 and section 3.2. All questions were designed to the Likert scale using ‘1’ strongly disagree to ‘5’ strongly agree. In Section A, respondents were asked to indicate their extent of agreement with a list of barriers identified from the literature in section 3.2.3. Section B aimed to elicit views on the best practices that should be adopted based on the literature discussed in section 3.2.4. Finally Section C aimed to gather respondents' views on the extracted requirements from the literature (see chapter 2) to be placed in the proposed PMM for UIC projects. The questionnaire survey used for this research is enclosed in Appendix 7.

5.4.1 Anticipated barriers and best practices in UIC

The purpose of this section in the questionnaire survey is to analyse the various opinion on the perceived barriers and best practices of UIC. Respondents were asked to indicate the extent of agreement with the barriers and best practices identified from literature in sections 3.2.3 and 3.2.4. List of challenges and best practices are each categorised into four categories (see Table 3.4 and Table 3.5). The total response rate is shown in Table 5.3 and Table 5.4. The list of anticipated challenges and best practices was grouped under four factors; collective, project management, cultural and environment.

Table 5.3 Frequency of response for Section A

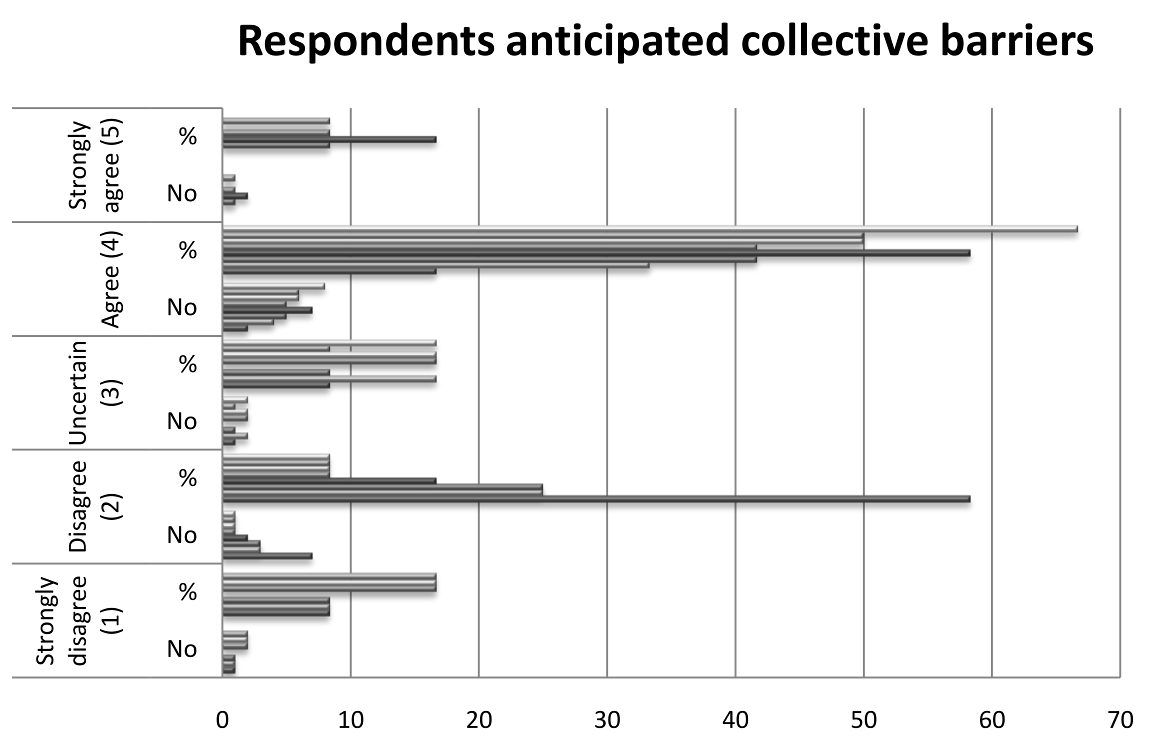
Questions	Strongly disagree (1)		Disagree (2)		Uncertain (3)		Agree (4)		Strongly agree (5)	
	No	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
A1.1	1	8.3	7	58.3	1	8.3	2	16.7		
A1.2	1	8.3	3	25.0	2	16.7	4	33.3		
A1.3	1	8.3	3	25.0	1	8.3	5	41.7	1	8.3
A1.4			2	16.7			7	58.3	2	16.7
A1.5	2	16.7	1	8.3	2	16.7	5	41.7	1	8.3
A1.6	2	16.7	1	8.3	2	16.7	6	50.0		
A1.7	2	16.7	1	8.3	1	8.3	6	50.0	1	8.3
A1.8			1	8.3	2	16.7	8	66.7		
A2.1	1	8.3	2	16.7	2	16.7	6	50.0		
A2.2			1	8.3	2	16.7	8	66.7		
A2.3			2	16.7	2	16.7	7	58.3		
A2.4			1	8.3	2	16.7	8	66.7		
A2.5			2	16.7			9	75.0		
A2.6			1	8.3	1	8.3	8	66.7	1	8.3
A2.7					2	16.7	9	75.0		
A2.8			3	25.0	1	8.3	7	58.3		
A2.9			2	16.7	5	41.7	4	33.3		
A2.10			1	8.3	4	33.3	6	50.0		
A2.11			1	8.3	3	25.0	7	58.3		
A3.1	1	8.3	3	25.0	2	16.7	5	41.7		
A3.2	1	8.3			3	25.0	7	58.3		
A3.3	1	8.3	1	8.3	4	33.3	5	41.7		
A4.1					1	8.3	10	83.3		
A4.2	1	8.3	1	8.3	3	25.0	6	50.0		
A4.3	1	8.3	1	8.3	1	8.3	7	58.3	1	8.3
A4.4	1	8.3	1	8.3	3	25.0	6	50.0		
A4.5	1	8.3	2	16.7	3	25.0	3	25.0	2	16.7
A4.6	1	8.3			3	25.0	6	50.0	1	8.3
A4.7			2	16.7	3	25.0	6	50.0		
A4.8	1	8.3	1	8.3	2	16.7	5	41.7	2	16.7

Table 5.4 Frequency of response for Section B

Questions	**Strongly disagree (1)**		**Disagree (2)**		**Uncertain (3)**		**Agree (4)**		**Strongly agree (5)**	
	No	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
B1.1					1	8.3	6	50.0	5	41.7
B1.2					1	8.3	7	58.3	4	33.3
B1.3							8	66.7	4	33.3
B1.4							7	58.3	5	41.7
B1.5					2	16.7	7	58.3	3	25.0
B2.1							8	66.7	4	33.3
B2.2							6	50.0	6	50.0
B2.3							8	66.7	4	33.3
B2.4					2	16.7	6	50.0	4	33.3
B2.5							8	66.7	4	33.3
B2.6					1	8.3	8	66.7	3	25.0
B2.7			1	8.3	1	8.3	8	66.7	2	16.7
B2.8			2	16.7			9	75.0	1	8.3
B2.9					3	25.0	8	66.7	1	8.3
B2.10	1	8.3	1	8.3	2	16.7	7	58.3	1	8.3
B3.1			2	16.7	2	16.7	4	33.3	4	33.3
B3.2							6	50.0	6	50.0
B3.3					1	8.3	7	58.3	4	33.3
B3.4					1	8.3	8	66.7	3	25.0
B4.1					1	8.3	6	50.0	5	41.7
B4.2			1	8.3	1	8.3	4	33.3	6	50.0
B4.3			1	8.3	2	16.7	5	41.7	4	33.3

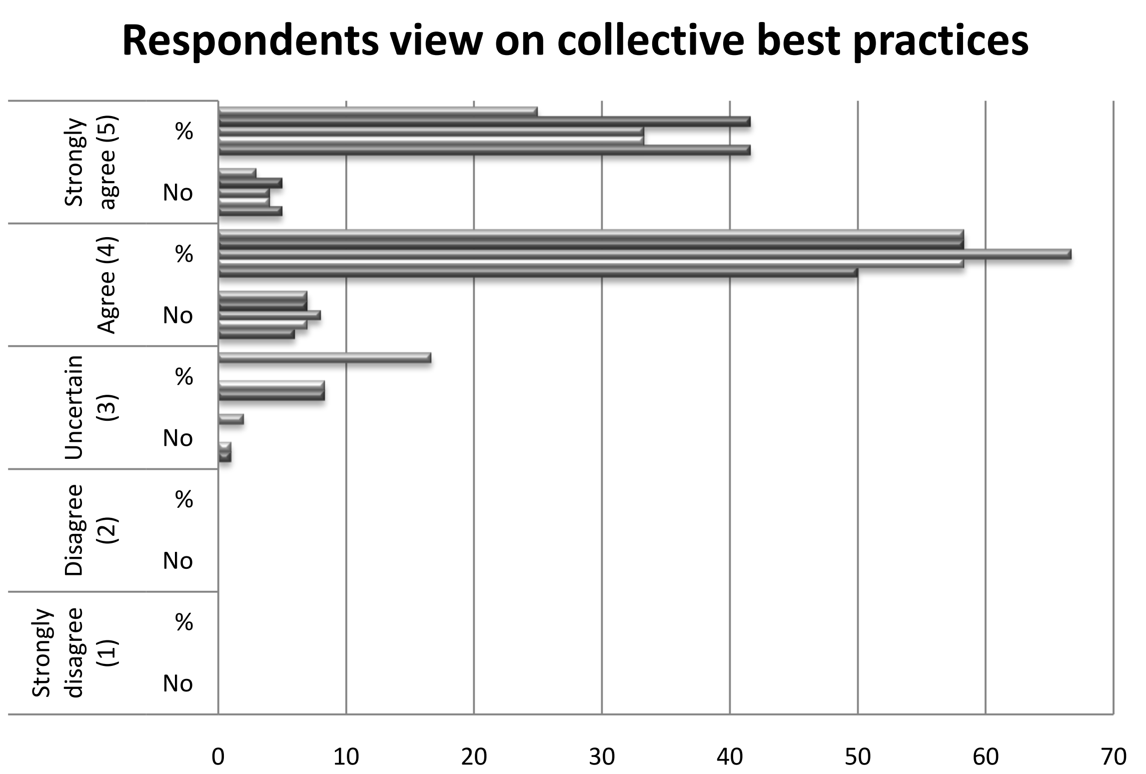
Figure 5.2 displayed the number of respondents and percentage of responses on the collective barriers identified from the literature finding in section 3.2.3. Most responses in this category generally fall in the 'agree' and 'disagree' classification. In Figure 5.2**,** most respondents (58%) disagreed that fear factor should be considered a critical barrier, while 67% identified differing interest/objectives as the key factor. Half of the respondents (50%) identified that poor partner selection was a contributing barrier to UIC success. In addition, a majority of respondents (75%) strongly agreed that the issue of IPR ownership is a barrier. 50% of respondents agreed that publications results in a loss of confidentiality and privacy. Alternatively, Figure 5.3 show a list of best practices where the majority of respondents rated either agree or strongly agree in each of the categories indicating strong agreement with the literature findings in section 3.2.4. The majority responded positively to the list of

best practices that are recommended for ensuring an effective and sustainable partnership in UIC.



	Strongly disagree (1)		Disagree (2)		Uncertain (3)		Agree (4)		Strongly agree (5)	
	No	%	No	%	No	%	No	%	No	%
A1.8			1	8.3	2	16.7	8	66.7		
A1.7	2	16.7	1	8.3	1	8.3	6	50.0	1	8.3
A1.6	2	16.7	1	8.3	2	16.7	6	50.0		
A1.5	2	16.7	1	8.3	2	16.7	5	41.7	1	8.3
A1.4			2	16.7			7	58.3	2	16.7
A1.3	1	8.3	3	25.0	1	8.3	5	41.7	1	8.3
A1.2	1	8.3	3	25.0	2	16.7	4	33.3		
A1.1	1	8.3	7	58.3	1	8.3	2	16.7		

Figure 5.2 Survey results of respondents anticipated collective barriers



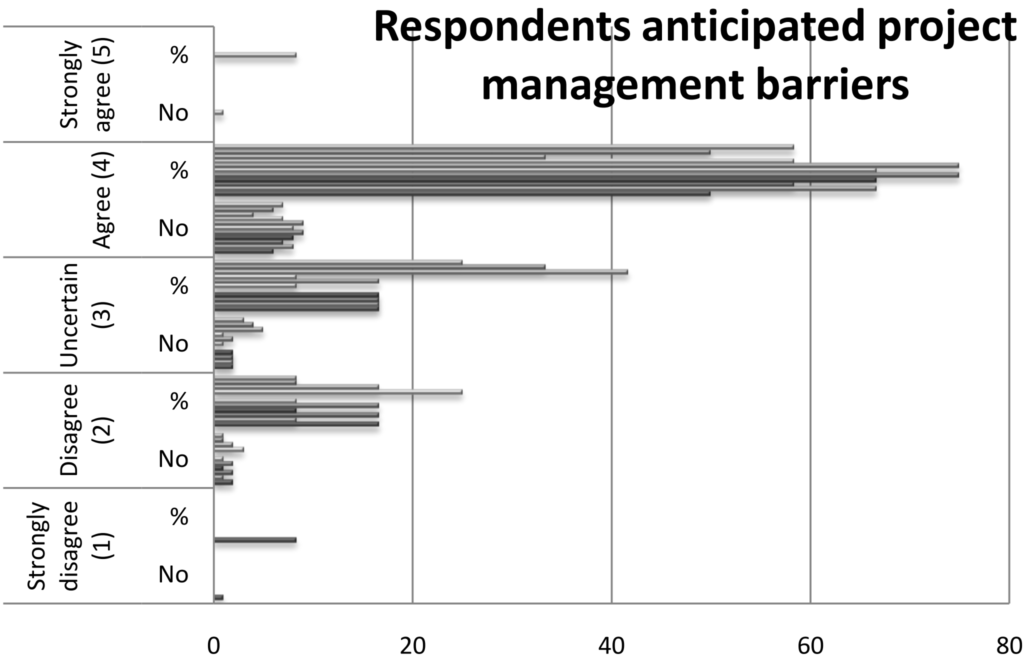
	Strongly disagree (1)		Disagree (2)		Uncertain (3)		Agree (4)		Strongly agree (5)	
	No	%	No	%	No	%	No	%	No	%
B1.5					2	16.7	7	58.3	3	25.0
B1.4							7	58.3	5	41.7
B1.3							8	66.7	4	33.3
B1.2					1	8.3	7	58.3	4	33.3
B1.1					1	8.3	6	50.0	5	41.7

Figure 5.3 Survey results of respondents view of collective best practices

Figure 5.4 contains a list of 11 factors identified as project management challenges to the success of UIC partnerships. Project manager selection was considered by 75% of respondents to be an important challenge to successful collaboration. This is in agreement with the literature identified and discussed in section 3.2.3. Another barrier stressed by respondents was related to the roles and responsibilities within the project team (67%). The observation indicates that there is a need to include roles and responsibility assignment in the proposed PMM. In the semi-structured interview findings, none of the respondents interviewed adopted specific project management processes, tools or templates for use in their projects.

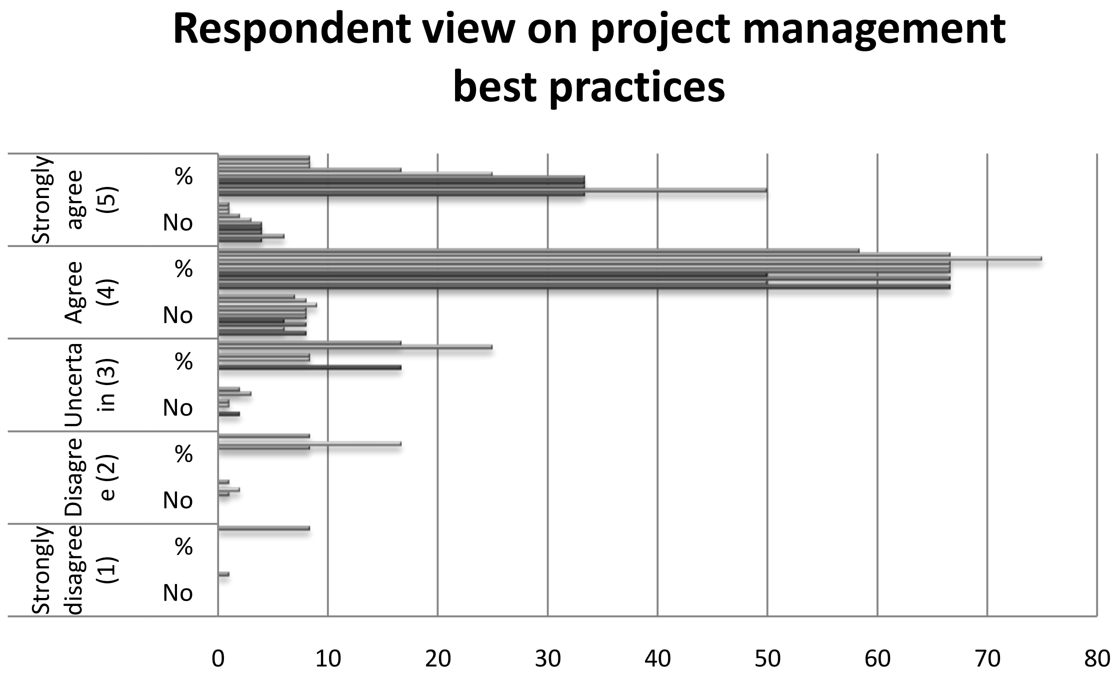
This was also supported by the results obtained from the questionnaire survey. Interestingly 42% of respondents identified that poor project management processes and use of tools and templates which are issues in their current projects is something which an appropriate PMM could help elevate.

Figure 5.5 list the best practices for project management in UIC partnership. Overall response rate is positive and encouraging that the given lists are of strong importance in the opinion of the respondents. Interestingly each respondent shared their own view on the use of PMM for managing UIC projects. This is indeed a notable factor that needs to be highlighted in order to better understand the reason from the respondents' perception. The reasons that may arise are respondent unawareness and knowledge on the effectiveness and usefulness of PMM which would increase the effectiveness of project management and likelihood of project success. Secondly their ignorance on the use of PMM as they perceived would increase the administrative workload. From the results, the proposed PMM aimed to ascertain a level of simplicity with the use of templates, checklist to minimise the burden of the project manager and team.



	Strongly disagree (1)		Disagree (2)		Uncertain (3)		Agree (4)		Strongly agree (5)	
	No	%	No	%	No	%	No	%	No	%
A2.11			1	8.3	3	25.0	7	58.3		
A2.10			1	8.3	4	33.3	6	50.0		
A2.9			2	16.7	5	41.7	4	33.3		
A2.8			3	25.0	1	8.3	7	58.3		
A2.7					2	16.7	9	75.0		
A2.6			1	8.3	1	8.3	8	66.7	1	8.3
A2.5			2	16.7			9	75.0		
A2.4			1	8.3	2	16.7	8	66.7		
A2.3			2	16.7	2	16.7	7	58.3		
A2.2			1	8.3	2	16.7	8	66.7		
A2.1	1	8.3	2	16.7	2	16.7	6	50.0		

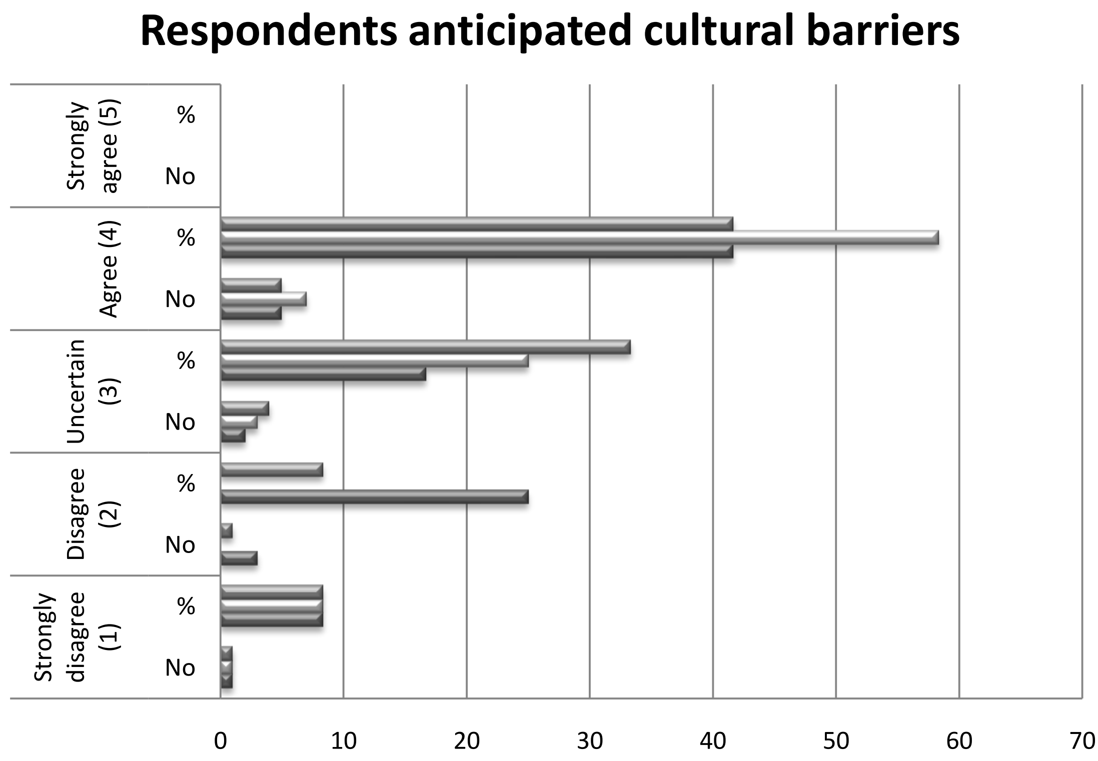
Figure 5.4 Survey results of respondents anticipated project management barriers



	Strongly disagree (1)		Disagree (2)		Uncertain (3)		Agree (4)		Strongly agree (5)	
	No	%	No	%	No	%	No	%	No	%
B2.10	1	8.3	1	8.3	2	16.7	7	58.3	1	8.3
B2.9					3	25.0	8	66.7	1	8.3
B2.8			2	16.7			9	75.0	1	8.3
B2.7			1	8.3	1	8.3	8	66.7	2	16.7
B2.6					1	8.3	8	66.7	3	25.0
B2.5							8	66.7	4	33.3
B2.4					2	16.7	6	50.0	4	33.3
B2.3							8	66.7	4	33.3
B2.2							6	50.0	6	50.0
B2.1							8	66.7	4	33.3

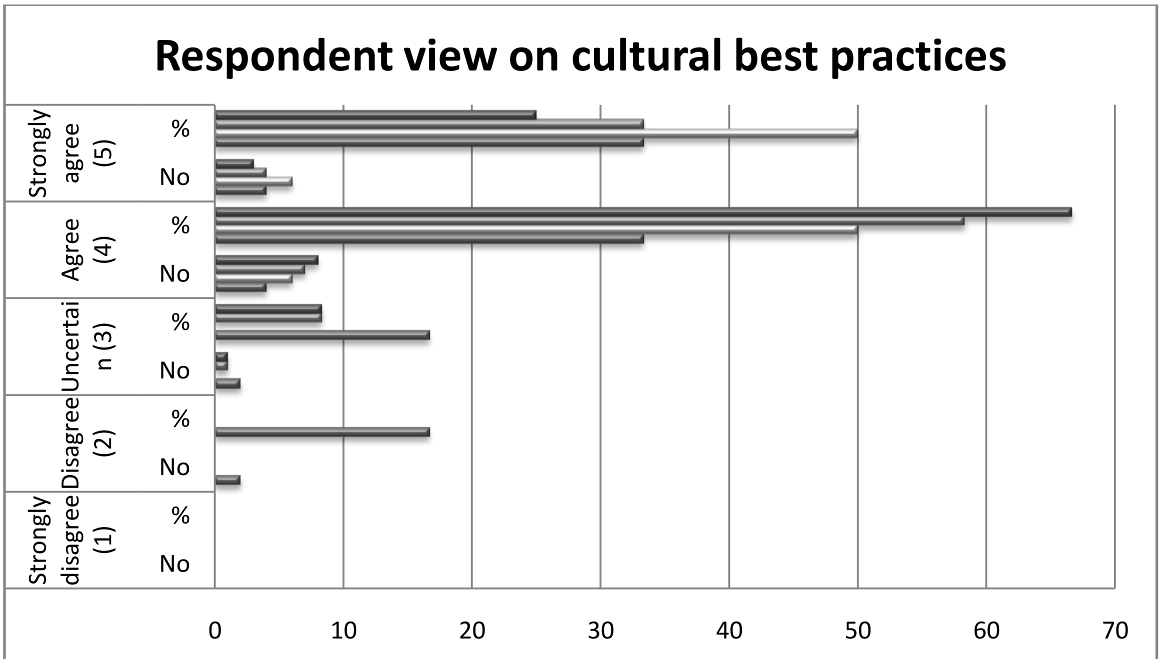
Figure 5.5 Survey results of respondents view of project management best practices

The cultural barriers relating to the differing work environment of both partners (58%) is shown in Figure 5.6. Under cultural aspects, a number of respondents view it as an important area to understand in order to establish successful partnerships. Positively the results in Figure 5.6 shows that the majority of respondents are presently in a trust based relationship, hence do not foresee the lack of honesty and openness as a barrier in their collaboration. A total of 42% respondents rated that one of the key obstacles in UIC is the variation in incentives and reward structure of institution which is due to unrecognised value of industrial contributions in academic performance appraisal. In addition, interviewed respondents commented that university academician merely adhere to governed key performance index (KPI) such as amount of publications and registered patents. Thus, this finding identified there is a need for restructuring of rewards in the university structure to encourage higher industrial involvement. A contrary view on cultural best practices in Figure 5.7 shows a very strong agreement on the listed practices such as compromise during negotiation process; establishment of trust, honesty; mutual respect and understanding. For this category, no significant differences were noted as compared to literature findings.



	Strongly disagree (1)		Disagree (2)		Uncertain (3)		Agree (4)		Strongly agree (5)	
	No	%	No	%	No	%	No	%	No	%
A3.3	1	8.3	1	8.3	4	33.3	5	41.7		
A3.2	1	8.3			3	25.0	7	58.3		
A3.1	1	8.3	3	25.0	2	16.7	5	41.7		

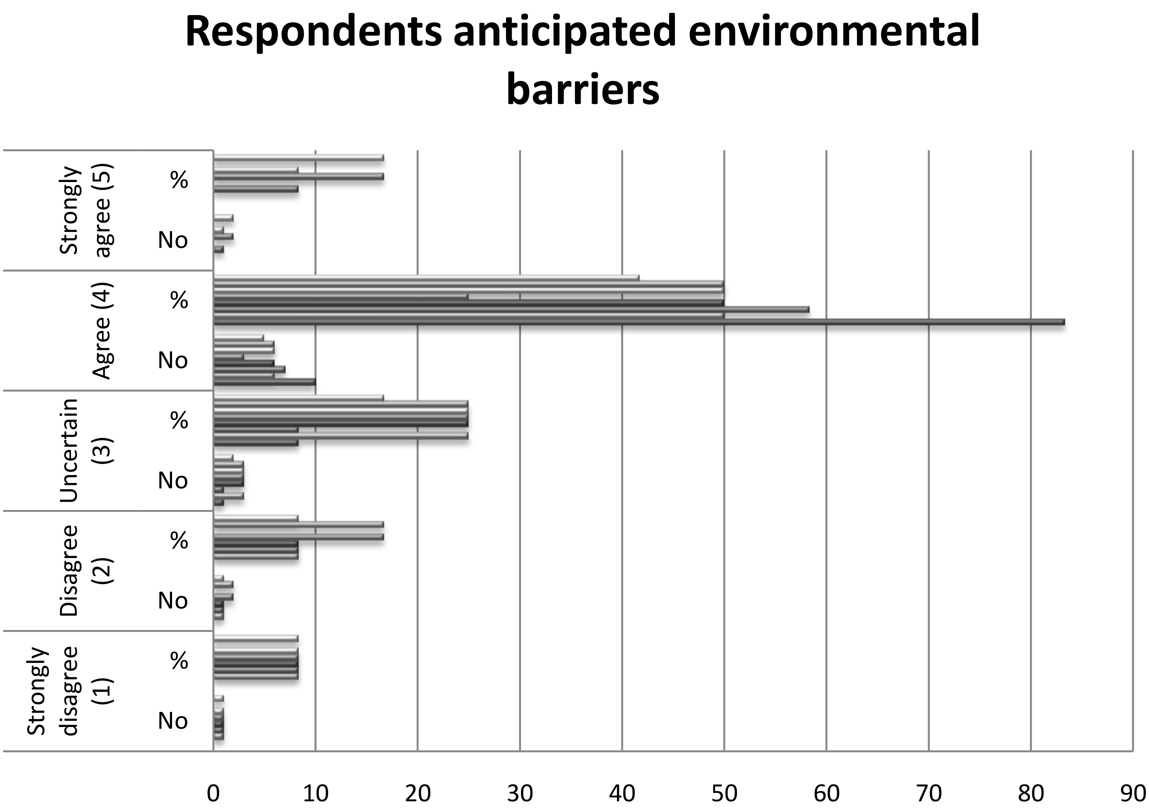
Figure 5.6 Survey results of respondents anticipated cultural barriers



	Strongly disagree (1)		Disagree (2)		Uncertain (3)		Agree (4)		Strongly agree (5)	
	No	%	No	%	No	%	No	%	No	%
B3.4					1	8.3	8	66.7	3	25.0
B3.3					1	8.3	7	58.3	4	33.3
B3.2							6	50.0	6	50.0
B3.1			2	16.7	2	16.7	4	33.3	4	33.3

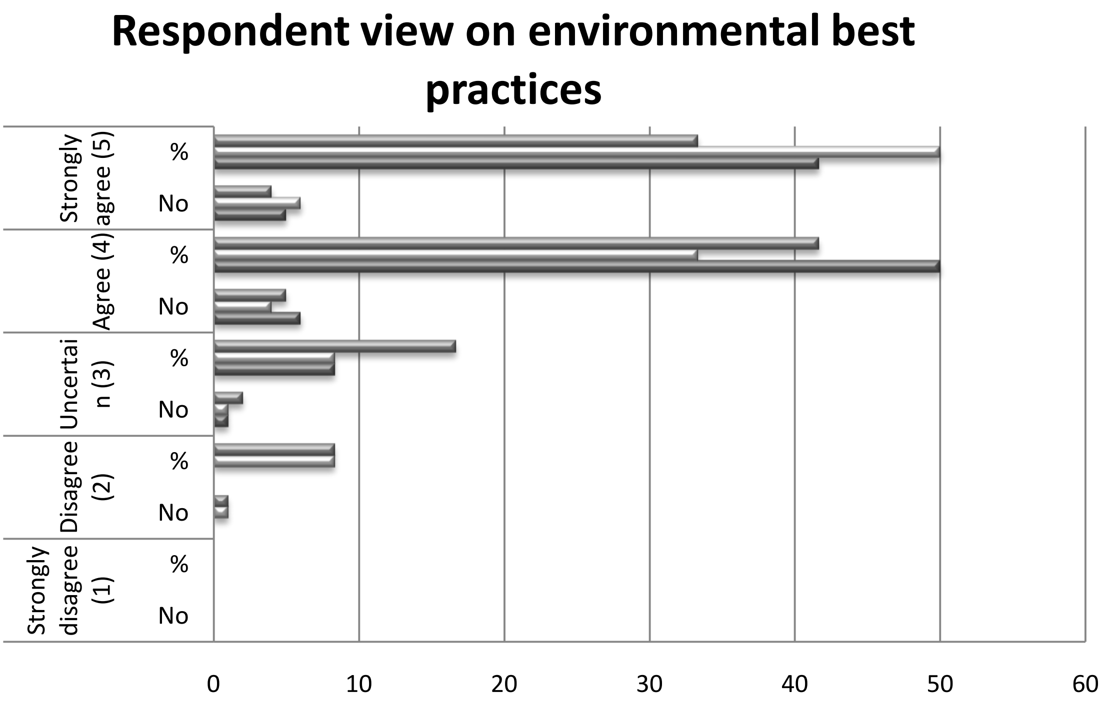
Figure 5.7 Survey results of respondents view of cultural best practices

Figure 5.8 shows the results obtained on questions related to the project environment. Half of the respondents (50%) agreed that many challenges are associated with various factors such as competitive forces, changes in government policies and regulations, industrial specific R&D interest and partner’s continuity for sustainability. Further, 83% of respondents agreed that technology and knowledge transfer are the key challenges for UIC. Finally Figure 5.9 showed that a large portion of respondents (75% - 83%) agreed with the need to enhance stature and recognition for both university and industry players in the market to promote UIC. There is also strong agreement on the need to promote research for all industries and disciplines knowing that it is a challenge to start such initiatives in the present market as shown in Figure 5.8.



	Strongly disagree (1)		Disagree (2)		Uncertain (3)		Agree (4)		Strongly agree (5)	
	No	%	No	%	No	%	No	%	No	%
A4.8	1	8.3	1	8.3	2	16.7	5	41.7	2	16.7
A4.7			2	16.7	3	25.0	6	50.0		
A4.6	1	8.3			3	25.0	6	50.0	1	8.3
A4.5	1	8.3	2	16.7	3	25.0	3	25.0	2	16.7
A4.4	1	8.3	1	8.3	3	25.0	6	50.0		
A4.3	1	8.3	1	8.3	1	8.3	7	58.3	1	8.3
A4.2	1	8.3	1	8.3	3	25.0	6	50.0		
A4.1					1	8.3	10	83.3		

Figure 5.8 Survey results of respondents anticipated environmental barriers



	Strongly disagree (1)		Disagree (2)		Uncertain (3)		Agree (4)		Strongly agree (5)	
	No	%	No	%	No	%	No	%	No	%
B4.3			1	8.3	2	16.7	5	41.7	4	33.3
B4.2			1	8.3	1	8.3	4	33.3	6	50.0
B4.1					1	8.3	6	50.0	5	41.7

Figure 5.9 Survey results of respondents view of environmental best practices

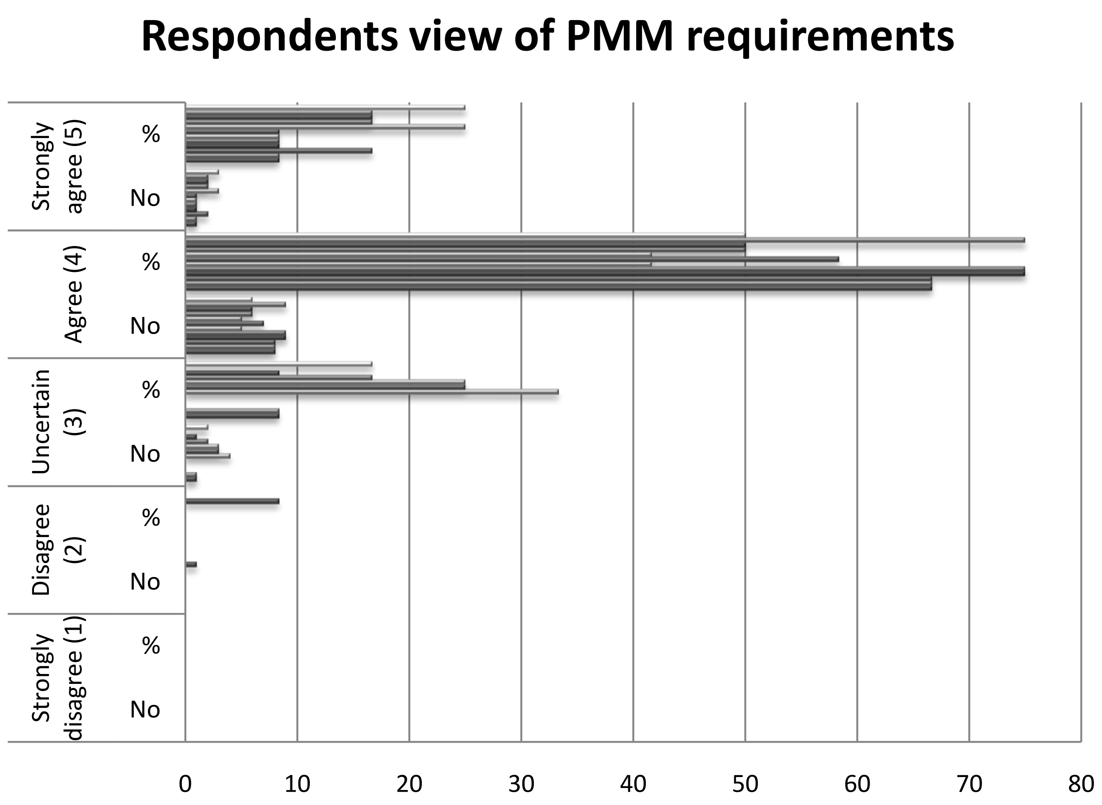
5.4.2 Requirements for university-industry collaborative PMM

One of the key objectives of this research is to identify a list of requirements that should be placed on a PMM suitable for use in UIC. This section aims to obtain the view of respondents on the requirements placed on a PMM. Table 5.5 indicates that the majority of respondents were in agreement with the best practices compiled from the literature.

Table 5.5 Frequency of response for Section C

Questions	**Strongly disagree (1)**		**Disagree (2)**		**Uncertain (3)**		**Agree (4)**		**Strongly agree (5)**	
	No	%	No	%	No	%	No	%	No	%
C1					1	8.3	8	66.7	1	8.3
C2					1	8.3	8	66.7	1	8.3
C3							8	66.7	2	16.7
C4							9	75.0	1	8.3
C5							9	75.0	1	8.3
C6					4	33.3	5	41.7	1	8.3
C7					3	25.0	7	58.3	1	8.3
C8					3	25.0	5	41.7	3	25.0
C9					2	16.7	6	50.0	2	16.7
C10			1	8.3	1	8.3	6	50.0	2	16.7
C11							9	75.0	2	16.7
C12					2	16.7	6	50.0	3	25.0

Only one respondent disagreed with the adoption of PMM in their project work flow see Figure 5.10. In summary, Figure 5.10 shows alignment between the views of the respondents and the literature findings discussed in chapter 2. The results obtained substantiate that the requirements placed on a PMM in a Malaysian R&D project environment are in agreement with the findings from the international body of literature.



	Strongly disagree (1)		Disagree (2)		Uncertain (3)		Agree (4)		Strongly agree (5)	
	No	%	No	%	No	%	No	%	No	%
C12					2	16.7	6	50.0	3	25.0
C11							9	75.0	2	16.7
C10			1	8.3	1	8.3	6	50.0	2	16.7
C9					2	16.7	6	50.0	2	16.7
C8					3	25.0	5	41.7	3	25.0
C7					3	25.0	7	58.3	1	8.3
C6					4	33.3	5	41.7	1	8.3
C5							9	75.0	1	8.3
C4							9	75.0	1	8.3
C3							8	66.7	2	16.7
C2					1	8.3	8	66.7	1	8.3
C1					1	8.3	8	66.7	1	8.3

Figure 5.10 Survey results of respondents view of PMM requirements

5.5 Chapter Summary

The results of the qualitative and quantitative approach conducted in this research were outlined in this chapter. The chapter provides the results obtained from the semi-structured interview and questionnaire survey carried out with a total of 19 respondents. In the process of data preparation and analysis, pilot interviews were conducted to assess the reliability and validity of the interview questions in relation to the research objectives. The study was conducted from the month of September to November 2009. Based on the data gathered, several themes were grouped according to the list of questions that provided a basis to refined interview question and inputs for the development of the PMM. The second section presents the results obtained from the analysis of the questionnaire survey which was based on literature findings.

The following chapter discusses the development of the PMM based on literature and results obtained.

CHAPTER 6 DEVELOPMENT OF THE PROJECT MANAGEMENT METHODOLOGY

6.1 Introduction

This chapter deals with research objective no.3, to conceptualise and develop a PMM for adoption in the Malaysian UIC research environment. This chapter will starts with a discussion on the formation of the PMM derived from the literature reviewed in chapter 2, data discussed in chapter 5 and prior works carried out in Phase 1 and Phase 2 of this project (see Figure 4.1). The subsequent sections of this chapter describe the primary evaluation of the PMM conducted using the expert review panel model. It includes descriptions of the PMM evaluation results which aimed to assess its feasibility, usability and usefulness. Evaluation feedback was used to refine, improve and finalise the PMM development for strategic use in a UIC R&D project environment.

6.2 Forming the Project Management Methodology

The foundation of the PMM is based on the work completed in Phase 2, section 4.2.2. By leveraging the literature review on the undergraduates and doctoral research environments, a PMM which aimed to facilitate undergraduate research project management was developed, implemented, evaluated and improved. The feedback obtained was then used to develop a PMM for use in doctoral research projects. A similar experimental approach was carried out to evaluate the effectiveness and usability of the PMM. The findings from the doctoral PMM were extended to lay as a foundation for the development of the PMM structure and content suitable for adoption in a UIC research environment, as shown in Figure 6.1.

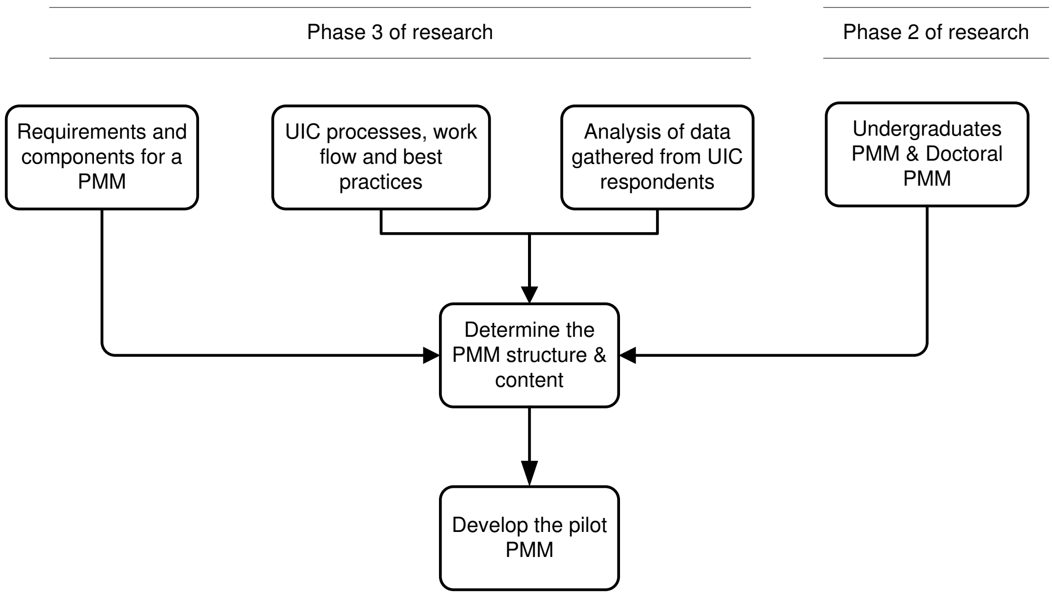


Figure 6.1 Formation of the pilot PMM

Through examining and analysing the available literature, it was evident that a PMM is an important approach to improve the probability of achieving the project goals. To date there is no single well defined generic PMM that fulfils all the requirements identified in section 2.2 and by definition no PMM can be universally applied to manage a broad range of projects across all sectors (Chemma, 2006, Cockburn, 2004, Charvat, 2003). Therefore the objective of this study is to conceptualise and develop a generic PMM which is scalable and suitable for adoption in a UIC research environment. The first step in achieving this objective is to identify the requirements to be placed on a PMM suitable for the management of UIC research projects, second to examine and understand the UIC research context, life cycle and best practices, followed by collecting data from real UIC cases in the market before finally designing and evaluating a suitable PMM.

The research begins with an investigation to define and understand the concept of PMM. Faced with this challenge, five groups of leading project management best practices were reviewed and examined as presented in section 2.4. The resulting findings identified that an ideal and generic design of a PMM should be an integration of two project management best practices; the PMBOK (PMI, 2008) and PRINCE2 (PRINCE2, 2005). Further, the design of the PMM should be dynamic and scalable to enable it to be customised to fit the needs of the organisation and the project scope. This is an important element that needs to be integrated in the design of the PMM. By examining the structure, components, strengths and limitations of each of these leading best practices, the best combination of project management approaches in managing UIC projects should be integrated (see section 2.5 and Table 2.6).

Further in chapter 2 sections 2.3, the investigated project management best practices were classified into five levels and based on the degree of specificity presented in Figure 2.1. With the classification distinguished, this study aimed to focus on designing a L3 methodology suitable for the Malaysian UIC research environment. From the literature review of the relevant methodologies, it was evident that the use of project processes varies across organisations. Though the majority of processes integrated into PMM are based on the PMI PMBOK guide (PMI, 2008), many organisations were found to customise their PMM process groups to suit their needs and the environment in which they worked. The most frequently used process groups in the PMM were initiation; planning and closing process (see Table 2.11). Another component common to the majority of PMM examined was the various types of tools, techniques and templates embedded in the methodology. Across the PMM the project proposal was one of the most frequently used toolkits, and commonly placed in the initiation process. In the planning process, risk plans, communication plans and work breakdown structures were the three toolkits most frequently used in the majority of the PMM examined. In the execution and controlling process, change request plans seem to be a favoured toolkit. Finally, in the closing process group only a few organisations utilised the lesson learned report and end project report to formalise the end of the project. The output from this investigation was a compiled list of requirements to be placed on the PMM for UIC research projects (see section 2.5.4).

Upon determining the list of requirements for the PMM development, the study followed with an investigation to understand the growth and need of UIC in the literature and specifically in the Malaysian research environment. The key elements from this investigation were the challenges anticipated in UIC (see Table 3.4), best practices to ensure successful UIC partnerships (see Table 3.5) and the process involved in UIC development (see section 3.3), all of which were integrated into the structure of the PMM. The findings from chapter 3 were used to design the questions for the semi-structured interview and questionnaire survey which were used to validate the PMM. Chapter 5 identified several themes and lists of essential element that needed to be integrated into the PMM. These included:

- To develop a shared mission statement, vision and goals for the mutual benefit of both partners
- The importance of recruiting and selecting a high calibre project manager from each partner to oversee the planning and monitoring of the project
- The need for a standard list of regulations and guidelines to be placed in the PMM
- The importance of risk management to mitigate and respond to risks
- To create a communication plan to build more effective communication channels between partners
- To facilitate separation of responsibilities between the technical and management aspects of the project to enhance productivity and delegation of work
- To contain an integrated team commitment which is well understood by every team member during the initiation process of the project to ensure accurate activity planning and team commitment is achieved
- To create a structured process of partner selection in the initiation process
- To provide references and samples of collaboration agreements extracted from Lambert collaboration agreement model for use in establishing the UIC
- To include information on sourcing external funds from funding bodies such as the government to support and aid UIC R&D costs and to integrate the management of funding bodies in the PMM e.g. with the use of communication plan etc
- To identify the arrangement of partners under different situations with different forms of cooperation (see section 3.2.1) in UIC establishment
- To establish an advisory board to oversee the structure of the collaboration; to evaluates, monitor and approve the key decisions related to project activities
- The following components suggested by respondents should also be included in the PMM; relationship management, partner matching, project planning, contract management and ethical guidelines (see section 5.3.4)
- To foster and maintain a sustainable long term relationships

- To establish a framework to measure the value of the collaboration e.g. commercial value, knowledge management, technology transfer etc

In view of the findings extracted from chapters 2, 3 and 5, a new PMM needs to be developed. The structure adopted was an extension of the PMM developed for doctoral level explained in Phase 2 (see section 4.2.2). Having identified the structure and content, a pilot PMM was developed and sent for expert evaluation. The PMM structure and contents are discussed in the section below.

6.2.1 Determining the structure of the PMM

This section presents the structure and contents of the pilot PMM framework for UIC. The PMM is structured into three modules based on the identification of the three stages life cycle of UIC described in section 3.3 and the findings of the UIC project presented in section 5.3.1. This section presents how the stages are mapped the PMM. The process of mapping the UIC work flow to the three modules in the proposed PMM is shown in Figure 6.2.

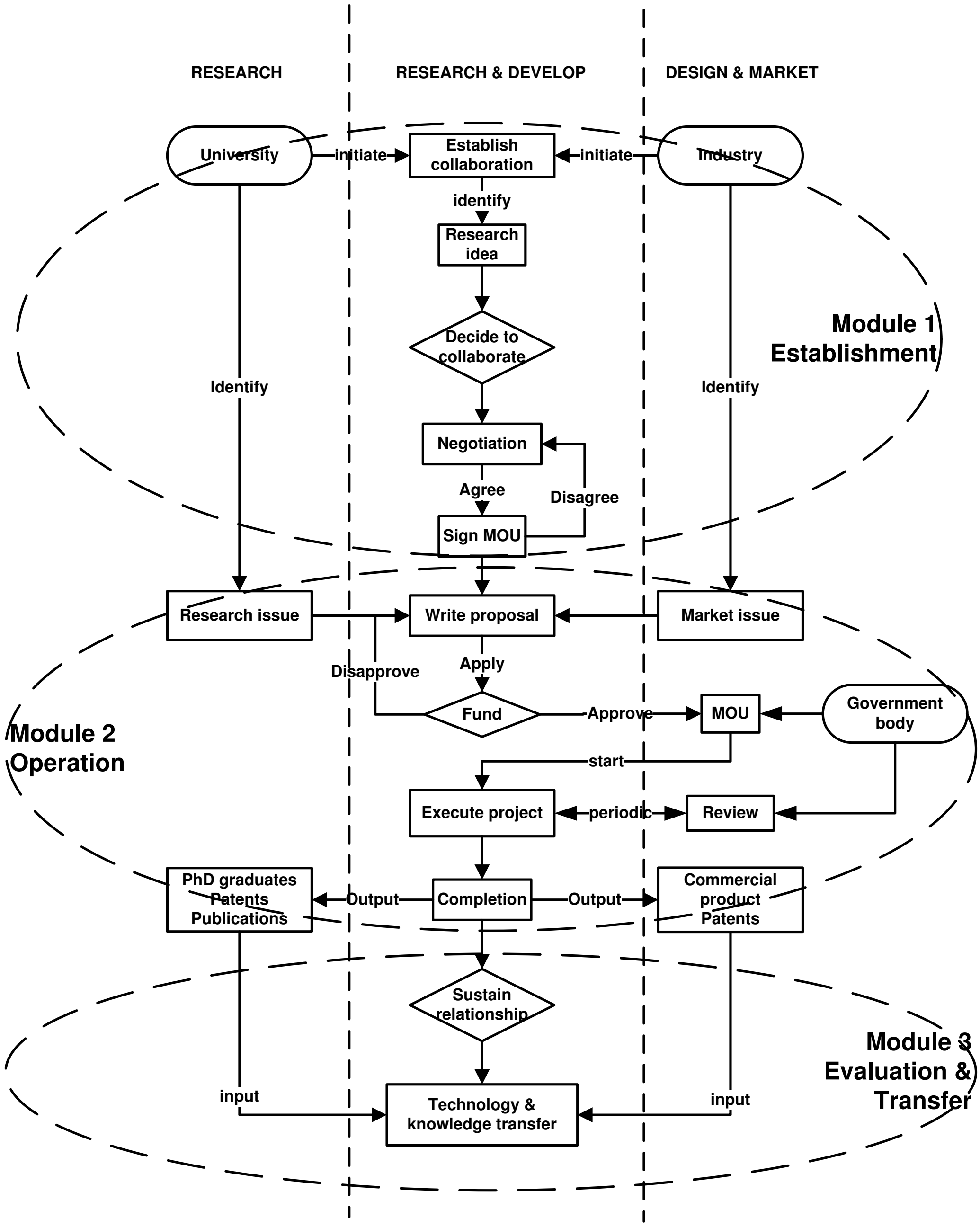


Figure 6.2 Mapping of UIC workflow with PMM framework before refinement

The structure of the initial PMM framework consisted of three phased modules as shown in Figure 6.5. Module 1 aimed to assess the feasibility and facilitate establishment of the collaboration and contains sequential best practice processes extracted from literature findings in chapter 3 and interview results in section 5.3. The output from Module 1 contributes as an input into Module 2. The framework of Module 2 is shown in Figure 6.3. It consisted of four project management process group; project initiation, project planning, project monitoring and project closing. In the framework of Module 2, project initiated are followed by planning of resources, then constant monitoring, tracking and review by the collaboration agents. Project is closed when it is completed and assessed accordingly prior handover to stakeholders. Each of the processes is reviewed by the collaborative agents through milestones as a review gate. Module 3 focuses on the collaboration completion, evaluation and transfer of new technology or knowledge.

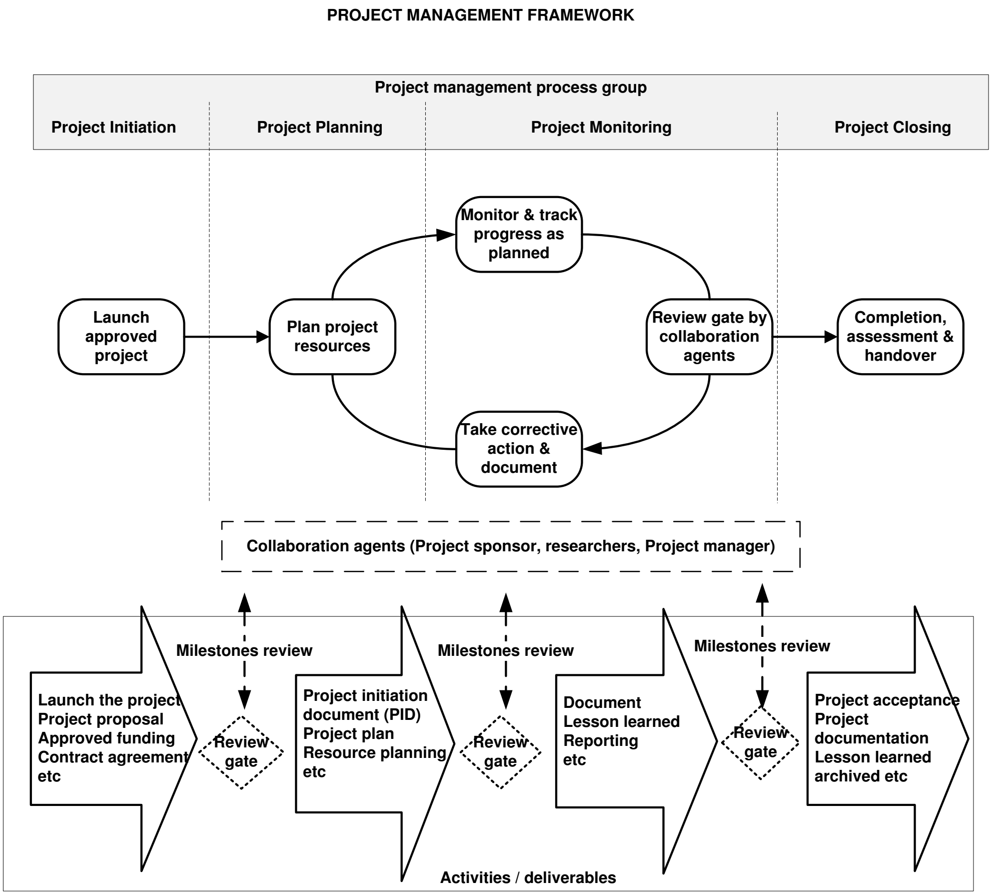


Figure 6.3 Expansion of Module 2 PMM before refinement

The PMM structure also includes a review gate at the end of each module. The review gate is carried out prior to proceeding to the next module (see Figure 6.4). The review gate is a point whereby a committee known as collaborative agents consisting of project board, project manager, research leader and research team is setup to oversee the execution of project activities are in accordance to its initiated plan. The review process is iteratively monitored and controlled by the collaborative agents to ensure project completion criteria are satisfied and accomplished its stated quality and project objectives. Each of the modules is suggested with a list of activities that will be performed by the project team under the project manager's leadership.

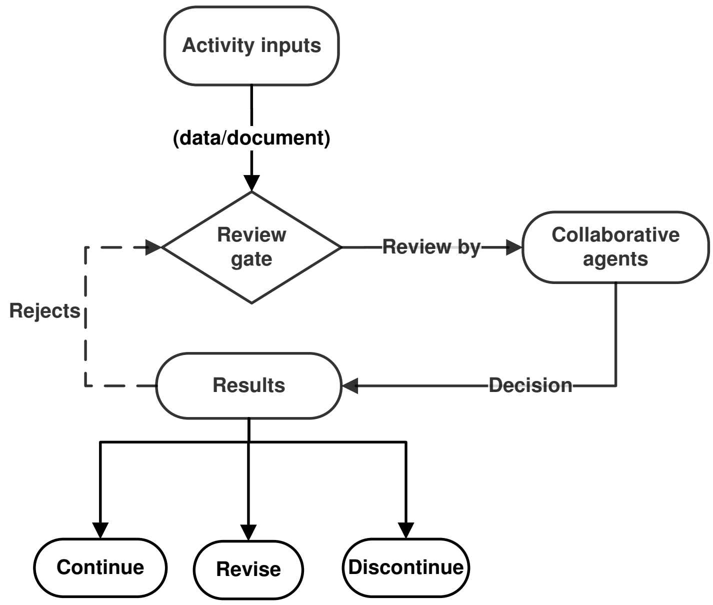


Figure 6.4 PMM review gate process before refinement

This section has defined the structure of the proposed PMM on the basis of a UIC life cycle, its workflow and processes. The next section will determine the components of the PMM.

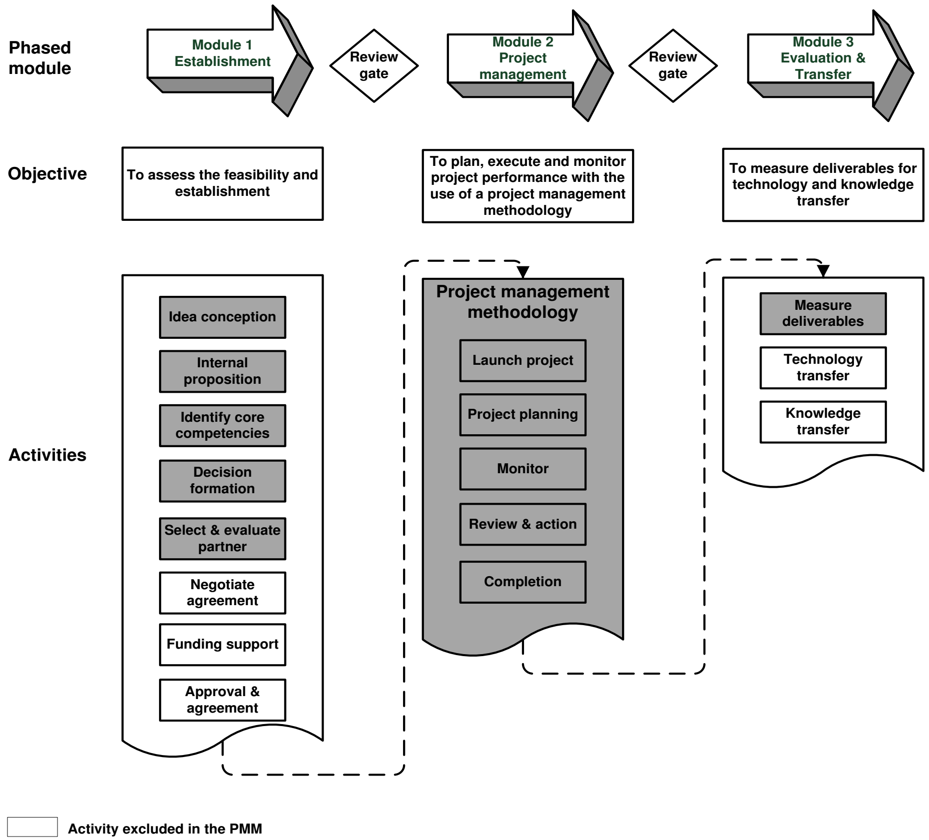


Figure 6.5 Proposed PMM before refinement

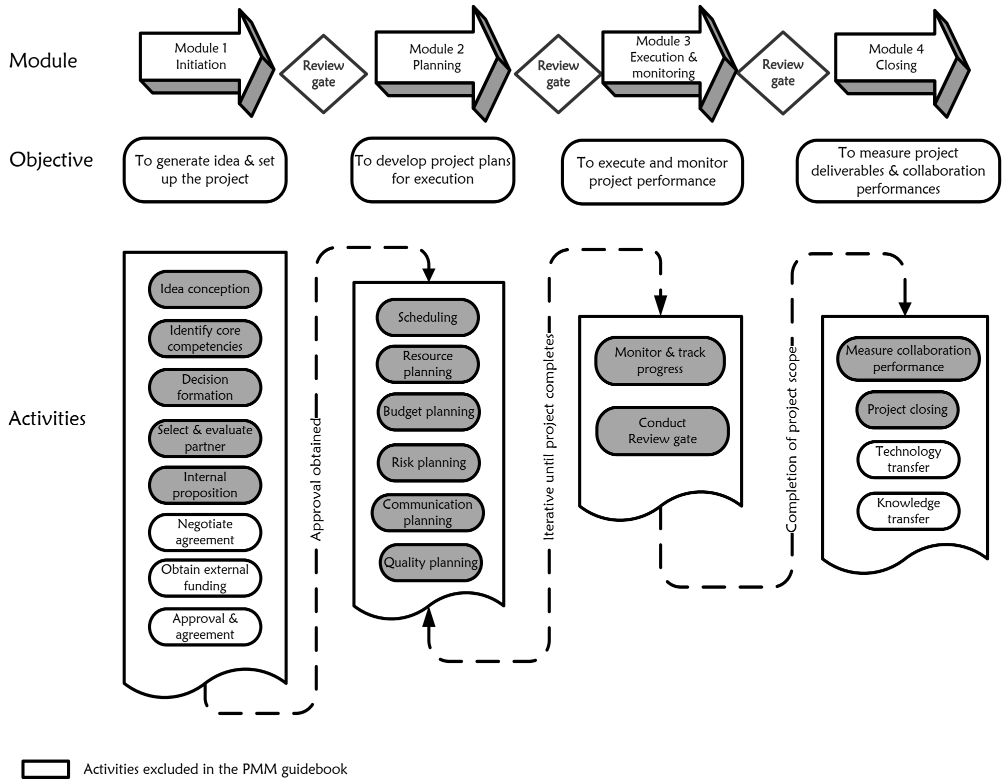


Figure 6.6 Pilot PMM after refinement

6.2.2 Determining the components of the PMM

The purpose of this section is to determine what should be included in the pilot PMM. The contents of the pilot PMM have been determined by incorporating the list of requirements to be placed on a PMM from chapters 2 and 3 and analysis of the results from chapter 5.

There are four main components contributing to the contents of the PMM. The PMM component to be developed consists of:

- Project management processes: what to do specifying all the steps/activities
- Project management best practices: how best to do it
- Project management toolkits (templates, techniques and checklists): the way to do it
- Project management terms of references: definitions of terminology

The proposed PMM will specify all the common steps or activities in a UIC R&D project environment. These processes also specify the primary inputs needed to conduct each major process step, the toolkits required and the output as a result of performing the set of tasks. As one of its criteria, the PMM will also need to be designed in a scalable and adaptable way. This includes consideration for how the processes can be scaled down for smaller projects or expanded for larger, longer duration complex research projects. Hence the PMM will contain a sequential flow of work which will function as a guide towards achieving successful UIC R&D projects.

The second component involves best practices elicited from the literature, interviews and surveys on how best an organisation understands and values the practices that are performed as a means towards successful management of research projects. Best practices are perceptions in the eyes of the beholder (Hill, 2008) but views and opinions vary widely. Third component of the methodology aims to facilitate a repeatable process for the project manager and team. A selected list of tools consisting of templates, techniques, tools and checklists applicable for use in a UIC R&D project environment is developed to support the management of the project.

This helps the project manager to easily identify the right tools for the right process and to use them in the right way.

The final component provides references to standards and common terminologies which are used in the project management environment. The terms of references ensures that all project stakeholders uphold the same language, minimise miscommunication and enhance information exchange within the project environment. The content of the terms of reference is a list of terms and definitions to be used in the collaborative research environment.

6.3 The Pilot Project Management Methodology

The creation of the pilot PMM is outlined in this section. Having established its structure and content, these are then integrated to create the pilot methodology shown in Figure 6.6. After refinement, the pilot PMM was structured into four modules, Figure 6.6 shows the outline structure along with the key objectives and key activities in each module. The structure of the pilot PMM will be presented in the next section.

6.3.1 Overview and structure

Four modules contribute to the structure of the pilot PMM are Module 1-Initiation, Module 2-Planning, Module 3-Execution & Monitoring and Module 4-Closing. This structure is based on the PMBOK project management process groups discussed in section 2.4. The methodology integrates the best practices and toolkits identified in chapter 2 and customise it to fit into the UIC research environment. Outlines of each component in the PMM modules are listed in Table 6.1 and the high level descriptions of each module in the PMM are presented in Table 6.2, Table 6.3, Table 6.4 and Table 6.5. The final PMM will be fully described in chapter 7.

Table 6.1 PMM modules' activities

Module 1: Initiation	1. Idea conception 2. Identify core competencies 3. Decision formation 4. Select and evaluate partner(s) 5. Internal proposition 6. Negotiate agreement 7. Obtain external funding 8. Approval and agreement
Module 2: Planning	9. Schedule planning 10. Resource planning 11. Budget planning 12. Risk planning 13. Communication planning 14. Quality planning
Module 3: Execution & Monitoring	15. Monitor and track progress 16. Conduct review gates
Module 4: Closing	17. Measure collaboration performance 18. Project closing

Table 6.2 PMM Module 1: Initiation (MI) high level structure

Description	The objective of this phase is to generate potential ideas and set up the project. The activities involve writing up a project proposal, selecting and evaluating potential partners, developing a project initiation document and signing contractual agreements.
Key objectives	• To identify the unique purpose of the project • To define the project objectives, goals and mission • To identify potential collaborative partners • To develop a project initiation document • To write up an agreement and obtain approval to initiate the project planning module
Key activities	• Develop a project proposal to set the objectives and purpose • Collaborative partners are assessed based on a list of criteria • A project initiation document (PID) is produced which provides a high level plan of the project, a description of the project, objectives, scope of work, deliverables, approaches, and constraints. • Project manager and team members need to be recruited and a project organisation structure created. Project stakeholders are identified and roles and responsibilities are assigned.

Table 6.2 PMM Module 1: Initiation (MI) high level structure (cont)

Key activities	• A kick off meeting between partners is held to clarify the project scope, requirements and expectations from each partner for example schedule, budget, quality, roles and responsibilities, reporting plan etc. This also strengthens communications channels. • A contractual agreement is written and agreed
Key outputs	• Project proposal • Project initiation document (PID) • Selected collaborative partner • Contractual agreement

Table 6.3 PMM Module 2: Planning (MP) high level structure

Description	This module is the main component of PMM and covers project planning such as schedule, budget, resources, risk, communication and quality planning. The output from Module 1 will contribute as input to this module.
Key objectives	• To develop an activity schedule • To identify project resources and budget • To identify, plan and response to risk and uncertainties in the project • To plan the communication and information distribution channel • To identify and assure quality target meets stakeholders expectations
Key activities	• Break down project activities into manageable work packages • Sequence and schedule all activities using a Gantt chart • Create a resource plan and estimate budget for procurement • Create a risk plan to mitigate and control risks in the project • Create a communication plan to identify who, what and how to distribute information throughout project life cycle • Create a quality plan to identify acceptable criteria and standards
Key outputs	• Work breakdown structure (WBS) and WBS dictionary • Project schedule (Gantt chart) • Resource plan • Budgetary plan (baseline) • Risk plan and risk log • Communication plan • Quality plan and quality log

Table 6.4 PMM Module 3: Execution & monitoring (ME) high level structure

Description	Completion of project planning documents and approval from stakeholders will initiate the execution and development of the project. This module is critical because the project manager needs to constantly control and monitor project performances to ensure it meets the expectations of all stakeholders. The monitoring process begins when the project starts and continues until it ends.
Key objectives	• To ensure each project objective is delivered as planned • To coordinate the completion of all tasks within schedule and budget • To monitor change requests and minimise impact on project scope, schedule and budget • To keep track of project progress against plans through performance reporting • Take corrective action against changes as recommended by collaboration agents committee
Key activities	• Conduct meetings to monitor and track project progress • Document project performance through minutes, progress report, and progress log • Document change requests and monitor execution against the plan • Perform activity review gate at the completion of each activity in a module • Perform module review gate at the completion of each module • To iterate the above activities until all project objectives are delivered
Key outputs	• Project minutes • Project progress report • Progress log checklist • Change request plan and request log

Table 6.5 PMM Module 4: Closing (MC) high level structure

Description	The closing module includes measuring the deliverables of a collaborative project, documenting lesson learned and project archives, official acceptance signoff and handover of final product by/to stakeholders. This module is also important to determine as to whether the collaboration can be sustained.
Key objectives	• To identify and measure collaborative performance • To document lesson learned from project experience • To gain acceptance of the completion of all project work • To signoff and handover to stakeholders to close the project • To sustain the relationship for future partnerships
Key activities	• To measure the collaborative performance indicators in terms of four perspectives; financial, customer, internal processes and learning and innovation growth • To create lesson learned report for future project reference • To update and archive all scope of work completed and variances of project performances in the end project report • Prepare formal acceptance for signoff and handover of project
Key outputs	• Collaborative performance measurement indicators • Lesson learned report • End project report • Signoff and handover of the project

In the design of the pilot PMM guidebook, the structure of the guidebook consists of four parts namely:

Part A – Introduction sets out the general concepts of a PMM, outlines who should be using this guidebook, why the adoption of this PMM is beneficial and its structure. It is an easy step by step guide which provides details of each module objectives, activities, inputs, outputs and toolkits (see Figure 6.7). With the given guidelines in the PMM, it will assist those involved in UIC research projects. It is also intended for research management office (or equivalent) of university and industry to use this guidebook to design their own organisation specific PMM (aligned with their own internal systems) to help them work more effectively on UIC research projects.

Part B – UNMC Project management methodology introduces the modules of the methodology, objectives, inputs, tasks, relevant tools and techniques, outputs and hints and tips to guide throughout the process of setting up, planning and running a project as shown in Figure 6.7. The PMM guidebook is an easy step by step guide which provides details of **WHEN** to do it? **WHO** will be involved? **WHAT** is it? and **HOW** to do it?. It is also aligned with international best practice; therefore it integrates easily with the other systems within the organisation. Further details of the final PMM guidebook are discussed in chapter 7

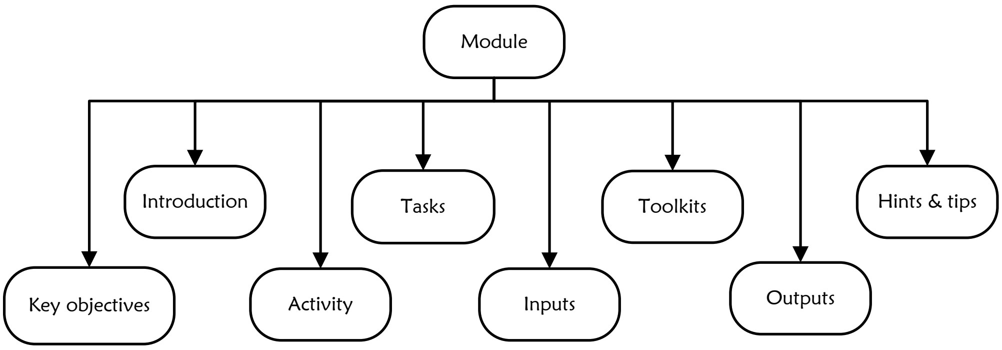


Figure 6.7 Structure of the pilot PMM guidebook

Part C – Toolkits provide a set of library sample tools and templates designed to reduce the administrative burden of effectively managing projects. It contains 32 sets of toolkits enclosed with simplified templates, hints and tips to give guidance especially to first time UIC researchers. Each tool and template is structured in the following way: what it is, what is its purpose, how to do it, hints and tips and samples to simplify the tool as much as possible. The PMM guidebook does not aim to be an answer book. It adopts a flexible structure enabling both university and industry players to customise the available approaches, tools and templates and makes them readily accessible in the guidebook to fit the project size, complexity, objectives and requirements.

Part D – Terms & definitions contains a set of terms and abbreviations used within the methodology to ensure a common language between team members.

An overview of the PMM guidebook structure had been discussed. The following section 6.4 presents the results of the evaluation and validation of the PMM guidebook from experts in the field of project management, industry and university actors experienced in UIC projects. Based on suggestions and evaluation the refined PMM is presented in chapter 7.

6.4 Evaluation and Validation of the Pilot Project Management Methodology

The evaluation method was outlined in chapter 4 sections 4.5.4 and 4.5.5. Further, in section 4.6.3, three aspects were used as evaluation criteria namely feasibility, usability and usefulness. The results and findings from the questionnaire survey evaluation are discussed in the following section. Further this section will present the suggestions highlighted by the expert review panel. The overall goal of this evaluation and validation is to determine and improve the applicability of the PMM for use in a real UIC research environment.

6.4.1 Evaluation of the pilot PMM

This section presents the findings from the PMM evaluation questionnaire survey. The objective of this process was to measure three elements; feasibility; usability and usefulness. The evaluation questionnaire survey contained five sections; Section A evaluate feasibility; Section B usability; Section C to discover if the methodology will assist researchers to better manage their projects; Section D was for respondents to provide areas of improvement in the methodology and Section E to collect some background information on the experiences of respondents. A total of 13 respondents participated in the evaluation process (see Table 6.6). A pilot evaluation was carried to assess the suitability of the approach. Each respondent had a varied background, organisation, experience, specialisation and nationality with the following common attributes:

- working on projects for 11-20 years (36%),
- worked on more than 5 projects (43%),
- previously taken course/training on project management (57%),
- used a PMM before (50%)

Table 6.6 Pilot PMM evaluation sample expert respondents' profile

No	Respondent ID	Organisation type/industry	Experience (years)	Research projects involved (no)	Used a PMM (Y/N)	Evaluation date
1	U1	Foreign university	6-10	>10	N	6/8/10
2	U2	Foreign university	6-10	>5	N	12/8/10
3	U3	Foreign university	1-5	>5	Y	23/8/10
4	U4	Focused university	>20	>5	N	27/7/10
5	U5	Foreign university	11-20	>20	Y	27/7/10
6	U6	Private university	>20	>10	Y	4/8/10
7	U7	Foreign university	>20	>10	Y	26/8/10
8	U8	Apex university	11-20	>10	N	13/9/10
9	E1	Research agency	6-10	>5	Y	16/8/10
10	I1	Consultancy for Teaching & Learning Organisation	6-10	>10	N	26/8/10
11	PME1	Project management	>20	>20	N	29/7/10
12	PME2	Project management	>20	>20	Y	16/8/10
13	PME3	Project management	>20	>20	Y	27/8/10

Notes: University (U); External research agencies (E); Industry (I); Project Management Expert (PME)

The design of the evaluation questions and approach has been discussed in sections 4.5.5 and 4.6.3 in chapter 4. The following sections A, B and C reports the findings and results obtained. The final version of the evaluation questionnaire survey is enclosed in the Appendix 9.

Section A: Feasibility

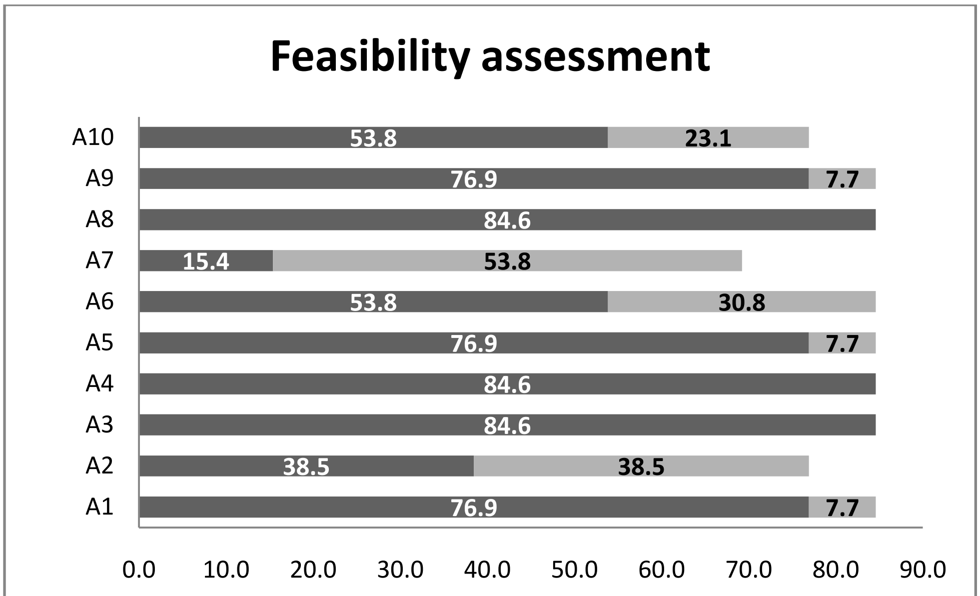
Section A of the evaluation questionnaire survey aimed to assesses the feasibility of the PMM developed. The evaluated respondents indicated that PMM was feasible for practical application. In addition, all respondents agreed that the PMM had adequate content, was transparent and consistent. The majority, 53.8% respondents indicated that they would have no difficulty communicating the methodology to their project teams as shown in Figure 6.8. The remaining (15.4%) addressed the comprehensiveness and length of the guidebook as part of an issue. Over three quarters (76.9%) agreed that the activities in the methodology were easy to follow; specific, appropriate to UIC research environment and suitable to guide the project manager. Although the results were largely positive, there were criticisms. Some examples of the negative comments are:

> *"...most likely for consumer products development, not practical for product R&D projects"* (PME1)

> *"...not as described because in collaborative research project there is more spiralling in the* execution phase; small features or milestones driving changes and unpredictable results, forcing new directions that are hard to predict thus numerous decision points need to exist in the *execution phase" (PME2)*

> *""In general yes, I think initiation phase will be ver*y useful but many concepts may be new to academic researchers and difficult to convince them to apply. A clear structure will be a good *basis but adaption to own use may be necessary" (U1)*

An equal percentage of 38.5% of respondents agreed that number of activities in each module of the PMM may or not be a significant administrative burden on the project team. 53.8% of respondents agreed that the proposed methodology should be put forward for adoption in their research group or organisation. For example, an academician (U4) requested for the adoption of PMM for use in their CRADLE fund project. Further, the PMM is also being adopted by a foreign university consulting team (another one of the expert evaluation panel) for their collaborative projects. It will be externally facilitated in this case due to geographical distance. However, the PMM still requires further improvement for more widespread practical implementation.



	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Yes %	76.9	38.5	84.6	84.6	76.9	53.8	15.4	84.6	76.9	53.8
No %	7.7	38.5			7.7	30.8	53.8		7.7	23.1

Figure 6.8 Evaluation questionnaire survey results on PMM feasibility assessment

Question A11; an open ended question relates to the implementation strategy of the designed PMM. Two project management experts suggested the PMM to be supported through training and unwavering management support for organisations that may require a simple to follow methodology. A university respondent also added that it would be viable for the PMM to be tested in a real research environment in order to refine the methodology. The given suggestions would certainly add value to this research and both elements will be an important part of Phase 4 (see Figure 4.1). Overall, the findings in this section indicated that the designed PMM could be used to guide researchers to plan and manage their research projects because it is feasible, customisable, practical and applicable for a collaborative research environment.

Section B: Usability

Based on the responses from Section B Figure 6.9, a high percentage of respondents 76.9% agreed that the designed PMM is both practical and sufficiently easy to use because of the integrated toolkits, templates and common terms. Moreover, only 7.7% of respondents encounter problems while evaluating the PMM. 61.5% of respondents agreed that the PMM could supplement their existing practices largely because their current practices were not aligned with any methodology.

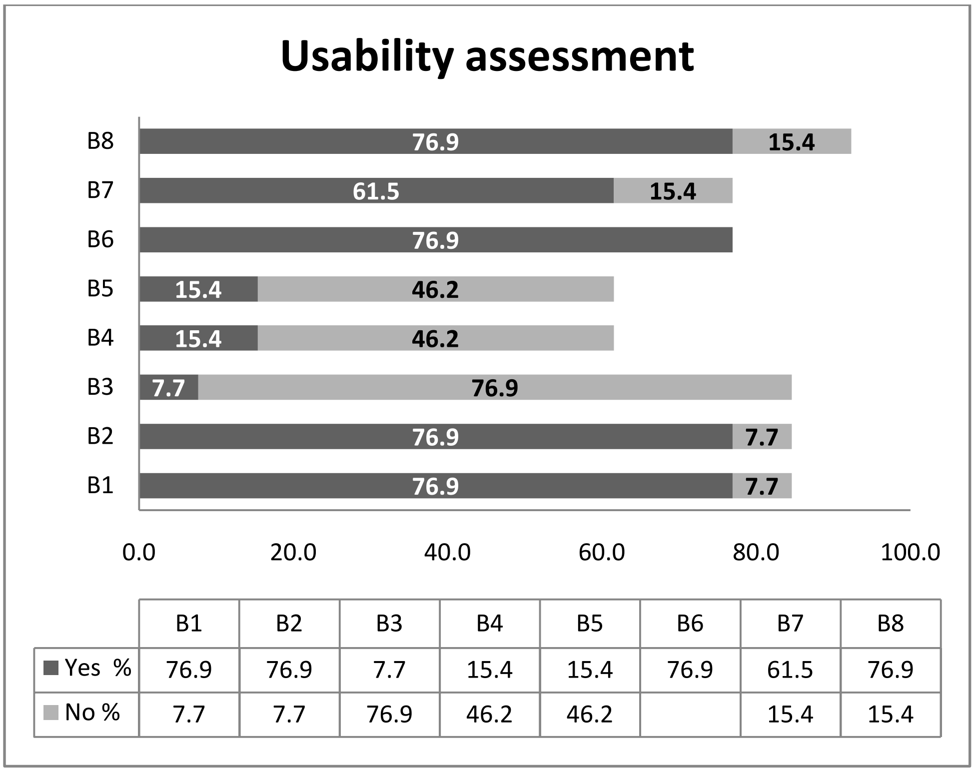


Figure 6.9 Evaluation questionnaire survey results on PMM usability assessment

To conclude section B evaluation, respondents were requested to suggest other factors that would be important to aid them to use the PMM. Several comments were provided by the following respondents:

"...for business manager who needs guidance in managing collaborative project for the first time" (PME1)

"...for large project $100million with partners that I had no previous experiences doing *something that has never been done before" (PME2)*

"simplified/automated version" (U3)

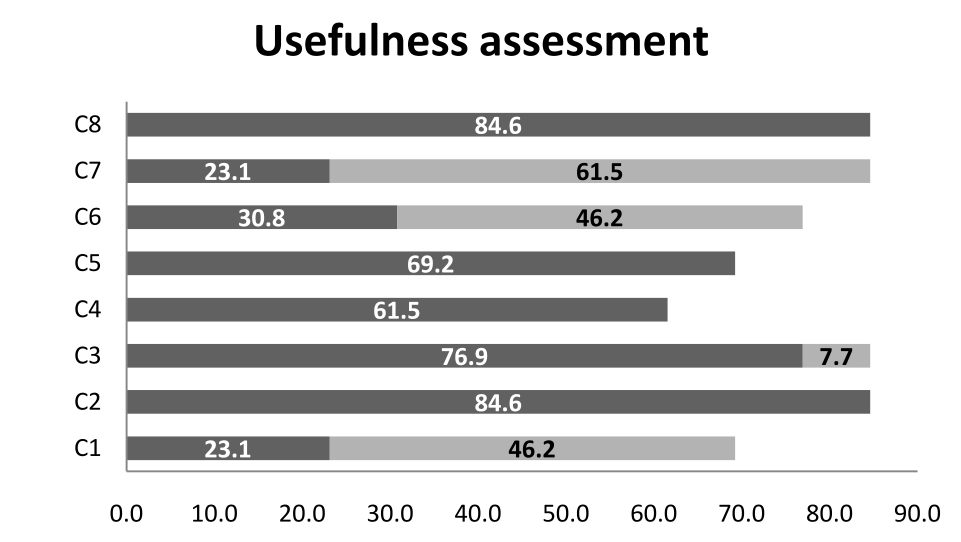
"its modules and tools" (U7)

Section C: Usefulness

Section C consists of 11 questions which aimed to evaluate the PMM's usefulness in assisting researchers to better manage their projects. Each question is also provided with a comment box.

Presented in Figure 6.10, all respondents unanimously (84.6%) agreed with the contents and structure of the methodology indicating that it would help researchers to better manage their projects. It was also significant that most of the respondents (76.9%) agreed that the given inputs, tasks, toolkits, outputs and hints associated with each activity of the PMM were useful. As a strong measure of support, 69.2% of respondents were considering using the proposed PMM for the management of their projects. Although this is a positive result, a small number of respondents (23.1%) indicated that the methodology will consume excessive amount of time and resources for managing projects. To address this issue the methodology facilitate user the easy of customisation, adaptability and selection of e.g. templates, tools and techniques based on the nature and scale of project in the UIC environment.

Two open questions were given at the end of the section to evaluate the strength of the methodology and its differentiation from other methodologies. Some of the respondents identified strengths in the methodology commenting on its simplicity and clarity as well as appreciating its comprehensive, integrated, structured approach and the user friendly navigation links.



	C1	C2	C3	C4	C5	C6	C7	C8
Yes %	23.1	84.6	76.9	61.5	69.2	30.8	23.1	84.6
No %	46.2		7.7			46.2	61.5	

Figure 6.10 Evaluation questionnaire survey results on PMM usefulness assessment

In terms of the distinction between the PMM designed in this work and other methodologies, respondents commented that the designed PMM is unique in terms of its structure and layout which was primarily attributed to its guidebook approach. The PMM was considered to provide a balanced view between university and industrial requirements. It also aims to include all the appropriate modules, tools and templates. Despite positive feedback from all, a project management expert commented that the only individually distinct component of the PMM was its partnership selection tool as it is not integrated in other available methodologies at present. However the development of the PMM had incorporated many other aspects in relation to UIC research environment. It had mapped the work flow and processes of UIC and project management as presented in sections 6.2 and 6.3. In addition, partner selection is one of the key issues based on literature and findings that are of high concern yet understudied and practice in the Malaysian UIC research environment (see sections 3.3 and 3.4).

Section C also consists of questions in the Likert scale to evaluate the level of usefulness of each tool and technique integrated into the PMM. Answers are provided in a scale of 1 – least useful; 2 – slightly useful; 3 – uncertain; 4 – useful and 5 – very useful. The 32 toolkits presented in the PMM guidebook were evaluated. Based on the overall responses displayed in Table 6.7 and shown in Figure 6.11, the majority of respondents' answers generally fall in the 'useful' and 'very useful' category. Finding denote that 76.9% to 69.2% of respondents viewed the following as the most 'useful' toolkits in managing research projects; designing project management teams, project minutes, project progress reports and change request plans, followed by stakeholder analysis, quality plans, and the change request log template. In addition, equal percentage 38.5% of respondents viewed the project initiation document as 'useful' to 'very useful', while 7.7% of respondents were uncertain of the tool.

However, 38.5% of respondents were uncertain about the usefulness of the Plus/Minus/Interesting (PMI) tool which aimed to aid the decision making process. A total of 39.5% viewed the PMI tool as 'useful' to 'very useful' and 7.7% disagree on its usefulness. Furthermore, around 23.1% were uncertain about the usefulness of the expert judgment tool for managing projects, although 38.5% of respondents agreed it would be useful. 7.7% of respondents identified SWOT analysis and project balanced scored card as least useful. This may not be a significant issue because the majority of respondents still agree that these two tools would be useful in managing research projects.

Table 6.7 Frequency of response Questions C11.1 – C11.32

Questions	Least useful (1)		Slightly useful (2)		Uncertain (3)		Useful (4)		Very useful (5)	
	No	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
C11.1	1	7.7					7	53.8	2	15.4
C11.2			3	23.1	3	23.1	5	38.5		
C11.3			1	7.7			8	61.5	2	15.4
C11.4	1	7.7	1	7.7	1	7.7	4	30.8	4	30.8
C11.5			1	7.7	5	38.5	4	30.8	1	7.7
C11.6			1	7.7	2	15.4	6	46.2	2	15.4
C11.7					1	7.7	5	38.5	5	38.5
C11.8							9	69.2	2	15.4
C11.9					4	30.8	2	15.4	5	38.5
C11.10					1	7.7	8	61.5	2	15.4
C11.11					1	7.7	5	38.5	5	38.5
C11.12					2	15.4	7	53.8	2	15.4
C11.13					1	7.7	5	38.5	5	38.5
C11.14					1	7.7	6	46.2	4	30.8
C11.15			1	7.7			6	46.2	4	30.8
C11.16			1	7.7			6	46.2	4	30.8
C11.17							6	46.2	5	38.5
C11.18			1	7.7	2	15.4	7	53.8	1	7.7
C11.19			1	7.7			8	61.5	2	15.4
C11.20							7	53.8	4	30.8
C11.21					1	7.7	8	61.5	2	15.4
C11.22					2	15.4	6	46.2	3	23.1
C11.23							9	69.2	2	15.4
C11.24							9	69.2	2	15.4
C11.25			1	7.7	1	7.7	7	53.8	2	15.4
C11.26							10	76.9	1	7.7
C11.27							8	61.5	3	23.1
C11.28					2	15.4	5	38.5	4	30.8
C11.29	1	7.7			1	7.7	5	38.5	4	30.8
C11.30					2	15.4	5	38.5	4	30.8
C11.31							7	53.8	3	23.1
C11.32					1	7.7	7	53.8	3	23.1

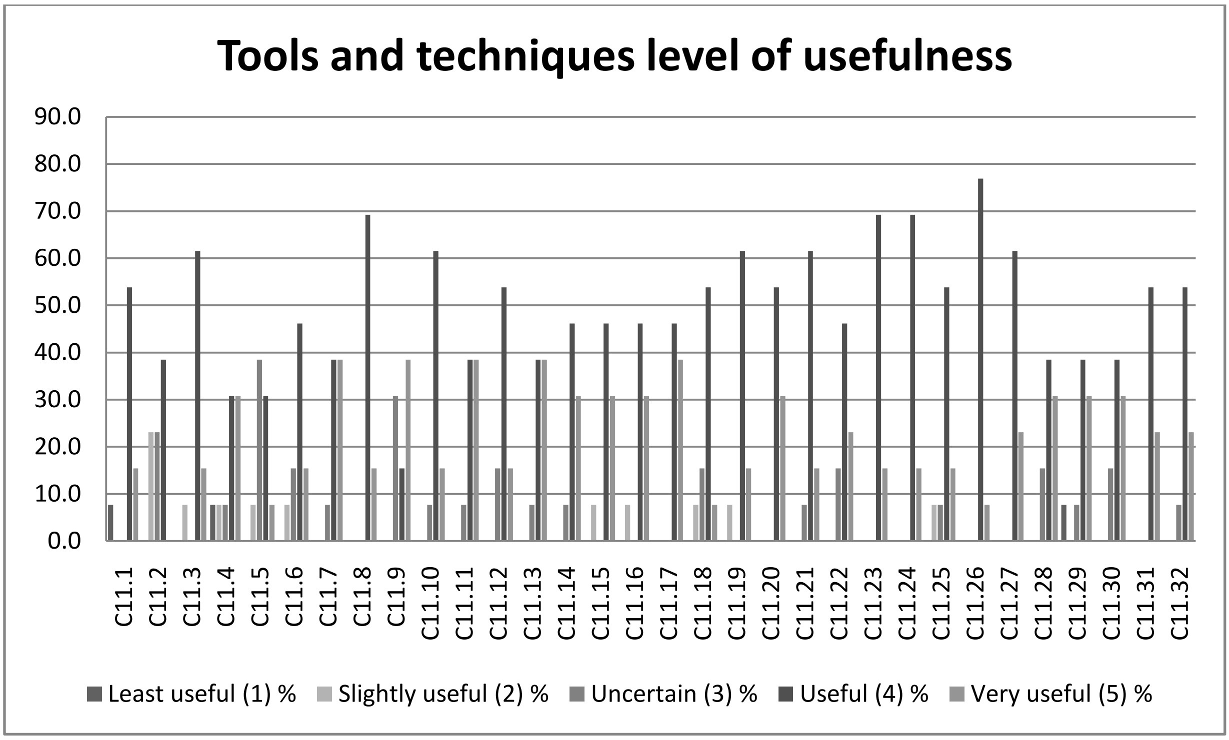


Figure 6.11 Evaluation questionnaire survey results on PMM tools and techniques usefulness

6.4.2 Suggestions for improvements and refinement to the pilot PMM

This section presents the feedback and suggestions gathered from the pilot PMM evaluation with a view to refine and improve the methodology. From the evaluation, a number of areas for minor changes were suggested by the respondents as shown in Table 6.8.

Areas suggested for further improvement include idea conception, internal proposition, selection and evaluation of partner; identify core competencies, schedule planning and risk planning activities. New areas were also suggested by expert such as to create an issue management section to manage possible issues with a view of preventing them from becoming risks, to identify the key personnel involved in each task, to emphasise the importance of expert review as an individual toolkit for managing UIC projects and finally to automate the PMM guidebook as a web enabled application for greater usability. The suggested changes for the pilot PMM were used to refine, improve for use and are repeated in the final version of the PMM.

Table 6.8 Areas for improvements identified via pilot PMM evaluation

Component	Areas for improvement
Idea conception	• To include a task to prioritise ideas generated before probing the idea further in Module 1
Internal proposition	• The task 'identify stakeholders' should be completed in parallel with the project initiation document
Select and evaluate partner	• More details on the evaluation of partners and negotiation process • The 7C partner selection model should include some flexibility for different importance/priority weights and to leave the decision making in the hands of the project manager
Identify core competencies	• To integrate SWOT analysis with partner selection • To include expert judgment in partner selection
Schedule planning	• To create schedule with work package description (Level 3 work breakdown structure) and allow the team to define the Level 4 work breakdown structure • To sequence work within each phase
Risk planning	• To evaluate risks at every step of the way from project initiation
Others	• To create an Issue Management activity in Module 2 to manage possible issue and prevent them from becoming risks
	• To separate the expert review from phase gate review
	• To identify key persons in the initiation of each task in each module
	• To automate the PMM guidebook as a web enabled application

Throughout the pilot evaluation, several observations and comments were also highlighted by respondents. Each of these comments were categorised based on the three criteria used to evaluate the pilot PMM is shown in Table 6.9.

Table 6.9 Observations and comments from the pilot PMM evaluation

Criteria	Observations and comments by respondents
Feasibility	• It is a comprehensive approach (U1, U3, U5) • It is clear and concise, not too complex with good examples, hints and tips (U1, U8) • It sets things in a structured step by step for project manager so each project could be managed in the same way (U5, U6) • It includes too many activities therefore some specialisation may be useful (U6) • It could be very time consuming and expensive (U6, U8, PME2) • Every organisation could benefit from this discipline while research group would required more tailoring and flexibility (PME2)
Usability	• It seems a bit more complicated than industrial practices especially end-user environment (U3) • It is simple to follow and identical to current company practices (PME1) • Navigation in the online version would be useful (U1, U3, U4, U6) • Useful to encourage industry participation as this gives them more visibility into the progress of the project, opportunities for communication and to evaluate the outcome (U1) • More specificity (U5) • It is easy to fill in but not with the correct input (U6) • Adequate for basic research in management which can be a great help for researchers (U8) • For business managers who need guidance in managing collaborative project for the first time (PME1)
Usefulness	• Good layout, user friendliness, easy to follow, detailed definitions and information, clearly articulated (U8, PME1, PME2) • Its simplicity and ease of use should be highlighted to encourage sceptics (U1) • It is very comprehensive and includes all the techniques and theory developed by various authors (U6)
Notes: University (U); Project Management Expert (PME)	

Overall, the pilot evaluation of the PMM supported the feasibility; usability and usefulness of the methodology (see section 6.4.1). The evaluation also indicated a need to test the PMM in the next phase of this study in order to further validate its level of maturity and capability (see Figure 4.1). Suggested changes and comments observed from the evaluation were used to refine the PMM and the final version of the PMM is discussed in the following chapter 7.

6.5 Chapter Summary

In this chapter, the pilot PMM overview formation, structure and components were discussed. This chapter also outlined the analysis and respective results from PMM evaluation conducted by a group of selected experienced actors from the university, industry, research agency and experts in the field of project management. A total of 13 experts evaluated the PMM in the aspects of its feasibility, usability and usefulness. The results indicated that the PMM developed in a guidebook form was a well acceptable methodology for use in a UIC research environment. Experts from different sectors of the industry were also responsive on the adoption of the proposed PMM for implementation in their UIC research projects. It was deemed as a potential strategic tool for better project management of UIC projects especially for first time researchers.

The following chapter presents the final PMM after refinement and improvement from the evaluation.

CHAPTER 7 THE FINAL PROJECT MANAGEMENT METHODOLOGY FOR USE IN A UNIVERSITY-INDUSTRY RESEARCH ENVIRONMENT

7.1 Introduction

The aim of this study is to develop a generic L3 PMM (see sections 1.2 and 2.3.3) for adoption in UIC research projects. The final methodology was formed by integrating findings from the following logical sources:

- Defining PMM, reviewing the leading project management practices and various PMM available in the market (chapter 2)
- Understanding the best practices and processes involved in a UIC research environment at large and from within Malaysia (chapter 3)
- Feedback from the PMM implementation and evaluation of L3 methodologies in Phase 2 of this study (Chin and Spowage, 2008b, Chin et al., 2011, Chin and Spowage, 2008a, Spowage and Chin, 2009)
- Findings and results analysed from semi-structured interviews and questionnaire survey (chapter 5, sections 5.3 and 5.4)
- Forming, evaluation, feedback of pilot PMM evaluation from expert review panels and refinement of the pilot PMM (chapter 6)

These sources represented the collective body of knowledge needed to construct the final version of the PMM which represents the major output of this work as shown in Figure 7.1.

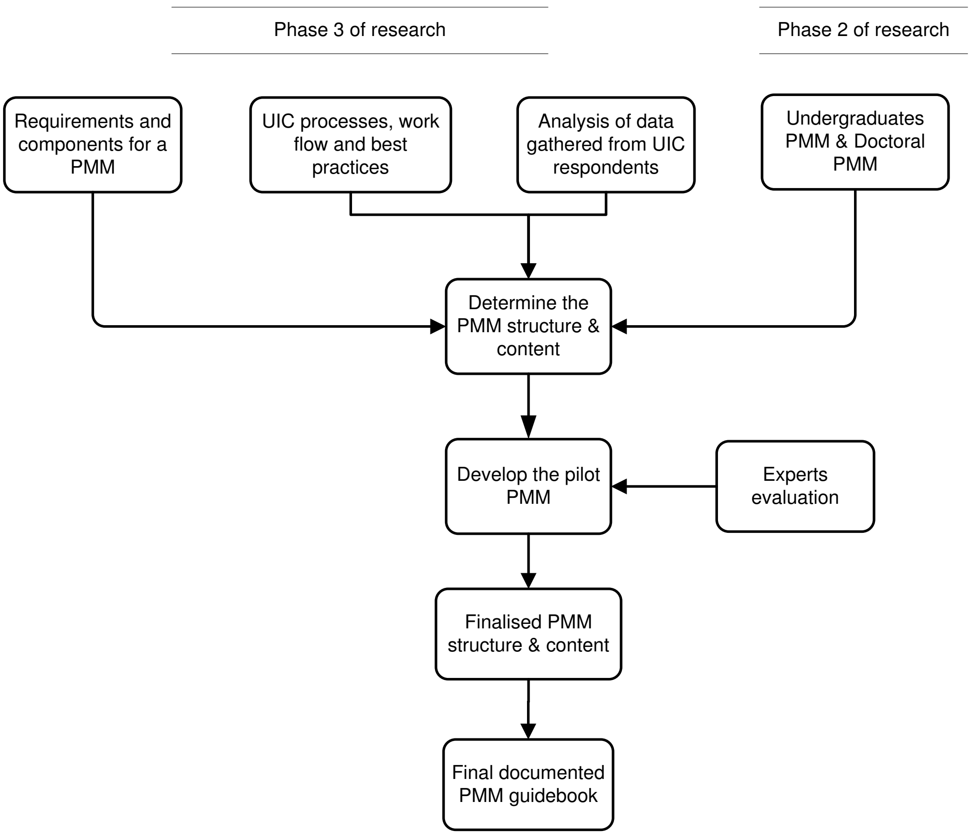


Figure 7.1 Sources and steps leading to the final development of the PMM guidebook

The final structure of the PMM guidebook is based on four modules, 19 activities each with a list of inputs, tasks, outputs and a total of 34 toolkits. In every module the PMM contains a short description of the activity, a definition and the tasks to be carried out in step by step approach followed by a list of toolkits to perform the tasks. Further the expected output from the activity is also presented to ensure that the users know what is required at each stage. The guidebook aims to be generic and flexible to be customisable to the dynamic nature of the UIC research environment. The guide is presented as an e-book, equipped with hyperlinks which ease navigation for first time users. With one click on the hyperlink the users can navigate to the relevant toolkit or template.

It should be emphasised that the PMM guidebook does not aim to answer all questions from university researchers, industry players or project managers. However it is designed as a do-it-yourself guide to the process of initiating, planning, monitoring, executing and closing a UIC research project.

Based on suggestions, the final PMM added an activity on issues management; two additional toolkits and templates (see Figure 7.2). In addition, it also lists the key people involved in the specific tasks outlined in the guidebook. The evaluators agreed that these elements will improve the usability and help users to identify and select who are the relevant people that need to be involved in and responsible for each activity of the PMM (see Figure 7.3). The final documented PMM guidebook is enclosed.

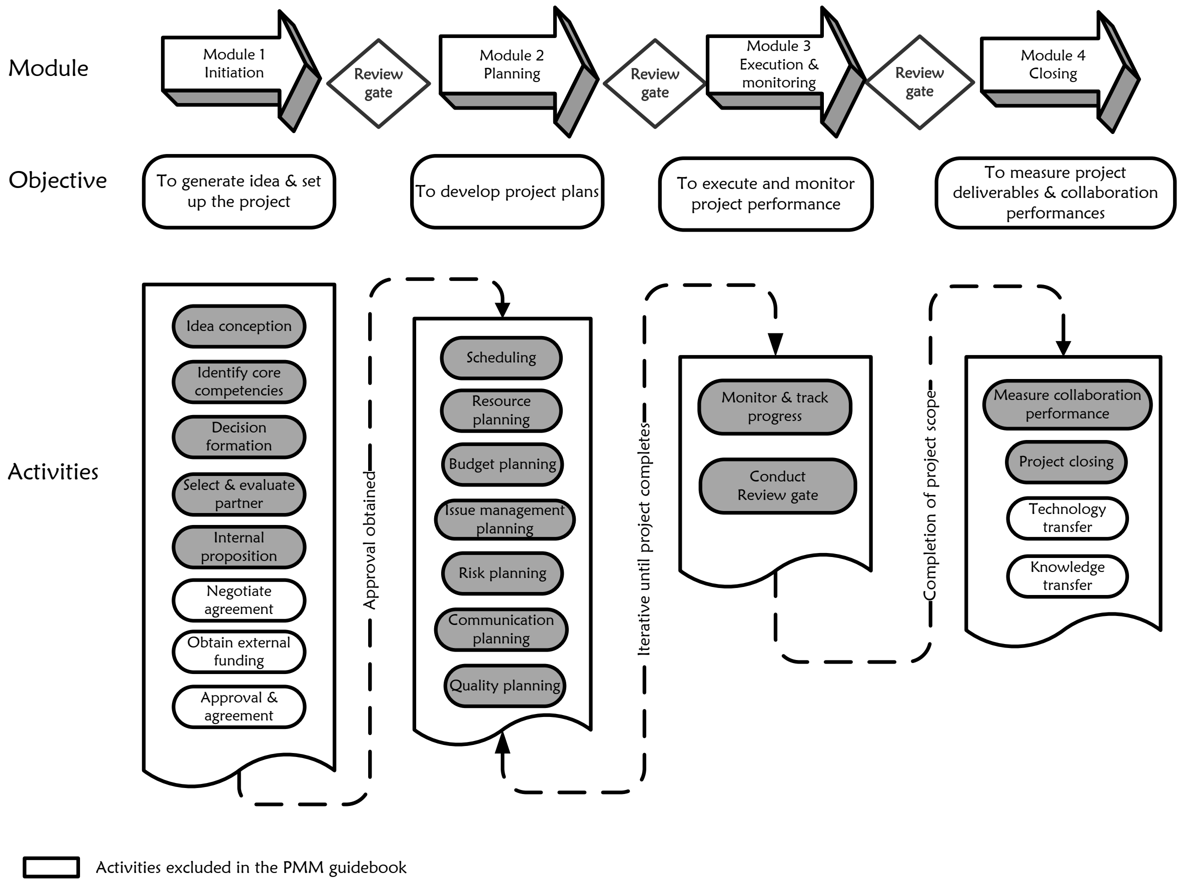


Figure 7.2 Final PMM high level framework after evaluation and refinement

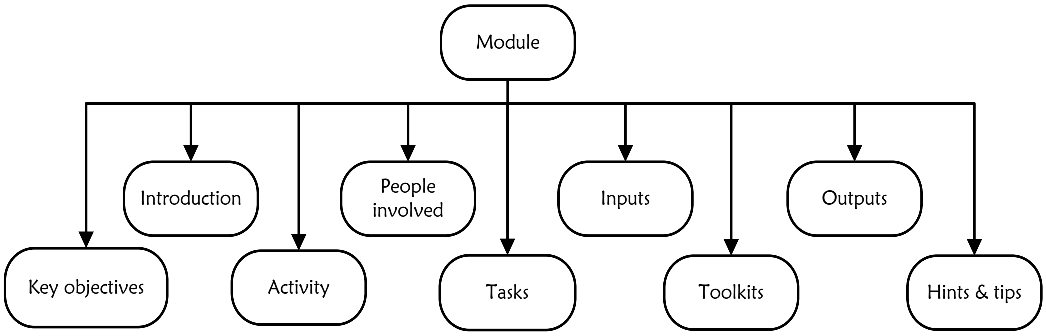


Figure 7.3 Structure of the final PMM guidebook after evaluation and refinement

The following sections describe the detailed contents of the final PMM guidebook.

7.2 Module 1: Initiation (MI)

Module 1: Initiation (MI) as shown in Figure 7.4. The objective of this module is to generate potential ideas and to set up the project. A total of 8 major activities for this module are listed together with its associated inputs, tasks, toolkits and outputs as shown in Table 7.1. The following key objectives of MI are:

- To identify the unique purpose of the project
- To define the project objectives, goals and mission
- To identify potential collaborative partners
- To develop a project initiation document
- To write up an agreement and obtain approval to initiate the project planning module

Details of how to use the methodology are described in the PMM guidebook. The following sub-sections present an overview discussion of each of the 8 major activities in MI.

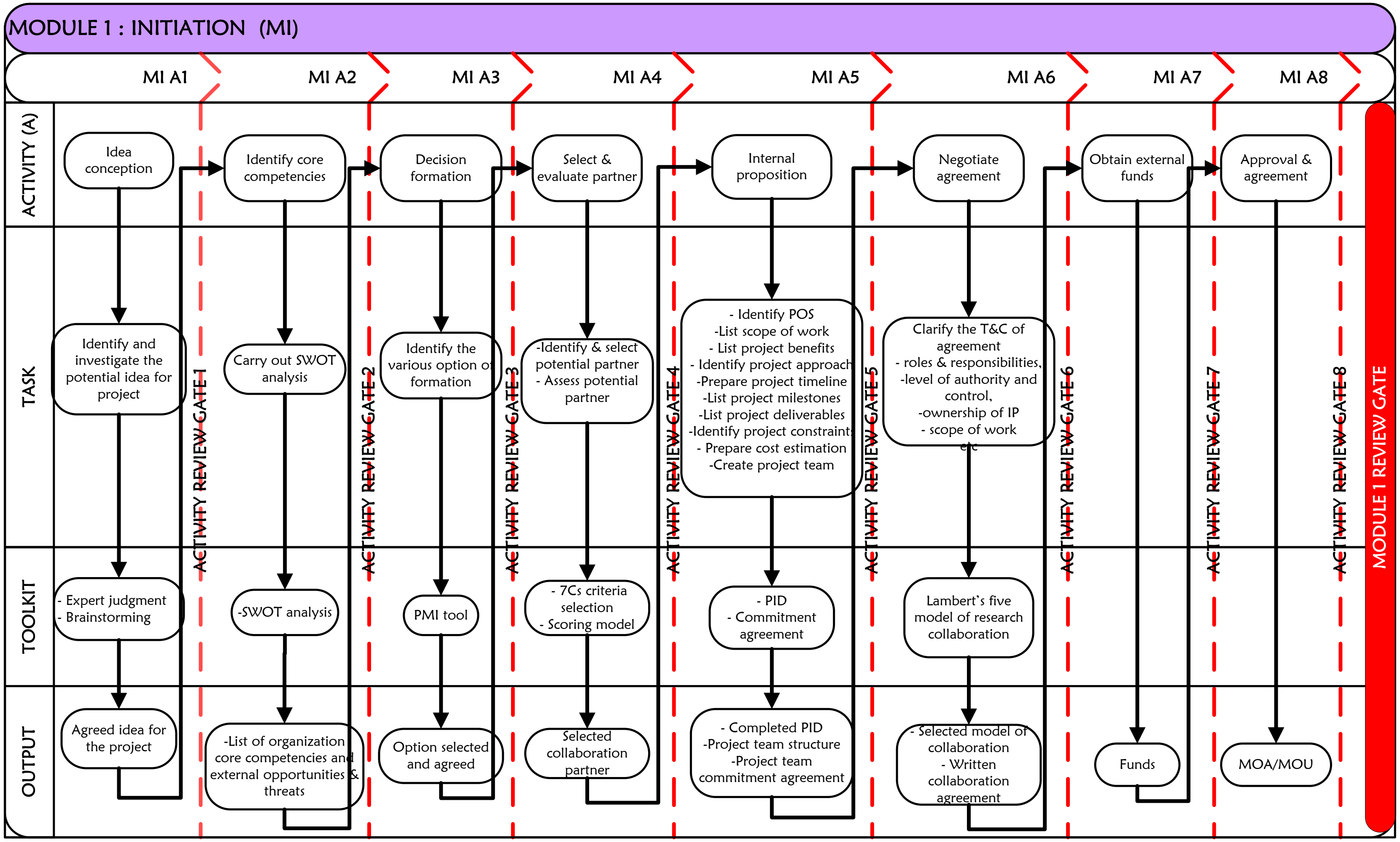


Figure 7.4 PMM Module 1: Initiation flowchart

Table 7.1 Final PMM guidebook Module 1: Initiation contents

Activity	Key people involved	Inputs	Tasks	Toolkits	Output
MI A1	University researchers(s) or Industry		1. Generating ideas 2. Evaluating & prioritising the Idea 3. Probe your Idea 4. Document your Idea	Project proposal template Expert judgment Brainstorming session PMI tool	Conceptualised agreed idea for the project Completed project proposal
MI A2	University researcher(s) or Industry Senior management	Completed project proposal	1. Identify organisation strengths 2. Identify organisation weaknesses 3. Identify organisation opportunities 4. Identify organisation threats	SWOT analysis	List of organisational core competencies, strengths and weaknesses List of external opportunities and threats
MI A3	University researcher(s) or Industry Senior management	Completed project proposal SWOT analysis report	1. Analysis of options 2. Decision making	PMI tool Expert judgment	Decision to collaborate

Table 7.1 Final PMM guidebook Module 1: Initiation contents (cont)

Activity	Key people involved	Inputs	Tasks	Toolkits	Output
MI A4	University researcher(s) or Industry Senior management	Completed project proposal SWOT analysis report Agreed decision to collaborate	1. Identify & select matching partner(s) 2. Assess selected partner(s)	7C partner selection scoring model Expert judgment	Partner(s) selected
MI A5	Project sponsor Project manager Project research leader(s) Senior management	Completed project proposal SWOT analysis report Partner(s) selected	1. Create a PID 2. Create project team & appoint project manager 3. Identify stakeholders 4. Arrange kickoff meeting	PID Team commitment agreement Stakeholder analysis Kickoff meeting guideline Project minutes	Completed and agreed Project Initiation Document Assembled project team structure Appointed Project Manager Identified stakeholder and completed stakeholder analysis Project team agreed & signed commitment agreement Project minutes for kickoff meeting

Notes: Activities MI A6, MI A7 and MI A8 are not discussed in the PMM guidebook. Only brief explanation provided along with links to external sources of information are given to identify the execution of these activities in Module 1.

*M: Module; A: Activity

MI A1: Idea conception

The task in this first step consists of generating or collecting a list of project ideas, prioritising, probing and finally documenting the idea in a proposal.

In the most basic innovation model, the act of idea formation is usually presented in the most embryonic form of a new product or service and requires iterative refinement. It often consists of a high-level view of the solution envisioned for the problem identified by the opportunity (Koen et al., 1998). Once an opportunity is recognised the idea must be incubated to the point at which it can be evaluated by decision makers who need answers to several questions for example will the idea work? do we have the know-how, skills and technology? will it create value? etc.

Ideas that produce affirmative answers to these questions and obtain organisational support are used to form concepts. The idea formulated would need to be documented in a well-defined form, both a written and visual description, that includes its primary features and customer benefits combined with a broad understanding of the technology needed (Koen et al., 1998). The template proposed in the PMM guidebook to aid this task is defined as project proposal. It is one of the most important project management milestones used to present the formulated idea to potential stakeholders and source for funding support.

MI A2: Identify core competencies

The output of the project proposal will be used for project stakeholders to identify and assess the organisation’s core competencies. The next stage is to evaluate the suitability of the concept for delivery using either internal resources, outsourcing to external partners or opt for collaboration. The SWOT analysis tool is adopted to facilitate organisation to assess their internal and external competencies. Organisations will be able to use this analysis tool to assess their strengths and weaknesses (internal competencies) in comparison with the opportunities and potential threats in the market (external competencies).

MI A3: Decision formation

Once the relevant competencies have been identified and weighed, the decision whether to form or not to form UIC is initiated based on the organisations recognition of its R&D imperative. In this activity, organisations need to make various decisions; for example to identify their objectives and motivational drivers to form a collaboration (see section 3.2.2); the obstacles anticipated (see section 3.2.3), types of collaboration (see section 3.2.1) and the factors influencing its success (see section 3.2.4) (Hynes and Mollenkopf, 1998). These decisions are influenced by numerous factors including the required time frame for product innovations (Wonglimpiyarat and Yuberk, 2005). The decision to form the collaboration will also require the assessment of the organisations core competencies from MI A2. The three options for decision formation are in-source projects, (to run the projects in house completely), outsource project (to run the project external completely) or to form collaboration (partnership).

The PMM guidebook includes a decision matrix tool known as Plus/Minus/Interesting (PMI) tool which weighs the pros and cons of a decision. The output from this activity is the organisation's decision on either one of the identified options. The remaining modules in the methodology are only applicable if the design is to form a UIC.

MI A4: Select and evaluate partner(s)

The next activity in MI focuses on the selection and evaluation of an appropriate partner for the collaboration. The primary task in this activity involves selecting matching partners by assessing their quality, experiences and capabilities through the use of a set of criteria.

The published literature discussed in section 3.3.1 focused on the analysis of a large number of strategic collaborations and attempted to distil the key characteristics of successful projects and the traits of the various types of partners. For example factors to consider are technological capability, geographical factor, previous experience of strategic alliances, availability of external finance, project management capability, technical infrastructure, assessment of personality match etc.

In the developed PMM guidebook, a list of suggested means of identifying potential partners is provided. The identified matching partners are then assessed utilising a guided set of criteria generated identified based on review from literature discussed in section 3.3.1 and Table 3.7 analysis. Then it is scored with the use of a weighted scoring model where each criterion on the check list is assigned based on the analysis of the project stakeholders.

A list of 7Cs criteria for assessing collaborative partners were derived through extensive study and analysis of the existing literature (Brouthers et al., 1995, Bierly III and Gallagher, 2007, Wu et al., 2009)and data collected. These criteria had been validated in a number of studies identified in Table 3.7 which shows each of the criteria importance. In the methodology, each of the criteria is utilised to guide university and industry to conduct a comprehensive search of their potential partner(s):

- Complementary skills questioned on the potential partner’s experiences and capabilities in contributing to the collaboration. This assures that collaborative partner is willing to provide to each other simultaneously maximising interdependencies level.
- Compatible goals and objectives assess partners mutuality of shared vision and mission that fits into each partners desire to collaborate. This criterion is also the most important success factor in collaboration based on literature investigation in section 3.2.4.
- Cooperative alliance culture looks into partner’s style of management, culture, practices, leadership etc. In the selection of a partner, one need to understand the differences of cultures, priorities etc. To assess partner’s cooperativeness in the collaboration, organisation need to take the initiative to perform visitations to understand partners wants, desire and participation level (see sections 5.3.4 and 5.3.6).
- Commensurate level of risk; requires organisations to assess the level of risk involved and to collaborate as a mean of risk reduction. Partners’ need to be willing to share and anticipate some of the major risk area such as financial pressure.
- Cooperative relationship assessment includes aspect of partner confidence, trust, openness and honesty working towards collaboration and possible future relationships. It also includes the level of relationship between geographically dispersed workforces.

- Characteristics of partners need to be assessed with respect to personality matching, unique competencies, historical background, past performance etc
- Capabilities in terms of technology, resource and facilities available to the project need to be defined and allocated along with any constraints (e.g. resource calendar) need to be established. Hence partners which are better equipped with the necessary facilities or infrastructure are given higher priorities.

MI A5: Internal proposition

Upon selection of the appropriate partner for the collaboration, the next activity involves creating a project initiation document (PID). The PID facilitates understanding and communication of the project objectives, benefits, timeline, milestones, deliverables, cost estimation and associated project constraints. The creation of a PID is one of the most critical factors to successful delivery of the project.

Upon completing the PID, the activity proceeds with creating the project team and appointment of the project manager. Based on discussion in section 3.2.4 and the findings from section 6.2, the methodology also includes a project team commitment agreement. The agreement is created to establish an understanding, shared vision and commitments from all team members. It also aids in ensuring that each member involved in the project accepts his/her responsibility to fulfil all aspects of the project as planned. This is followed by identifying the key stakeholders in the project with the use of a stakeholder analysis. Finally, the stakeholders are briefed in a kickoff meeting.

The following activities in MI presented below (MI A6, MI A7 and MI A8) are not within the scope of the methodology. Hence, the PMM guidebook only provides a brief explanation.

MI A6: Negotiate agreement

This activity requires partners to negotiate their mode of collaboration. To aid this activity, the guidebook leverages on the work done by Lambert toolkit for research collaborative agreements which was recently updated in 2008 (Department of Innovation Universities & Skills, 2008). The Lambert toolkit consists of a set of 5 model research collaboration (one to one) agreements and four consortium (multi-party) agreements. The objectives of the toolkit are to facilitate negotiations between potential collaborators by providing the best practices in this area to reduce the time to secure a mutually acceptable agreement between collaborators (Department of Innovation Universities & Skills, 2008).

In all cases it is important that the model is compatible with the way the organisations work. Hence, to ensure successful planning, it is recommended that joint agreements on the level of control and authority, clear roles and responsibilities and issues associated with IPR, patents, publications, policy etc are defined. It is also vital for both partners to establish their contractual trust, openness, honesty and transparency in the work performed. Among the many issues to be resolved in the collaborative agreement, the following aspects should be raised, clarified and agreed:

- Area/scope of research (in terms of objective, scope, deliverables)
- Role and level of commitment of both partner
- Agreement on the ownership (distribution rights for patents, publication of results, licensing, royalties)
- Financial terms and sponsorship by external source
- Confidentiality of information (non-disclosure agreement)
- Rules of researchers (allocation of time and commitment spent on the project, staffing allocation, administrative work)
- Project organisation structure (reporting channel and authority level)
- Usage of facilities, laboratory, equipment, infrastructure
- Project risk and constraints
- Project schedule and costing
- Ethical code of conduct
- Termination of contract/collaboration

MI A7: Obtain external funding

It is not uncommon for collaborative projects to seek for external fund from government, charities and even other external organisation to support the project. Although financial support is generally the expected resources there are various forms of support for instance resources like manpower, materials and machinery which may be identified as lacking in the collaboration need to be negotiated with a third party. Since these activities often involve funding agencies, the amount of time, the complexity and the uncertainty should not be underestimated.

MI A8: Approval and agreement

The final activity in MI is the approval and agreement signing. The two agreements that are commonly drawn up and signed are the Memorandum of Understanding (MOU) and the Memorandum of Agreement (MOA). The initial MOU is signed earlier in the process as an expression of interest to collaborate. It is not a significant legally binding document. The MOA is a cooperative agreement written upon agreed objectives by both parties to work together. It is a written understanding between parties outlining the parties' responsibility and commitment to the partnership. Lastly, this is usually accompanied by a ceremonial possession to officiate the bilateral agreement between parties.

At the completion of Module 1 the outputs need to be reviewed and approved by the collaborative agent committee before proceeding to Module 2.

7.3 Module 2: Planning (MP)

The second module of the PMM guidebook is referred as Module 2: Planning (MP) as shown in Figure 7.5. The objective of MP is to create a set of documents to help the project team establish a standard set of toolkits for reporting and documenting project information. These toolkits are able to assist integration, promote effective communication and are required to be updated as the project progresses to highlight variation from the baselines.

A total of 7 major activities for this module are listed together with its associated inputs, tasks, toolkits and outputs as shown in Table 7.2. The following key objectives of MP are:

- To develop an activity schedule
- To identify project resources and budgets
- To document and track issues arising in the project
- To identify, plan and respond to risk and uncertainties in the project
- To plan the communication and information distribution channel
- To identify and assure quality target meets stakeholders expectations

Details of each activity are described in the PMM guidebook. The following sub-sections present an overview discussion of each of the 7 major activities in MP.

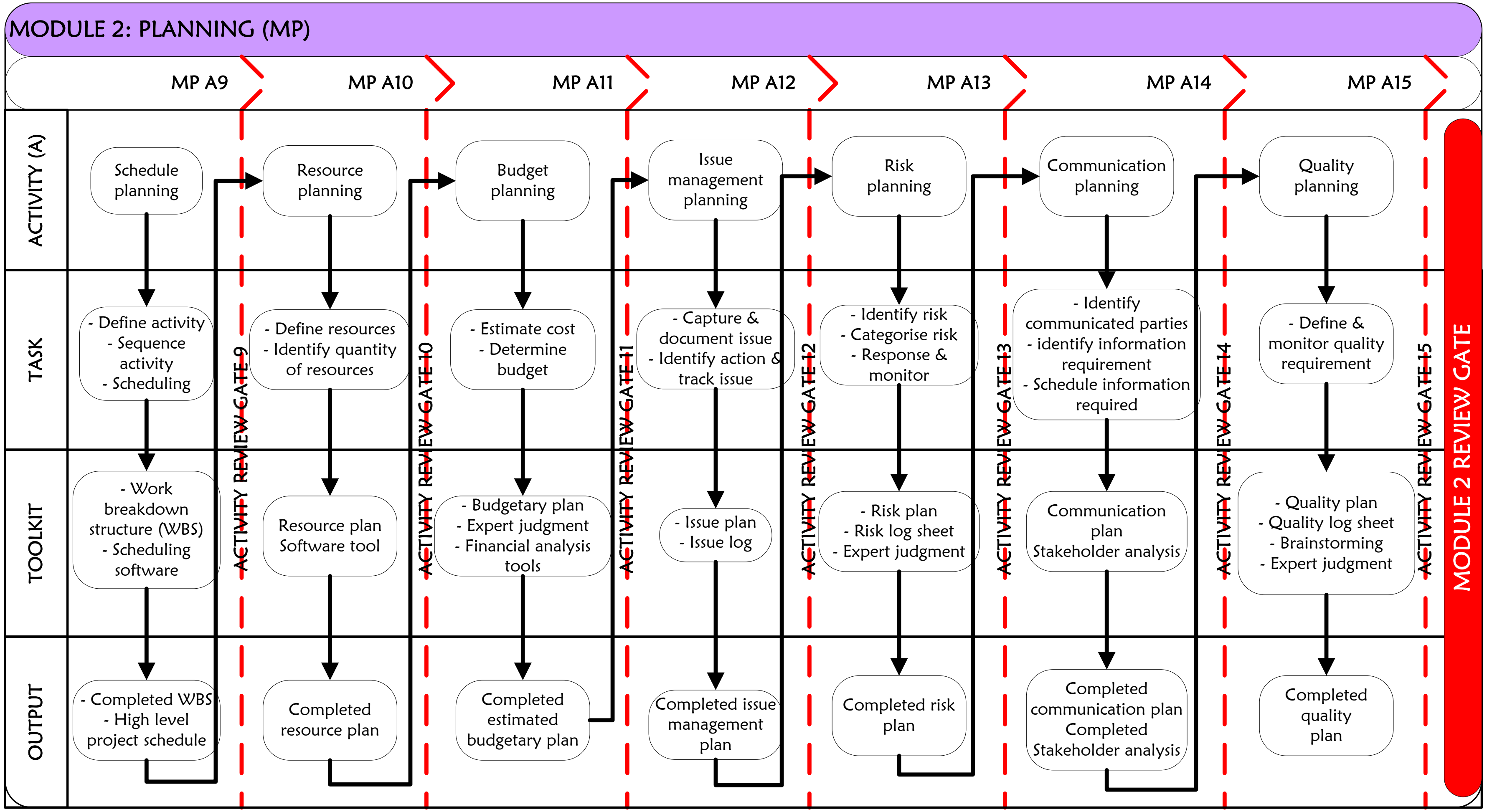


Figure 7.5 PMM Module 2: Planning flowchart

Table 7.2 Final PMM guidebook Module 2: Planning contents

Activity	**Key people involved**	**Inputs**	**Tasks**	**Toolkits**	**Output**
MP A9	Project manager Project research leader(s) Project team member Project sponsor	PID Project team structure Stakeholder analysis Signed collaborative agreement	1. Activity definition (a). Create a WBS (b) Create a WBS dictionary (c) Create a RAM 2. Activity sequencing 3. Activity scheduling	WBS template WBS dictionary template RAM template Scheduling software	WBS WBS dictionary RAM Project schedule (Gantt chart)
MP A10	Project manager Project research leader(s) Project team member Project sponsor	PID Signed collaborative agreement WBS/WBS dictionary RAM Project schedule	1. Define resources 2. Identify quantity of resources 3. Schedule resources	Resource plan template MS Project software Expert judgment	Completed resource plan
MP A11	Project manager Project research leader(s) Project team member Project sponsor	PID Signed collaborative agreement WBS/WBS dictionary Project schedule Resource plan	1. Estimate cost 2. Determine budget	Budgetary plan template Expert judgment Financial analysis tool	Completed budgetary plan (cost baseline)

Table 7.2 Final PMM guidebook Module 2: Planning contents (cont)

Activity	Key people involved	Inputs	Tasks	Toolkits	Output
MP A12	Project manager Project research leader(s) Project team member Project sponsor	PID Signed collaborative agreement WBS/WBS dictionary Project schedule Resource plan Budgetary plan	1. Capture and document issue 1. Identify actions and track issue	Issue management plan template Issue log template	Issue management plan Archive issue log
MP A13	Project manager Project research leader(s) Project team member Project sponsor	PID Signed collaborative agreement WBS/WBS dictionary Project schedule Resource plan Budgetary plan Issue management plan	2. Identify risk 3. Categorise risk 4. Response and monitor risk	Risk plan template Risk log template SWOT analysis template Expert judgment Brainstorming session Data gathering techniques	Risk management plan Archive risk log

Table 7.2 Final PMM guidebook Module 2: Planning contents (cont)

Activity	Key people involved	Inputs	Tasks	Toolkits	Output
MP A14	Project manager Project research leader(s) Project team member Project sponsor	PID Stakeholder analysis Signed collaborative agreement WBS/WBS dictionary Project schedule Resource plan Budgetary plan Issue management plan Risk plan	1. Identify information requirement 2. Schedule information required	Communication plan template Expert judgment	Completed communication plan
MP A15	Project manager Project research leader(s) Project team member Project sponsor	PID Stakeholder analysis Signed collaborative agreement WBS/WBS dictionary Project schedule Resource plan Budgetary plan Issue management plan Risk plan Communication plan	1. Define quality requirement 2. Monitoring quality requirement	WBS dictionary Quality plan template Quality log template Expert judgment Brainstorming session	Completed quality plan

*M: Module; A: Activity

MP A9: Schedule planning

This is the first activity of MP. A work schedule helps the project team to have a better vision of the project timeline and work that must be completed. This document serves as the foundation for all other plans and as a baseline to monitor performance against the actual plan.

To create the work schedule, the methodology guides users to breakdown the project work into smaller and manageable pieces. A tool known as a work breakdown structure (WBS) is used. Once project work has been broken down, it is easier and more accurate to assign resources, responsibilities, duration, cost etc. The methodology will guide users how to apply the WBS to better create the work schedule. The next task involves creating a responsibility assignment matrix (RAM) as a tool to clearly define who is responsible for each work packages in the WBS. MP A9 contains some print screen samples to guide users in sequencing and scheduling the project activities with the use of the Microsoft Project. The outputs from this activity are WBS, WBS dictionary, RAM and a Gantt chart.

MP A10: Resource planning

Once the project schedule has been created, the next activity follows by listing the types of resource that will be utilised in the project. A few steps are required in order to complete the resource plan; (1) define resources, (2) identify quantity or number of each resource type required and (3) schedule resources.

The resource plan describes the physical resources such as manpower, material and machinery that are required to complete the project. It also includes a schedule determining when and where each resources is to be assigned and utilised as defined in the project plan. In creating a resource plan for smaller projects the use of planning tools such as Microsoft Project is appropriate as it offer adequate capability yet it can be easily used by a novice user. However for more complex projects, a full resource plan template needs to be established by the project team to ensure the right amount and types of allocated resources are planned in accurate and timely manner for project execution. A detail guide on how to complete the given resource plan template is explained in the PMM guidebook.

MP A11: Budget planning

After the resource plan has been created, the budget for the allocated resources needs to be estimated. The purpose of this plan is to prepare a summary list of cost that is likely to be incurred by the project in terms of the physical and non-physical resources assigned in MP A10. Further, it also caters for various respective types of cost that are likely to be incurred. The steps involved in performing this activity are to estimate the costs for each resource identified in the resource plan and determine the budget by cumulating the estimated cost of individual categories to establish a cost baseline. Creating this plan helps the project manager to measure financial performances over the project life.

MP A12: Issue management planning

During the course of managing the project, various problems, changes and queries will occur and may impede the progress of the project. These problems may arrive in a varied manner that will need to be captured in a proper way so it can be assessed and managed. The process of managing these problems is known as issue management planning. It is important to document issue identified in the project because during the course of the project, issues could become risks and may impact the schedule, costs or delivery. When issues are addressed, it reduces project risk and increases project success. The first step in MP A12 is to identify and raise any issues which may affect the project. When the issue had been documented and reported, the next step is to respond to the issue as approved by the collaborative agent committee. To enable progress on its resolution to be tracked, this methodology also provides an issue log to register and archive any issues which occurred during the project.

MP A13: Risk planning

One of the major factors to consider in the management of a project is risk planning. Project management is about being proactive in planning and managing issues and constraints. Thus, planning and managing risk is one of the most important responsibilities for the project manager. The activities in MP A13 involves steps to guide the project manager to identify, categorise, respond and monitor each risk that will occur and reoccur in the project life span.

By identifying risks, one can understand the potential problems that might hinder project success. This forms an assurance because by undertaking the risk plan, it can reduce the impact and probability of loss in the project. When each of the identified risk is documented and detailed, the next step is to categorise the impact of each risk with a scale of lowest risk impact to highest risk impact.

In project management, responding to risk without monitoring and control does not ensure that the relevant risk had been responded to appropriately. Therefore, this methodology includes a risk log which aims to help the project team to keep track of each identified risk in the project. The log records an outline of the risk category, descriptions, likelihood of occurrence and response strategy. Each risk is assigned to a specific team member and will also be reviewed by the collaborative agent committee. MP A13 is carried out as part of review gate hence it is only terminated when the project comes to an end.

MP A14: Communication planning

Effective communication is the key success factor in project management. This activity must be carried out from the start until the end of project handover. The communication plan documents the following;

- Interested parties; who are the people that will be requesting for the information e.g. supervisor, external party etc
- Information required; what type of information e.g. project status, performance, future plan etc
- Frequency level; how often the information will be distributed e.g. weekly, monthly, fortnightly etc
- Method; what media/techniques will be used to distribute the information e.g. facsimile, internet, intranet, etc
- Remarks; to highlight any comments or notes for review

The next step in this activity involves identifying the type of information which needs to be distributed to keep project stakeholders up to date on the project progress. Such information are required to describes what information goes to whom, when and how it is distributed. The conduct of this activity allows project manager to monitor and control the dissemination of information across project.

MP A15: Quality planning

The following activity is to determine the quality aspects of the project and to ensure it is well managed so that it conforms to the project requirements defined as quality planning. It includes identifying the standard or criteria expected from each partners (both university and industry) and the processes undertaken to accomplish and satisfy them.

The first step in developing a quality plan is to identify what are the criteria or standards that satisfy all project stakeholders. Then determine how best to meet those standards by identifying its acceptance criteria and assign a team member to be responsible on the quality action. To keep track of the project requirement as to ensure it conforms to the quality criteria or target, the methodology uses the quality log which assigns a responsible team member to control the deliverable of the quality standard. Any change requested for quality requirement need to be review by the collaborative agent committee.

At the completion of Module 2 activities, it would need to be reviewed and approved by the collaborative agent committee before proceeding to Module 3.

7.4 Module 3: Execution & monitoring (ME)

The third module of the PMM guidebook is referred as Module 3: Execution and monitoring (ME) as shown in Figure 7.6. The important task in this activity is to ensure the work performed is as planned by monitoring the progress consistently. The steps required to accomplish this activity are to monitor and keep track of progress and to conduct review gate process in the event of change requests as shown in Figure 7.7.

The two major activities in this module together with their associated inputs, tasks, toolkits and outputs are shown in Table 7.3. The following key objectives of ME are:

- To ensure each project objectives are achieved as agreed and planned

- To coordinate the completion of all tasks within schedule and budget
- To monitor change requests and minimise impact on project scope, schedule and budget
- To keep track of progress against plans through performance reporting
- Take corrective action against changes as recommended by the collaborative agent committee

Details of how to use the methodology is described in the PMM guidebook. The following sub-sections present an overview of each of the two major activities in ME.

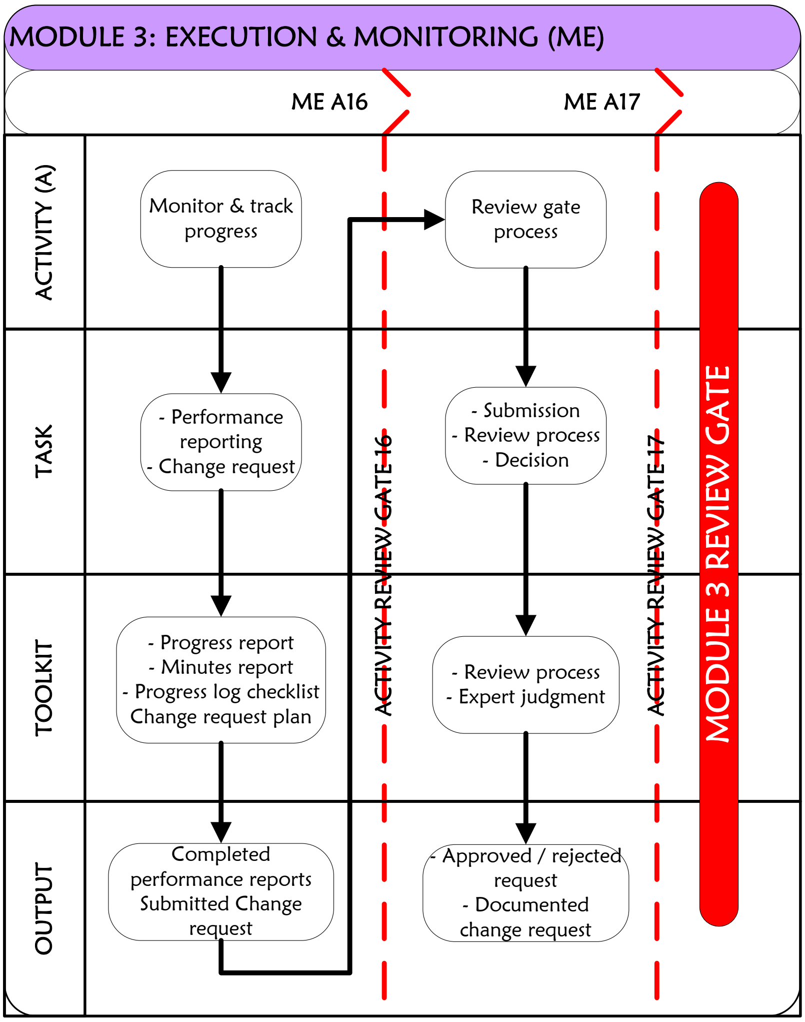


Figure 7.6 PMM Module 3: Execution & monitoring flowchart

Table 7.3 Final PMM guidebook Module 3: Execution & monitoring contents

Activity	**Key people involved**	**Inputs**	**Tasks**	**Toolkits**	**Output**
ME A16	Project manager Project research leader(s) Project team member Project sponsor	PID Stakeholder analysis Signed collaborative agreement WBS/WBS dictionary Project schedule Resource plan Budgetary plan Issue management plan Risk plan Communication plan Quality plan	1. Performance reporting 2. (a) Change request plan (b) Monitor change requested	Progress report Progress log checklist Project minutes Change request template Change request log	Completed progress report Archive progress log Project minutes Change request plan Archive change request log sheet

Table 7.3 Final PMM guidebook Module 3: Execution & monitoring contents (cont)

Activity	Key people involved	Inputs	Tasks	Toolkits	Output
ME A17	Project manager Project research leader(s) Project team member Project sponsor	PID Stakeholder analysis Signed collaborative agreement WBS/WBS dictionary Project schedule Resource plan Budgetary plan Issue management plan Risk plan Communication plan Quality plan Performance reports Change request plan Change request log	1. Submission 2. Review process 3. Decisions and actions	Review gate process Expert judgment	Archive change request log Updates on relevant project plan documents

*M: Module; A: Activity

ME A16: Monitor and track progress

This activity is continuously performed to provide project stakeholders a view on the inside out of the project health. The monitoring tasks aid to identify any areas requiring additional work or attention. To gain that information, one needs to organise inspections to audit the project progress apart from reviewing the documented work.

The primary task in ME A16 is reporting of project performance to the project stakeholders. Regular updates and documentation of change have been identified as best practices to ascertain if stakeholders' expectations are being met. These documents are also required by the collaborative agent committee in order to make decisions on project progress. There are various types of performance reporting generated, for example technical report, financial report, milestones report etc. In the guidebook, three forms of reporting are the minimal requirement; project minutes, project progress report and project progress log checklist.

The second task in ME A16 involves developing a change request plan. The plan aids the project manager to record the many requests that can have major impact on the scope, cost, schedule and quality of the project. These changes are documented and presented in both written form for review process by the collaborative agent committee to decide upon the appropriate actions.

In any event when a change request plan had been generated, the next step is to monitor the request by recording it into a log. The change request log records the description, justification for the request, impact, requester and the person responsible to rectify the requested change submitted to the collaborative agent committee for decision and action. It also helps to keep track of the number of requests submitted throughout the project lifecycle.

ME A17: Conduct review gate

This second activity under ME is iteratively reviewing the completion of each module in the project lifecycle. There are two review gates to be carried out in the methodology:

- Activity review gate – conducted at the completion of each activity in a module.
- Module review gate – conducted at the completion of each module in the project.

Key people involved in this activity are defined as collaborative agent committee in the methodology and they include:

- Project sponsor
- Project research leader(s)
- Project manager
- Senior management

The committee structure often consists of top level management board and in this methodology they are identified as collaborative agents. They are primarily a control party for reviewing the work performed and the changes requested to decide on any corrective action needed. The process is shown in Figure 7.7. Inputs must be provided to the committee for review, of which there are two categories of submission:

- Completion of an activity or module stage. The output generated is presented to the collaborative agent for review.
- Submission of a change request for an identified area that requires attentions.

Upon completion of review process, the collaborative agent decides on the appropriate actions, which are:

- Approval given to continue with the planned schedule and work
- Revision required and corrective actions recommended before proceeding with project works.
- Termination recommended; an ultimate decision to end the project works or changes made.

At the completion of Module 3 activities, a review and approval by the collaborative agent committee needs to occur before proceeding to Module 4.

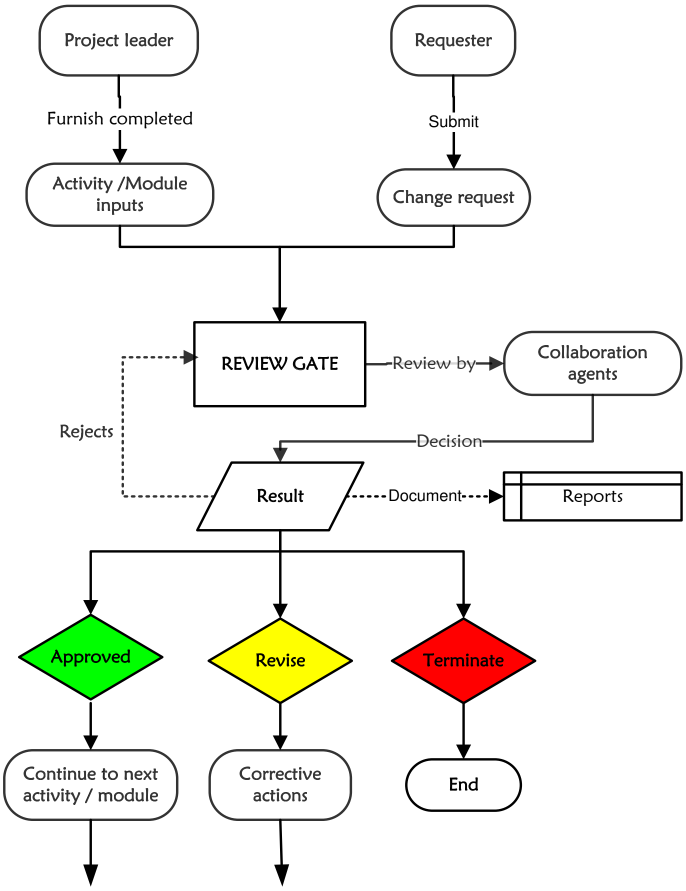


Figure 7.7 PMM review gate process after refinement

7.5 Module 4: Closing (MC)

The final module of the PMM guidebook is referred as Module 4: Closing (MC) as shown in Figure 7.8. To ensure the official signoff and handover can be carried out successfully, there are some activities that need to be performed. In this module, the methodology guides users on how to measure the collaborative performance, ascertain project deliverables, create a lesson learned report, archive all project documentations and prepare an end project report before officially exiting from the project.

The two major activities for this module are listed together with their associated inputs, tasks, toolkits and outputs as shown in Table 7.4. The following key objectives of MC are:

- To identify and measure collaborative performance
- To document lesson learned from project experience
- To gain acceptance of the completion of all project scope of work
- To signoff and handover to stakeholders
- To sustain relationship for future partnership

Details of how to use the methodology is described in the PMM guidebook. The following sub-sections present an overview discussion of each of the two major activities in MC.

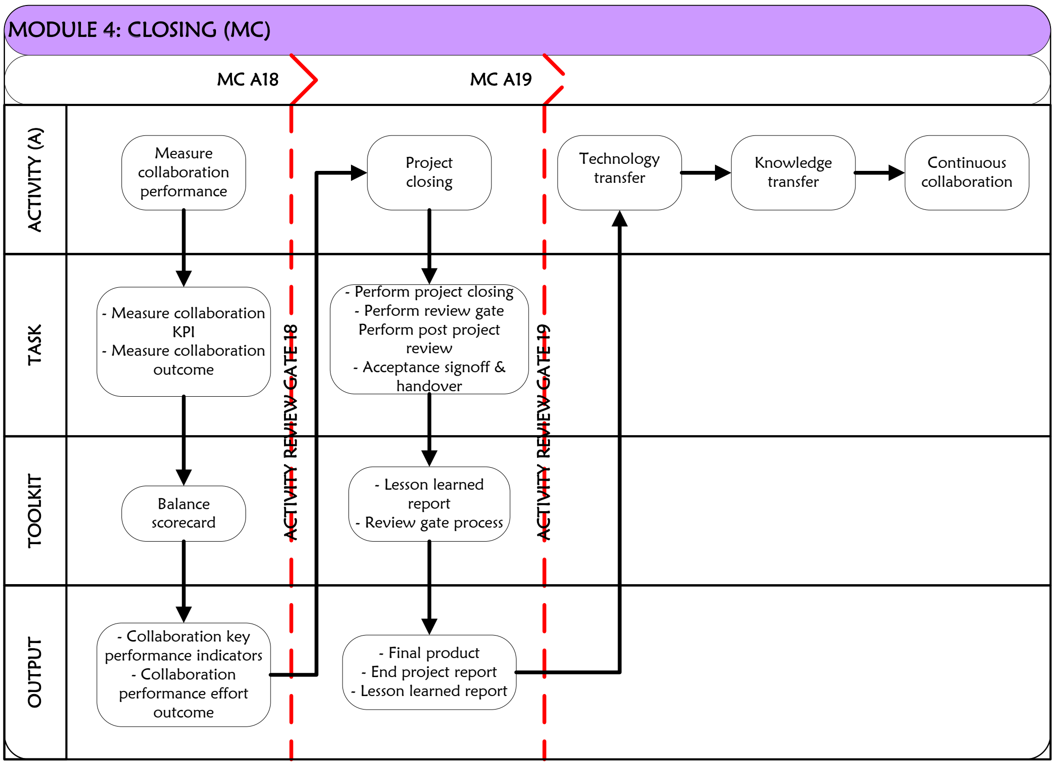


Figure 7.8 PMM Module 4: Closing flowchart

Table 7.4 Final PMM guidebook Module 4: Closing contents

Activity	**Key people involved**	**Inputs**	**Tasks**	**Toolkits**	**Output**
MC A18	Project manager Project research leader(s) Project team member Project sponsor Project owner Senior management	PID Stakeholder analysis Signed collaborative agreement WBS/WBS dictionary Project schedule Resource plan Budgetary plan Issue management plan Risk plan Communication plan Quality plan Performance reports Change request plan	1. Measure collaborative key performance indicators 2. Measure collaborative outcome	Project balanced scorecard model	List of collaborative key performance indicators Project balanced scorecard analysis

Table 7.4 Final PMM guidebook Module 4: Closing contents (cont)

Activity	Key people involved	Inputs	Tasks	Toolkits	Output
MC A19	Project manager Project research leader(s) Project team member Project sponsor Project owner Senior management	PID Stakeholder analysis Signed collaborative agreement WBS/WBS dictionary Project schedule Resource plan Budgetary plan Issue management plan & issue log Risk plan & risk log Communication plan Quality plan & quality log Performance reports Change request plan & request log List of collaborative performance indicator Collaborative effort outcome	1. Document lesson learned 2. Produce end project report 3. Acceptance signoff & handover	Lesson learned report template Review gate process Acceptance signoff template	Lesson learned report Final product End project report Archives of project documentations Acceptance signoff

*M: Module; A: Activity

MC A18: Measure collaborative performance

A measure of the deliverables attained indicates whether the collaborative effort was a success or a failure. The information is all essential when the partners are considering extending the collaboration. Based on literature review in section 3.3.3 and primary findings in section 5.3.1, both tangible and intangible performance indicators are measured in UIC projects. Tangible measurement indicators include the development of the particular product/technology; potential spin-off as a result of the collaboration; number of graduates generated; patents and non patentable property; list of publications in journals or conferences and financial success derived from the collaboration. Intangible performance indicators measure the exploration of new knowledge or findings from the collaboration research, increase of experiences, relationship building and its contribution into societal needs.

The next step in MC A18 involves measuring the collaborative outcomes with the use of a project balanced scorecard model. The technique uses a collection of measurements to evaluate project performance from four different and balanced perspectives; financial, customer, internal processes, learning and innovation (Kaplan and Norton, 1992). The purpose of the project balanced scorecard is to have a balanced view to understand the many interrelationships in the collaboration in order for improved decision making and problem-solving in UIC projects.

MC A19: Project closing

This is the final activity in the methodology. To initiate the closure of the collaborative project, all documents must be updated, project execution completed and reviewed by the collaborative agent committee. In this activity, lists of documents are produced to verify and audit the project requirements to ensure all the work has been carried out in a satisfactory manner.

In addition, the project manager and team reflect on their project learning experiences by documenting what forms of lesson learned .The final output of this activity includes formal acceptance of the project by both partners and official handover. At the closing of the project, follow-up actions are drawn up and the project manager and research team will be disbanded from its structure, officially closes, terminating the project.

7.6 Evaluation and Validation of the Final Project Management Methodology

This section presents the results of the evaluation and validation from the expert review panel on the developed final PMM guidebook. The aim of this validation is to test the final PMM guidebook as to determine whether the methodology is generic and practical for use in a much wider application and implementation in Phase 4 (see Figure 4.1). To enable a valid evaluation, the final PMM guidebook and the questionnaire survey were re-sent to the same group of expert review panel who had evaluated the pilot PMM as discussed in section 6.4. The questionnaire survey was structured and simplified into only three sections; feasibility, usability and usefulness (see Appendix 10). A total of 8 experts responded and evaluated the final PMM guidebook (see Table 7.5). The following discussion reports the responses obtained.

Based on the evaluation of the methodology's feasibility, all respondents agreed that the finalised PMM guidebook was easy to follow as it is comprehensively adequate to be communicated in between team members in a project based research environment. In addition, according to the majority of the respondents, the final PMM guidebook is appropriate as it has included all the necessary activities for use for better managing a collaborative research project environment. Although only one respondent perceived the activities in the PMM guidebook as labour intensive and requires facilitation in order to better use the methodology. The majority agreed that the methodology should be put forward for adoption in their research group or organisation with appropriate customisation. The PMM guidebook had been successfully adopted by an academician (U4) to manage his Cradle Fund project. The designed toolkit was adopted by his project team for documentation, execution, monitoring and controlling of the project. Overall, the results in this section had significantly indicated that the final PMM guidebook's is feasible and practical for application in a collaborative research environment.

On the PMM guidebook's usability, the final results from all respondents showed that the methodology is usable for individualised project or to supplement existing practices and method in an organisation. The supporting reasons that majority of the respondents agreed to, was the methodology has included the relevant toolkits and templates which are easy to use, modifiable and customisable in a collaborative research environment. Yet, two respondents indicated that other tools or techniques should be included in the methodology however no further comment was provided. In general, the evaluation from this section indicated the designed tools and techniques usability in a research organisation.

Lastly, the questionnaire survey evaluated the final PMM guidebook's usefulness to assist researchers to better manage UIC project. Positively, the majority of respondents indicated their support and consideration in utilising the methodology for their collaborative project as they unanimously was satisfied with the structure, design and contents of the methodology. Although a minority viewed the methodology as time consuming, yet majority agreed that it is a credible application for distribution to the market catered especially for the UIC research environment. Based on the suggestions and comments of expert panels in section 6.4.2 and future direction of this study (see section 8.6), the methodology would be developed as a web based application to minimise the administrative effort in managing collaborative project for university and industry partner. This section also evaluated a total of 34 toolkits. Based on the overall responses, the majority of respondents indicated that the designed toolkits were 'useful' to 'very useful' whilst the WBS dictionary, SWOT, 7Cs and the RAM were 'slightly useful' as viewed by the respondents. However, there were some toolkits that two respondents were uncertain about its usefulness for managing projects such as issue log, risk log, stakeholder analysis, project balanced scorecard, end project report and acceptance signoff. This may not be a significant issue as the majority of the respondents still agree that the mentioned tools are useful in managing collaborative research projects.

Overall, the final evaluation and validation of the PMM guidebook received positive recognition and feedback on its feasibility and usefulness for adoption and application in a UIC research environment. This evaluation had also significantly indicated that the next phase of this study (see Figure 4.1) could be put forward in a real UIC case project with certainty.

Table 7.5 Final PMM evaluation sample expert respondents' profile

No	Respondent ID	Organisation type/industry	Experience (years)	Research projects involved (no)	Used a PMM (Y/N)	Evaluation date
1	U2	Foreign university	6-10	>5	N	11/10/11
2	U3	Foreign university	1-5	>5	Y	3/10/11
3	U4	Focused university	>20	>5	N	7/10/11
4	U5	Foreign university	11-20	>20	Y	17/10/11
5	U6	Private university	>20	>10	Y	5/10/11
6	U7	Foreign university	>20	>10	Y	18/10/11
7	U8	Apex university	11-20	>10	N	9/10/11
8	PME2	Project management	>20	>20	Y	10/10/11
Notes: University (U); Project Management Expert (PME)						

7.7 Chapter Summary

This chapter presented the development of the final PMM. It has provided a holistic view and discussion on the construction of the PMM in terms of its components, structures and contents. Each module of the PMM was also discussed in detail outlining its key objectives, activities, tasks, inputs, toolkits and outputs. The final PMM is structured sequentially, comprehensive with accessible toolkits and templates for adoption and customisation. Designed in a guidebook, it focuses on a step by step approach from how to initiate, plan, monitor to closing a UIC research project. This chapter had also presented the evaluation and validation of the final PMM guidebook by 8 experts from the sample expert panel review group in section 6.4. The results had confidently indicated that the developed final PMM guidebook is a well practical and acceptable methodology for application in a real UIC research project environment.

The next chapter will conclude the research objectives in this study, contribution to knowledge, implication to policy and practice, limitations and direction for future research.

CHAPTER 8 CONCLUSION, CONTRIBUTION, IMPLICATIONS AND DIRECTION FOR FUTURE RESEARCH

8.1 Introduction

This chapter concludes the study by summarising the research findings against the research objectives and outline the contributions of this research. It continues to look at the implications to policy and practice, limitations of the research and finally some thoughts on the directions for future research in this area.

8.2 Conclusion on Research Objectives

This section provides an outline of the research aims and summarises the principal finding from this study.

The ultimate aim of this study is:

'To develop a PMM for use in a UIC research environment'

The above aim was addressed by completing a set of specific objectives as follows:

1. **RO1**: Reviewing the body of literature on PMM and evaluate the various PMM in the market to identify a list of requirements to be placed on a PMM suitable for the management of UIC research projects
2. **RO2**: Reviewing the body of literature to identify the need for UIC projects in the Malaysia context and to investigate current practices used to manage UIC partnerships in Malaysia using an exploratory case study approach
3. **RO3**: To conceptualise, evaluate, refine and develop a PMM guidebook suitable for adoption in the Malaysian UIC research environment

The research strategy adopted for this study was the exploratory case study approach. In this study, the context would be a UIC in Malaysia and the development and application of a suitable PMM to manage such research projects. Two main data collection techniques were utilised; semi-structured interview and questionnaire survey. A total of 19 interviews were carried out with university and industry partners from September to November 2009. As well as conducting interviews, respondents also participated in a self-administered questionnaire survey to validate factors and issues identified as common in a UIC project environment. A pilot PMM was formed on the basis of the literature review and primary data gathered through the above methods

In this study, formative evaluation and expert panel review (Evalsed, 2009) were utilised. A questionnaire survey was chosen as the most appropriate method of collecting quantitative data from the evaluation model selected due in part, to time and resource constraints. The objective of the questionnaire survey was aimed at evaluating the developed PMM in order to seek expert panel judgment and suggestions for further improvement. The purpose of the expert panel evaluation is aimed at measuring the following elements (Adesola and Baines, 2005, Platts, 1990);

a) Feasibility; could the methodology be easily followed?
b) Usability; is the methodology workable? Are the steps, tools and techniques easy to use and apply?
c) Usefulness; is the methodology worth following? Will the methodology help researchers to produce better results in project management?
d) To identify areas of improvement for the methodology.

A pilot evaluation was carried out in July 2010 to assess the reliability of the questions designed in the evaluation form. A total of 13 respondents participated in the evaluation process (see Table 6.6) from July to September 2010. Upon evaluation by expert panel review, the pilot PMM was refined and finalised for wider application (see PMM guidebook).

The following presents the findings and conclusions of each research objective in this study.

RO1 findings: A review of the literature identified a list of requirements to be placed on a PMM suitable for the management of UIC research projects

Research focusing on the leading project management practices were identified, collated and reviewed with particular focus on its merits and drawbacks. The aim of the study is to identify the best combination of project management methods to build a generic PMM. As such the study found that the best integration would be the use of PMBOK and PRINCE2 practices as each complements the shortcomings of the other. The findings from chapter 2 generated a new definition for PMM (see section 2.2) and a new system of classification (see section 2.3) used in this study. A rigorous review of existing PMM allowed the best practices from academic institutions, industry and governmental organisation to be established. A list of requirements placed on PMM was also outlined:

1. It should facilitate the identification and management of risks and opportunities.
2. It should facilitate the clarification of goals and scope of the project by incorporating the best practices of project management group processes (MSF, 2002, Kroll and Royce, 2005), tools, techniques (Charvat, 2003, Bolles, 2002, Murch, 2001) and templates to effectively plan and manage research projects.
3. It should create a project board to oversee, monitor and assess the research project progression.
4. It should be scalable and adaptable to project sizes; where it should be specific to the organisation but customisable to individual projects (Charvat, 2003, Cockburn, 2000, Chemma and Shahid, 2005, MSF, 2002).
5. It should leverage on the best practices of the specific environment/discipline to minimise obstacles and failure rate.
6. It must be in place to promote organisational learning (MSF, 2002).
7. It should be based on organisation, governmental and sector specific standards and regulations (Wideman, 2006, Turbit, 2005, Pitagorsky, 2003, Josler and Burger, 2005, Charvat, 2003).
8. It should model the work flow of typical project (Charvat, 2003, Turbit, 2005, Bolles, 2002, Murch, 2001).

RO2 findings: Primary data from the case studies indicated some critical issues implying the lack of practical application and the importance of PMM in managing UIC projects.

Current methods of UIC practices and management have been investigated, collated and documented via qualitative and quantitative approaches. Interview data was reviewed and categorically coded (see Appendix 5 and Appendix 6). The results suggest a lack of application of a structured methodology in managing UIC research projects. The following findings were drawn based on the results discussed in chapter 5.

What are the driving factors for the formation of UIC?

1. The need to provide complementary support on each other's needs and wants from both university and industry in many aspects such as subject matter expertise from university and financial support to the university researchers.
2. With a common ground of interest by viewing UIC as a window of opportunity to both university and industry in generating fruitful innovation to the community and the nation.
3. The provision and support of facilities, infrastructures and expertise in the field of research.
4. Industry viewed UIC as a primary key to increase their value chain of competitiveness in order to constantly develop and improve their product pipeline in the market.

What are the problems/challenges anticipated in UIC?

5. Though a central research management unit exits in the majority of universities, there is lack of appropriate skills and capabilities in managing industrial relations, resulting in a low rate of UIC partnering. The PMM developed thus needed to be more assertive in industrial relationship management.
6. There is lack of obligation for university academicians to be involved in industrial work and vice versa.
7. Performance measurement is viewed as a critical component of UIC projects. However, findings identified that there is lack of measurement toolkits to consistently assess and review successful delivery of products throughout the project with the exception of performance reporting.
8. Partner selection is deemed crucial in UIC projects; however findings revealed that this aspect was not taken seriously at present. To safe guard possible issues between partners, potential partners are preferably selected based on previous relationships.

What are the best practices for the management of UIC?

9. UIC effectiveness is inhibited by various factors e.g. bureaucratic structure of university administration, lack of autonomy for researchers, negotiation process and trust when establishing the UIC. There is a need for better understanding, communication and frequency of interaction to enhance UIC relationship.
10. The identified list of best practices from the case study presented in section 5.3.5 are to create mutual understanding and objectives, university academicians should be given certain degree of autonomy and flexibility and constant and transparent communication should be maintained between partners.

What are the processes involved in the operation/management of UIC?

11. There are increasing concerns in the management of university and industry attitude, mind set and communication skills during the initiation of UIC partnerships.
12. There were no structured PMM guidebook or guidelines adopted for the management of UIC project, rather university and industry partner management were based on practical experiences, skills and culture of the organisation management.
13. University and industry partners are not keen to appoint a project manager. In their view, it would only incur higher costs.

RO3 findings: A PMM guidebook was successfully developed and evaluated by experts for adoption in the UIC environment

The methodology aimed to assist university and industry partners (especially first time researchers) in the planning UIC projects has been successfully developed based on the research discussed in chapters 2 and 3, semi-structured interviews, questionnaire survey and expert evaluation in chapters 5 and 6. The structure and components of the final PMM are described in chapter 7.

Three criteria of assessment were evaluated by a group of expert panels presented in section 6.4.1 and experts' suggestions were noted in section 6.4.2 to improve the final PMM. Upon refinement of the final PMM, it was resent to be validated by the same group of expert panels to confidently indicate its applicability in the market. Overall, the PMM guidebook received positive feedback in terms of design, usability, usefulness, comprehensive nature and ease of use. In terms of its differences between other methodologies in practice, the majority of UIC respondents commented that the designed PMM is unique in the aspect of its structure, layout and partner selection technique. The PMM which focuses on UIC research environment provided a balanced view between university and industrial requirements. It is also easily comprehensible written appropriately in layman languages and includes all the appropriate modules, tools and templates.

8.3 Contribution to Knowledge

This study provides significant contributions to the project management knowledge, methodologies and the evolving area of UIC in Malaysia.

Firstly, the study showed that though a rigour literature on PMM and the UIC research environment exists, there is little research on the integration of these two knowledge areas. Hence, the main outcome of this research is developing a generic methodology for use in the UIC research environment. The methodology designed facilitates university researchers and industry players involved in UIC projects to work effectively together. It is complete with a set of 34 toolkits and templates that provide an ease of planning, monitoring, evaluation and reviewing process. The underlying methodology in the PMM guidebook forms the primary contribution of this study.

Secondly, this study has contributed to a new understanding of the PMM concepts and practices. The study discusses the five groups of leading project management practices, their merits, limitations, structure and components within the context of managing UIC projects. The research work defines the combination of project management best practices which when integrated give the optimum probability of delivering the project objectives on time and within budget (Chin et al., 2010). This became the basis in the design of the PMM. The study had also classified PMM into two major categories with five distinct but interdependent levels. The two categories were project management methodologies (that provide a high-level framework for the project) and application development methodologies (which provide details on project design and development) and five different classification levels were identified. The PMM classification also functions as an effective tool for novice project managers to understand PMM. Further, this study has critically reviewed and compared the various PMMs available in the market using a list of elements. Based on the analysis, the study had elicited a common set of requirements as presented in section 2.5.4.

Lastly, this study contributes towards a better understanding of the applicability of PMM in a UIC environment. Considering the importance of UIC partnership as a vital cog being the key to moving the nation towards a knowledge based economy, this study has provided an insight into UIC in Malaysia from the university and industry perspective. The study streamlined and leveraged the best practices by designing a methodology to support and cultivate UIC in this market.

In summary, this study has contributed to the project management knowledge and UIC literature. The research implication to policy and practice are presented in the next section.

8.4 Implication to Policy and Practice

Drawing from the discussions on research objective presented in the previous section, this section advocates several important lessons within the findings that can be applied to policy and practice by universities and industries.

First, this study found that organisations do not practice any specific guidelines in the management of UIC projects. In some institutions a research management centre monitors the performance of UIC projects in the aspects of finance and milestones. However, the majority of respondents indicated monitoring and coordination of UIC projects are merely based on individual effort with a lack of support for UIC partnership set up. Though such research units existed in the institutions, it lacks potential use in supporting UIC. Further, due to bureaucratic management structure and administration, the process of establishing UIC partnerships were a challenge as lengthy processing time becomes a constraint to many industry players. Thus, it is implied that this research creates a generic PMM guidebook that both university and industry players can use specifically for managing projects in the UIC research environment. It is designed to simplify the process of initiating, planning, executing and completing a UIC project. It also facilitates the process of learning and understanding of the fundamental knowledge of project management as the essence in the successful completion of the project.

Secondly, based on the findings of this study academic institutions should take more initiative as this will cultivate stronger UIC relationship in the long term. Visits to commercial environment will enable academicians to investigate and understand market needs to identify new R&D projects which have a potential leading to commercialisation. In addition, institutions should also impose a new strategy to encourage academicians to utilise their sabbatical leave for internship or placement in the industry and to investigate new fields of research.

Third, in the issue of partner selection, the study found that failure to sustain UIC was mainly due to incompatible interest and aims. An evident reason underneath this occurrence is due to poor selection of partners which consequently leads to poor understanding and communication in the partnership. In practice, the study found that respondents minimise problem occurrence by selecting partners based on their pervious relationship. However, this act consequently minimises the interaction of the institutions with a broader network of organisations in the market. Thus, this study implied that in practice, university and industry should select and evaluate their potential partners using a list of selection criteria which has been incorporated in the developed PMM guidebook.

Fourth, the study found that the appointment of a project manager was not considered as an important factor as the literature suggested. However, findings from respondents indicated there were no physical project managers in practice rather the role is generally taken by the project leader (from university) or project sponsor (from the industry). However, strong indication in the literature suggests that a project manager is one of the best practices for adoption in a collaborative research environment (Groman, 2006). Thus, this study implied that the recruitment of a project manager for UIC management would be a significant contributor to the project success. As such university and industry must commit to training an academic project manager to facilitate the UIC partnership and lessen the dependency on each partner. Further, with the appointment of a project manager for each partner, it will tailor the needs and style of the organisation culture (Cooke-Davies and Arzymanow, 2003).

Fifth, the findings from respondents noted that in UIC R&D projects technical skills are an easily accessible and manageable resource. However the management of UIC requires adequate soft skills, particularly relationship management. This factor requires commitment, understanding, compromise and trust building over the partnership. The study found this to be lacking in practice, it would require both organisations to place greater emphasis on managing soft skills in order to sustain UIC partnerships in the long term.

Finally, in the reflection, many respondents noted the value of equipping academicians with industrial experience. Based on the finding, an academician with industrial background have the tendency to better understand the needs and style of industrial management and are thus able to interact more effectively with industry partners. Hence, the implications made here is to encourage the university to recruit academicians with some industrial exposure as a value adding essence for the university especially in dealing with industrial relations. This also contributes to a better concept of learning which enables integration of experiences and practice as a way of developing new knowledge and innovation (Hill et al., 1998).

8.5 Limitations of Research

While this study contributes to knowledge, policy and practice, it also gives rise to some limitations that could affect the findings of this study. However, these limitations raise further questions and research opportunities.

One primary limitation noted was the sample size used to evaluate the PMM guidebook. As the sample was relatively small, there may be a lack of validity and reliability in the results obtained from the expert panel review evaluation process. The point noted here are obvious since due to the use of a case study research design, only a limited number of case reviews were possible within the time frame of this study. Further, the research focused on examining only UIC engineering based R&D

collaborations. It should however be noted that the lack of maturity of UIC in Malaysia means that even this small sample represents a significant fraction of those qualified and experienced to evaluate this research environment. It would be preferred to have conducted a greater number of case studies involving private higher educational institutions in Malaysia; however it was not possible within the timescale of the project. The comprehensiveness and robustness of the methodology might improve if more test cases were applied.

The second limitation of this study is related to the difficulty of achieving full access to available information on UIC projects. In the majority of interviews conducted with university and industry players, the issue of privacy and confidentiality of their collaborative information presented some constraints. It was intended in the study to corroborate evidence from project documentation, however the majority of respondents were not willing or able to provide full access to the documentation and the majority of validation was done through accessing publicly available documentation. It is an inevitable reality in a research environment; nevertheless every effort was taken to obtain all relevant project documentation.

The study aims at developing a PMM for adoption in the UIC research environment a significant and novel endeavour in the field of Malaysia UIC. Based on the study, this area is still under studied, especially in the Malaysian context. Significant efforts were committed to design the methodology which was evaluated and validated by a group of expert panel members. However, the implementation of the PMM in a real UIC project proved to be a challenge without ongoing engagement with an organisation during the study. Thus, due to the shortcoming of this challenge, certain issues could not be researched in depth and as a result, the developed PMM is still at pre-deployment stage. Though it was obvious that actual implementation and testing of the PMM in real UIC project should be carried out within the given time frame this was not possible. However, based on evaluation results, the PMM guidebook was considered feasible, usable and useful for implementation in the UIC research environment. It also demonstrated a structured methodology which would enhance UIC project success and partner relationship management.

Lastly, R&D activities can be characterised as complex, interdependent and responsive to sudden research environment changes (e.g., breakthroughs, new barriers, and collaboration changes) (EFCOG, 2010). For effective project management within R&D and engineering projects, there are many significant and diverse challenges. The outcomes from an R&D projects are frequently difficult to define (Commonwealth of Australia, 2003). Such projects often have unclear purpose or shifting objectives which lead to significant challenges in scope management, scheduling and resource management. As a result, it is common for R&D projects not to demonstrate immediate returns on investment at the close of the project. These characteristics of R&D projects reinforce the need for sound project management and for organisations to adopt a robust methodology to support the research environment. This work shows that for the value of project management methods in the R&D environment to be optimised, the methodology must be adaptable to the project environment and sufficiently flexible to ensure it can cope with the high degree of uncertainty and change which is endemic in research (Larsen, 2005). Therefore one of the purposes of developing the PMM is to assist the management of uncertainty common to the R&D project environment. However, the developed PMM could only be used for selective UIC R&D projects which fulfill the following parameters such as:

- R&D projects involved in contract research or joint contract,
- engineering based research projects only
- small to medium sized projects (budget range from RM50k to maximum of RM500k only)
- UIC projects which are only funded or supported by industry
- duration of project is 2 to 3 years (less than 5 years timeline)

Despite the limitations of this research, the developed PMM supports UIC project management and provides opportunities for future research. The directions for future research are outlined next in the following section.

8.6 Direction for Future Research

The establishment of UIC in Malaysia are still visibility lacking (Abdul Rahim and Mohd Said, 2006, Malairaja and Zawdie, 2008, Gomez, 2009). Malaysia is still in its infancy, establishing and promoting this effort to the market (Abdul Razak, n.d., Zahedi et al., 2000) although significant advancements have been made in the past decade. Until recently, the gaps between university and industry are more significant than expected hence more empirical work needs to be carried out to identify the impediments to produce more effective practices to cultivate UIC (Abdul Razak, n.d., Abdul Rahim and Mohd Said, 2006). The research objective for this study also aims to bridge the visible gap by providing new insight to the adoption of PMM as a strategy to improve the management of UIC and to subsequently increase UIC research efforts for the nation.

While this study offers a foundation for PMM adoption in the UIC research environment, further research is required to verify its findings to increase understanding on the effectiveness of PMM through application. Thus, this section recommends the following areas for further work to be carried out.

- **Implement and testing in real life UIC research environment to improve the PMM.** The PMM guidebook developed in this study has been assessed as usable and applicable by experts. However, it would benefit from further testing and refinements in real UIC research projects. Much of the processes were fairly straightforward and understandable from the expert viewpoints. However, it was also obvious that each respondent from university and industry did address a number of issues in regards of the design; components and structure of the PMM (see section 6.4). Further work on making the PMM more practical oriented to fit into the nature and needs of university and industry would be recommended.

- **Incorporate as a blueprint policy for use in the UIC research environment.** With the emerging trends facilitating the needs for a closer bond between university and industry in Malaysia, there is still lack of empirical evidence in research effort and streamlining of best practices and guidelines to purportedly support and cultivate this UIC effort in the market. Therefore, future research should contribute to the policy and practices of Malaysian UIC partnerships in the aspect of project management knowledge and application that has yet to be investigated by establishing a blueprint to guide university researchers and industry players.

- **Develop a web based methodology application.** Another important area suggested includes the development of a web-based PMM guidebook. The creation of which would enable quick navigation, communication, accessibility to readily designed templates and document management. It also facilitates distribution and sharing of communication between research teams in a distributed UIC research environment. By developing the web-based PMM, it functions as a repository database of the processes, toolkits and templates. This would also promote UIC partners to selectively customise the relevant tools and templates for use based on the nature and size of project.

- **Improve the developed PMM to assist the variability of scope arising in R&D project environment.** In scientific R&D projects, the outcome may be long term or difficult to define unlike an IT or construction project. In addition the research or policy environment may change rapidly, with new breakthroughs affecting the risk of the project. Thus, the future direction of this work will need to support the variability of scope in R&D project environment in order for research project to benefit the use of standard project management techniques and methods.

8.7 Concluding Remarks

In Malaysia, there is a growing need for universities to collaborate with industry. These interactions promote greater innovation and strengthen the nation’s economy. Though there has been many initiatives undertaken by the Malaysian government to promote UIC, it is still very much understudied as found in the literature review. Further prior to this study no PMM existed for use in the UIC research environment in Malaysia context. Thus, this study makes a significant contribution to the theory and practice of UIC project management in Malaysia.

Worldwide companies have strongly voiced their difficulties in matching their practical approaches with academicians theoretical views (Wu, 2000) especially in relation to the way projects are managed. In addition, academic researchers lack the skills in managing and planning research projects (Gist and Langley, 2007). They tend to disregard the importance of the project management elements and functions in the management of collaborative projects and concentrate only on the technical deliverables. Similarly, industry players lack understanding and appreciation of the academic research process. By developing a systematic PMM, this study aims to bridge the gap between industry and academic perspectives so partnerships can be strengthened.

This study also contributes to the body of knowledge regarding UIC in Malaysia which presently has received very little academic attention. It has further explored the work of Yee et al. (2009b) focusing on the aspects of project management for UIC that were not explored in their research (Yee et al., 2009b). It also aims to contribute to the policy and practice of Malaysian UIC partnerships in the aspects of project management knowledge and application that have yet to be investigated.

Studies by other authors have indicated the level of interaction and collaboration between UIC in Malaysia are still very limited which significantly impedes collaborative potential (Ali, 2003, Abdul Razak, n.d., Zakariah et al., 2004, Malairaja and Zawdie, 2008). With a number of initiatives taken by the government in recent years there is now more focus on cultivating a UIC culture. Data collected in this study recommends the need for more studies on UIC and their promotion for the Malaysian markets. This study has provided a dyadic view of the best practices and lesson learned from previous and existing UICs which contribute to the conceptualisation of the PMM.

This chapter has concluded the research findings of this study, discussed its major contributions, implications to policy and practice and the limitation of the research. Directions of future work have also been suggested. It is hoped that this study has made its significant contribution to the body of knowledge in theory and practice.

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APPENDICES

Appendix 1 Letter Requesting Information from the University

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

Faculty of Engineering
Jalan Broga
43500 Semenyih
Selangor Darul Ehsan
Malaysia
Tel: +6(03) 8924 8000
Fax: +6(03) 8924 8017
www.nottingham.edu.my

ATTENTION TO:
<Research Management Center Director>
<University ………>

REF: PERMISSION TO CARRY OUT AN INVESTIGATION INTO UNIVERSITY-INDUSTRY R&D PROJECTS

With regards to the above matter, we are personally requesting for assistance and permission to conduct an investigation at your institution.

My PhD student, **Christina Chin's** research focuses on understanding the mechanism of best practices, barriers and requirements to conceptualise a generic and scalable project management methodology for Malaysian Research Projects. In order to facilitate her investigation, she requires your institution's permission and assistance to identify only **TWO** project leaders whom are/were involved in any existing/past university-industry collaboration R&D projects for her data collection. To ascertain the appropriate project for her study, she had shortlisted some characteristics:

- R&D projects involving the university-industry in a greater or lesser extent (example contract research or joint contract)
- Engineering-based research projects (eg civil, mechanical etc)
- Small to medium sized projects (budget ranging to max RM500k)
- Project status are completed or in progress

Please note that all information will be treated in the strictest confidence. Through your participation in this investigation we hope to be able to develop a more effective method of managing research projects in Malaysia. Further, through your participation your institutions interests and views will form an integral part of the methodology thereby making it more useful to your researchers. It should also be noted that all participating institutions will be given access to the desensitised findings of the study for their own use.

We sincerely appreciate your kind co-operation in her investigation. We look forward to a favourable reply in return as soon as possible. Kindly reply to Christina at **May-May.Chin@nottingham.edu.my** or **016 665 8896**.

Thank you in advance.

Yours sincerely
Dr Yap Eng Hwa
Assistant Professor & Undergraduate Admissions Tutor
Department of Mechanical, Materials and Manufacturing Engineering

Appendix 2 Letter Requesting for Interview

Dear Respondent

Faculty of Engineering
Jalan Broga
43500 Semenyih
Selangor Darul Ehsan
Malaysia
Tel: +6(03) 8924 8000
Fax: +6(03) 8924 8017
www.nottingham.edu.my

REF: PERMISSION TO SCHEDULE AND CONDUCT AN INTERVIEW SESSION

The central part of my PhD research is to develop a project management methodology for use in managing university-industry collaboration (UIC) projects. As part of my data gathering, there will be a need to conduct interview sessions with project leaders whom are involved in industrial collaborative work.

Please be assured that your details were released with permission from the university research management database. With your participation in this investigation we hope to be able to develop a more effective method of managing research projects in Malaysia. Further, through your participation your institutions interests and views will form an integral part of the methodology thereby making it more useful to your researchers. Thus, sincerely requesting for your kind cooperation and assistance in this investigation.

Please be assured that all information and details provided will remain strictly confidential and use only for the purpose of this study. With your permission, the interview sessions will be recorded for ease of transcriptions. A consent form is enclosed for your acknowledgement and permission. Kindly complete the form and return by email to May-May.Chin@nottingham.edu.my or fax to **03-8924 8017**. It should also be noted that all participating institutions will be given access to the desensitised findings of the study for their own use.

A follow-up will proceed within **TWO** working days to confirm the interview session. Please call my number at **016 665 8896** if you need further clarification.

Thank you very much for your cooperation.

Yours sincerely

Christina Chin May May
Researcher
Department of Mechanical, Materials & Manufacturing Engineering

Appendix 3 Letter of Permission for Interview

Dear Respondent

Faculty of Engineering
Jalan Broga
43500 Semenyih
Selangor Darul Ehsan
Malaysia
Tel: +6(03) 8924 8000
Fax: +6(03) 8924 8017
www.nottingham.edu.my

REF: CONSENT TO PARTICIPATE IN INTERVIEW

You were selected as a participant in this study because of your direct involvement in a university-industry collaboration R&D project identified from your institution's research centre database.

Please should read the information below and clarify your doubts before deciding whether or not to participate.

- This interview is voluntary. You are free not to answer any question, and to stop the interview at any time for any reason. The interview is expected to take up between thirty to sixty minutes only.

- Unless you give the permission to use your name, title, and / or quote you in any publications that may result from this research, the information you provide will be kept confidential.

- With your permission, this interview will be recorded. The recording is for the sole purpose of creating an accurate text transcript and shortening the interview time. It will not be played or given to any party. This interview will not be recorded without your permission. Given the permission for this interview to be recorded, you still have the right to revoke recording permission and/or end the interview at any time.

- The completed interview report will be furnished to you in order to verify all contents stated are valid and given the opportunity to comment or correct any item. In addition, you will be provided a summary report and recommendation upon completion of this study.

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. Please tick all that apply:

[ ] I give permission for this interview to be recorded on audio.

[ ] I agree to make myself available for a further interview if required

[ ] I give permission for the following information to be included in publications resulting from this study: [ ] my name [ ] my title [ ] direct quotes from this interview

Name of interviewee:____

Signature of interviewee:_______________________________ Date _____________

Kindly state below your most convenient schedule for the interview to take place:

Time and date: ___________________________________

Location : ___________________________________

Method :[ ] Face to face interview ***most preferred method for this study**
[ ] Web-conference via Skype * please provide your Skype name:_____________
[ ] Telephone interview via Skype
[ ] Email interview ***MUST** reply questions within 1 working days

Appendix 4 Interview Guide

Interviewee name :
Organisation :
Date & time : Duration:
Method of interview :
Location :
*NOTE: be clear answers are from which perspectives; rephrase questions appropriately

Questions for university project leaders/ industry partner /researchers

Processes	Category code	Interview Question
Initiation	DEV	Describe the processes involved in establishing collaboration?
	DRIV-F	Why collaboration?
Planning	PROJ-MG	1. What key elements are needed in the planning process? 2. What structures are created / adopted to coordinate the collaboration? 3. Who are the key people involved in the project management? (Is there a project manager from each partner?) 4. Do you/institution adopt a PMM to manage the collaboration? If yes/no why? 5. If there is a PMM, what should be included in it?
Execution & Monitoring	PROJ-MG	How collaboration progress is monitored and controlled?
	BARR	What are the problems that may occur in the collaboration?
	BT-PRAC	What are the best practices /success element to better manage collaboration?
Closing	DEV	How the collaboration performance is measured?
	FUT	1. What are the sustainability criteria for UIC growth in Malaysia? 2. University researchers should be equipped with industrial experiences. What is your view? 3. Do you think project management skill is a contributing element to collaboration success? Why?
Please provide the contact details of your university/industry partner and project team/researchers? (purpose; research is a dyad view, interview data will be collected from other sources as well) Do you have any sample of documentations that are available for references?		

Appendix 5 List of Nodes and Codes from Interview Analysis (Pilot study)

Category code	Tree nodes	Node coding
DEV	Process establishing UIC	Contacts from industry Joint effort Agreement (official/unofficial) Connection (from personal relationship)
	Collaboration performance measurement	Individual effort Check-points Based on agreement Milestones achievement
	Collaboration outcome	Knowledge development Publication Validation of findings Commercial value/Market driven Satisfaction Solution
DRIV-F	Driving factors	Competition Need capability Accreditation for courses/programmes Commercialisation
PROJ-MG	Planning elements	Detailed planning Meetings Constant monitoring Reporting
	Structure	Open communication Simple procedures Flexibility
	People	Multiple roles
	Components of PMM	Infrastructure support Relationship management Customisable to project nature Contract management Resource management Financial management on cash flow Guidelines on ethics
BARR	Problems/challenges	Too research focus Attitude of partners Low capability Lack of funds Time constraints Confidence level Lengthy procedures High infrastructure cost Intellectual property ownership Poor interaction with industry Lack of visitation Hand-holding view Diverse interest/aim

Category code	Tree nodes	Node coding
BT-PRAC	Best practices/ success elements	Orient research path Improve incentive structure Open communication Relationship bonding Help unit Understanding Constant monitoring Infrastructure
FUT	Sustainability criteria	Spin off Incentive structure Exposure via placement and internship Fit to industry needs Policy Recruit industrial personnel

Appendix 6 List of Nodes and Codes from Interview Analysis

Category code	**Tree nodes**	**Node coding**
DEV	Process establishing UIC	To look for assistance Agreement (MOU) Discussion (6 months – 2 yrs) Idea for funding Look for collaborators Apply for external funds Generate proposal
	Collaboration performance measurement	Submission dateline Timeframe Milestones Customer satisfaction Reports
DRIV-F	Driving factors	Source for technical expertise Common interest Financial support To innovate To industrialise/commercialise High competition
PROJ-MG	Planning elements	Job specifications Objectives of collaboration Selecting the right partner Budgeting Deliverables Resource planning/leverage resources Suitability (personnel ability/capability) Set milestones
	Structure	University structure Deadlines No given guidelines
	People	Policy maker Industry Department head Faculty Dean Research assistant Academic staff
	Components of PMM	Terms of reference Clear and understanding roles & responsibility Common grounds (research objective, cost, benefits etc) Templates Agreement Proposal
	Progress monitoring	Monthly report Project leadership Scheduling (Gantt chart) Reporting (milestones, financial, technical) Regular meeting/discussion

Category code	Tree nodes	Node coding
BARR	Problems/challenges	Lack of commitment Risk adverse Selective interest Mismatching (personality compatibility) Timeframe Unique role and nature Distrust Finance (reluctant to invest) Lengthy negotiation
BT-PRAC	Best practices/success elements	Transparency Good relationship Monthly reporting Flexible with terms & conditions Common ground of interest Right partner Frequent visiting Trust and honesty Online discussion/communication Meeting expectations of partner Deliver as agreed
FUT	Sustainability criteria	Exhibition Workshops/seminar/showcase Database for matching partner Open to outlook Right partner Realistic on contribution aspects Industry collaboration advisory board Visit to industry

Appendix 7 Questionnaire Survey

SURVEY ON DEVELOPING A PROJECT MANAGEMENT METHODOLOGY FOR USE IN A UNIVERSITY-INDUSTRY COLLABORATION R&D PROJECT ENVIRONMENT

Thank you for your kind participation in the interview session. Please proceed with the short survey to validate some research assumption. This survey will only take around 5 minutes. Thank you for your patience.

*UIC = university-industry collaboration

A. UIC ANTICIPATED CHALLENGES/ BARRIERS

Please indicate the scale of 1 to 5 in the right column to state your extent of agreement on the list of identified barriers in UIC that requires critical attention for successful partnership.

1	2	3	4	5
Strongly disagree	Disagree	Uncertain	Agree	Strongly Agree

Category	Contributing barriers	Scale
A1 Collective	A1.1 Fear factor	
	A1.2 Partner(s) with hidden agenda	
	A1.3 Sharing of authority	
	A1.4 Ownership of intellectual property rights (IPR) & publication	
	A1.5 Loss of confidentiality and privacy of information	
	A1.6 Lack of support and involvement from management	
	A1.7 Poor selection of partner(s) (university/industry)	
	A1.8 Conflicting /differing interest and objectives	
A2 Project management	A.2.1Unclear requirements	
	A.2.2Project planning & progress monitoring	
	A.2.3Ineffective communication channel	
	A.2.4Unclear roles & responsibilities	
	A.2.5Unclear role of project manager/lead researchers	
	A.2.6Degree of commitment & motivation level	
	A.2.7Project manager selection	
	A.2.8Collaboration agreement not clearly written & agreed	
	A.2.9Poor management processes & use of tools, templates	
	A.2.10No proper project organisation structures	
	A.2.11Lack of project policies and procedures	
A3 Cultural	A.3.1Distrust, lack of honesty and openness	
	A.3.2Different nature of work	
	A.3.3Structures for incentives & reward varies	
A4 Environmental	A.4.1Technology transfer & knowledge transfer	
	A.4.2Competitive forces	
	A.4.3Increase of technological choices in market	
	A.4.4Changes in the regulation / government policies	
	A.4.5Political pressures to universities and industries	
	A.4.6Industry specific R&D interest	
	A.4.7Partner(s) instability & continuity	
	A.4.8Higher demand of innovation by market	
	Others, please indicate:	

B. BEST PRACTICES IN SUCCESSFUL UIC

Please indicate the scale of 1 to 5 in the right column to state your extent of agreement on the list of identified best practices for UIC that in a successful partnership.

1	2	3	4	5
Strongly disagree	**Disagree**	**Uncertain**	**Agree**	**Strongly Agree**

Category	Best practices for success	Scale
B.1Collective	B.1.1Create shared mutual mission & goals	
	B.1.2Clear level of control & authority	
	B.1.3Clear policy on IP rights & publications	
	B.1.4Top management involvement & commitment	
	B.1.5Complementary knowledge based partners	
B.2Project management	B.2.1Clear roles & responsibilities	
	B.2.2Frequent & effective communication channels	
	B.2.3Organise joint periodic meetings	
	B.2.4Recruit competent project manager (each for industry & university)	
	B.2.5Good documentation and lesson learned archive	
	B.2.6Well defined and agreed research contract	
	B.2.7Encouragement, motivation through team building	
	B.2.8Incentives & rewards structures	
	B.2.9Design project organisation structures	
	B.2.10Use of project management methodology	
B.3Cultural	B.3.1Compromise during negotiation process	
	B.3.2Establish trust, honesty, openness & transparency	
	B.3.3Mutual respect of differences	
	B.3.4Understanding	
B.4Environmental	B.4.1Increase awareness of new technologies	
	B.4.2Enhance stature, recognition in academia & industry	
	B.4.3Promotion in research for all industries areas	
	Others, please indicate:	

C. <u>REQUIREMENTS FOR UIC PROJECT MANAGEMENT METHODOLOGY</u>

Please indicate the scale of 1 to 5 in the right column to state your extent of agreement on the list of proposed requirements for a scalable and generic UIC project management methodology.

1	2	3	4	5
Strongly disagree	**Disagree**	**Uncertain**	**Agree**	**Strongly Agree**

List of requirements for UIC Project management methodology	**Scale**
C.1 It should integrate the principles, processes, guidelines and practices of both UIC and PM concepts	
C.2 It should include some decision analysis or tools in guiding organisation on the formation of a university-industry partnership	
C.3 It should facilitates the identification and management of risks and opportunity	
C.4 It should facilitate the clarification of goals and scope of the project by incorporating the best practices of project management group processes, tools and techniques to effectively plan and manage research projects	
C.5 It should create a project board/committee to oversees, monitor and assess the research project progression	
C.6 It should identify to the organisation which collaborative mode are more suited for the particular type of projects	
C.7 It should include a structural sample of collaborative agreement for ease of negotiation	
C.8 It should be scalable and adaptable to project sizes; where it should be specific to the organisation but customisable to individual projects	
C.9 It should involve technology elements which are integrative and neutral to the organisation's existing system	
C.10 It should model the work flow of typical project	
C.11 It should leverage the best practices of collaborative research environment to minimise the obstacles & failure rate	
C.12 The methodology must be in place to promote organisational learning	
Others, please indicate:	

Any other comments/suggestions

Thank you very much for your cooperation, time and effort.
Please return this survey by email to May-May.Chin@nottingham.edu.my

Appendix 8 Letter Requesting To Evaluate the PMM

Dear [old respondent]

Faculty of Engineering
Jalan Broga
43500 Semenyih
Selangor Darul Ehsan
Malaysia
Tel: +6(03) 8924 8000
Fax: +6(03) 8924 8017
www.nottingham.edu.my

REF: REQUEST TO EVALUATE A PROJECT MANAGEMENT METHODOLOGY

Firstly, thank you for your kind cooperation and assistance in the interview session that was conducted last year (September - November 2009). The data collected had been very informative for my research and development of the project management methodology for use in managing university-industry collaboration projects.

Now that the methodology had been successfully developed, I would like to request your expert participation again to evaluate and assess it. **I could schedule any available time to present the methodology via any accessible medium of communication that is convenient for you, if deem necessary.**

Please be assured that all information provided will remain strictly confidential and will only be used for the purpose of this study. An evaluation form and the methodology are enclosed in this letter for your assessment purpose. I would appreciate it if you could complete the evaluation form within **ONE** (1) week or as soon as possible.

In return of your cooperation, I can share with your organisation and facilitates the adoption of the methodology we are developing without breaching confidentiality. Please contact me should you need further clarification.

Thank you very much for your kind assistance.

Yours sincerely

Christina Chin May May
Email: May-May.Chin@nottingham.edu.my
H/P: +6 016 665 8896

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Dear [New respondent]

REF: REQUEST TO EVALUATE A PROJECT MANAGEMENT METHODOLOGY

I am a Research Assistant at the University of Nottingham Malaysia under the supervision of Assoc Prof Dr Andrew Spowage. The central part of my PhD research is to develop a project management methodology for use in managing university-industry collaboration (UIC) projects in Malaysia.

Presently the methodology has been successfully developed and I would like to request your expert participation to evaluate and assess it**. I could also schedule any available time to present the methodology via any accessible medium of communication that is convenient for you, if deem necessary.**

Please be assured that all the information provided will remain strictly confidential and will be used only for the purpose of this study. An evaluation form and the methodology are enclosed in this letter for your assessment purpose. I would appreciate if you could complete the evaluation form within **ONE** (1) week or as soon as possible.

In return of your cooperation, I can share with your organisation and facilitate the adoption of the methodology we are developing without breaching confidentiality. Please contact me should you need further clarification.

Thank you very much for your kind assistance.

Yours sincerely

Christina Chin May May
Email: May-May.Chin@nottingham.edu.my
H/P: +6 016 665 8896

Appendix 9 PMM Evaluation Questionnaire Survey

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

PROJECT MANAGEMENT METHODOLOGY GUIDEBOOK – PLANNING & MANAGING UNIVERSITY-INDUSTRY COLLABORATIVE PROJECT

EVALUATION FORM (JULY 2010)

Evaluator Name:	
Organisation & Position	
Date:	

PLEASE READ THE ENCLOSED PROJECT MANAGEMENT METHODOLOGY GUIDEBOOK BEFORE ANSWERING THIS EVALUATION FORM.

The purpose of this evaluation is:

1. To measure the :-
   a) Feasibility - could the methodology be easily followed?
   b) Usability – is the methodology workable? Are the steps, tools and techniques easy to use and apply?
   c) Usefulness – is the methodology worth following? Will the methodology help researchers to produce better results in project management?
2. To identify areas of improvement for the methodology.

Please answer as many questions as possible and rest assured that all information provided will remain strictly confidential.

THANK YOU VERY MUCH FOR YOUR KIND ASSISTANCE AND SUPPORT.

A. FEASIBILITY - Could the methodology be easily followed?

The purpose of this section is to evaluate if the methodology is easy for researchers to follow. Please select and type your answers in the given boxes.

*** Feel free to write your comments in the highlighted yellow textbox.**

	QUESTIONS	YES	NO	COMMENTS
A1	Do you find the activities in the methodology easy to follow?	☐	☐	
A2	Do you find the activities in each phase labour intensive?	☐	☐	
A3	Is the methodology described adequate and transparent?	☐	☐	
A4	Is the methodology internally consistent? If not, highlight which sections are inconsistent.	☐	☐	
A5	Were all the activities developed necessary to be followed in a collaborative research project? If not, which activity or phase is redundant and why?	☐	☐	
A6	Could the methodology be followed with minimal facilitation (e.g. training)?	☐	☐	
A7	Would you have any difficulty communicating the methodology to your project team?	☐	☐	
A8	Do you consider the methodology as a guide to better assist your project management? Why?	☐	☐	
A9	Is the methodology appropriate for use in a collaborative research project environment?	☐	☐	
A10	Do you think the methodology should be put forward for adoption in your research group/organisation? Why?	☐	☐	
A11	How do you think it should be carried out (implementation strategy)?			

B. USABILITY – Is the methodology workable? Are the steps, tools and techniques easy to use and apply?

The purpose of this section is to evaluate if the methodology is workable in practice for researchers in terms of the usability of selected tools and techniques. Please select and type your answers in the given boxes.

*** Feel free to write your comments in the highlighted yellow textbox.**

	QUESTIONS	YES	NO	COMMENTS
B1	Do you find the methodology usable in practice?	☐	☐	
B2	Do you find the toolkits, templates and forms easy to be filled?	☐	☐	
B3	Do you encounter any problem following the activities?	☐	☐	
B4	Which tools or templates do you foresee as unnecessary /redundant? Why?	☐	☐	
B5	Any other tools or techniques that should be included in the methodology? Why?	☐	☐	
B6	Has the methodology addressed all the necessary tools required for use in a collaborative research environment?	☐	☐	
B7	Can the methodology be a supplement to existing practice in your organisation? If no, why?	☐	☐	
B8	Do you think the methodology is easily comprehensible in layman term?	☐	☐	
B9	What factors would help you to use this methodology?			

C. USEFULNESS - Will the methodology help to produce better results in project management?

The purpose of this section is to discover if the methodology will assist researchers to better manage their project. Please select and type your answers in the given boxes.

*** Feel free to write your comments in the highlighted yellow textbox.**

	QUESTIONS	YES	NO	COMMENTS
C1	Do you think the methodology will consume excessive amount of time and resources?	☐	☐	
C2	Do you think the methodology will help researchers to better manage their projects?	☐	☐	
C3	Is the structure of the methodology in each activity useful e.g. ‘Inputs’; ‘Tasks’; ‘Toolkits’, ‘Output’ and ‘Hints’?	☐	☐	
C4	Do you think the methodology is credible for application in the market?	☐	☐	
C5	Would you consider using the methodology?	☐	☐	
C6	Do you think there are some activities or modules that can be exempted or merged? If yes, highlight these activities or the module.	☐	☐	
C7	Were any of the terms unfamiliar to you?	☐	☐	
C8	Overall were you satisfied with the contents and structure of the methodology?	☐	☐	
C9	What do you consider to be the strength of this methodology?			
C10	What makes this methodology different from other methodologies?			

C11. Please **<u>CHOOSE</u>** an answer that best reflects each tools and techniques' usefulness.

	TOOLKITS	LEVEL OF USEFULNESS
1	Project proposal	**Choose an answer.**
2	Expert judgment	**Choose an answer.**
3	Brainstorming	**Choose an answer.**
4	SWOT analysis	**Choose an answer.**
5	Plus/Minus/Interesting tool	**Choose an answer.**
6	7Cs partner selection scoring model	**Choose an answer.**
7	Project initiation document	**Choose an answer.**
8	Design project management team	**Choose an answer.**
9	Project team commitment agreement	**Choose an answer.**
10	Kickoff meeting	**Choose an answer.**
11	Work breakdown structure	**Choose an answer.**
12	Work breakdown structure dictionary	**Choose an answer.**
13	Responsibility assignment matrix	**Choose an answer.**
14	Project schedule (Gantt chart)	**Choose an answer.**
15	Resource plan	**Choose an answer.**
16	Budgetary plan	**Choose an answer.**

	TOOLKITS	LEVEL OF USEFULNESS
17	Risk plan	**Choose an answer.**
18	Risk log	**Choose an answer.**
19	Stakeholder analysis	**Choose an answer.**
20	Communication plan	**Choose an answer.**
21	Quality plan	**Choose an answer.**
22	Quality log	**Choose an answer.**
23	Project minutes	**Choose an answer.**
24	Project progress report	**Choose an answer.**
25	Progress log checklist	**Choose an answer.**
26	Change request plan	**Choose an answer.**
27	Change request log	**Choose an answer.**
28	Review gate process	**Choose an answer.**
29	Project balanced scorecard	**Choose an answer.**
30	Lesson learned report	**Choose an answer.**
31	End project report	**Choose an answer.**
32	Acceptance signoff	**Choose an answer.**

D. AREAS OF IMPROVEMENTS – How to improve the methodology?

The purpose of this section is to identify areas of improvements to further enhance the methodology for a full scale implementation in Malaysia. Please type your answers in the given boxes.

Please write your comment in the highlighted yellow textbox (eg. contents, sections, structure, components, elements etc) for further enhancement.

AREAS	SUGGESTIONS FOR IMPROVEMENTS
Introduction	
Module 1: Initiation	
Module 2: Planning	
Module 3: Execution & Monitoring	
Module 4: Closing	
Project proposal	
7Cs partner selection scoring model	
Project initiation document	
Project team commitment agreement	
Work breakdown structure dictionary	
Resource plan	
Budgetary plan	
Risk plan + risk log	
Stakeholder analysis	
Communication plan	
Quality plan + quality log	
Performance reporting - Project minutes - Project progress report - Progress log checklist	

Change request plan +request log	
Review gate process	
Lesson learned report	
End project report	
Acceptance signoff	

E. BACKGROUND INFORMATION

The purpose of this section is to understanding your experiences in handling research projects influences in assessing the methodology. Please choose your answers in the given box.

QUESTIONS

E1	How many years have you been handling projects?	**Choose an answer.**
E2	How many research projects have you been involved in?	**Choose an answer.**
E3	Have you previously taken any courses/training on project management?	**Choose an answer.**
E4	How much time did you spend reviewing the methodology?	**Choose an answer.**
E5	Have you used such a methodology before?	**Choose an answer.**

- END OF EVALUATION –

THANK YOU VERY MUCH FOR YOUR COOPERATION, TIME AND EFFORT.
PLEASE SAVE THIS FILE & EMAIL TO May-May.Chin@nottingham.edu.my

Appendix 10 Final PMM Evaluation Questionnaire Survey

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

FINAL PROJECT MANAGEMENT METHODOLOGY GUIDEBOOK – PLANNING & MANAGING UNIVERSITY-INDUSTRY COLLABORATIVE PROJECT

EVALUATION FORM (SEPTEMBER 2011)

Evaluator Name:	
Organisation & Position :	
Date:	Click here to enter a date.

The purpose of this evaluation is to validate the refined and improved final project management methodology (PMM) which was previously evaluated.

As you have read the PMM previously you should be able to complete this form within 10 minutes. However if you need to directly refer to the PMM, a copy is enclosed.

This questionnaire survey will have the same objective that is to measure the:-
Feasibility - could the methodology be easily followed?
Usability – is the methodology workable? Are the steps, tools and techniques easy to use and apply?
Usefulness – is the methodology worth following? Will the methodology helps researchers to produce better results in project management?

Please answer all the questions and rest assured that all information provided will remain strictly confidential.

THANK YOU VERY MUCH FOR YOUR KIND ASSISTANCE AND SUPPORT AGAIN

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A. FEASIBILITY - Could the methodology be easily followed?

The purpose of this section is to evaluate if the methodology is easy for researchers to follow. Please select and type your answers in the given boxes.

*** Feel free to write your comments in the highlighted yellow textbox.**

	QUESTIONS	YES	NO
A1	Do you find the activities in the methodology easy to follow?	☐	☐
A2	Do you find the activities in each phase labour intensive?	☐	☐
A3	Is the methodology described adequate and transparent?	☐	☐
A4	Is the final methodology internally consistent?	☐	☐
A5	Were all the activities developed necessary to be followed in a collaborative research project?	☐	☐
A6	Could the methodology be followed with minimal facilitation (e.g. training)?	☐	☐
A7	Would you have any difficulty communicating the methodology to your project team?	☐	☐
A8	Do you consider the methodology as a guide to better assist your project management?	☐	☐
A9	Is the methodology appropriate for use in a collaborative research project environment?	☐	☐
A10	Do you think the methodology should be put forward for adoption in your research group/organisation?	☐	☐

Any comments:

B. USABILITY – Is the methodology workable? Are the steps, tools and techniques easy to use and apply?

The purpose of this section is to evaluate if the methodology is workable in practice for researchers in terms of the usability of selected tools and techniques. Please select and type your answers in the given boxes.

*** Feel free to write your comments in the highlighted yellow textbox.**

	QUESTIONS	YES	NO
B1	Do you find the methodology usable in practice?	☐	☐
B2	Do you find the toolkits, templates and forms easy to be filled?	☐	☐
B3	Do you encounter any problem following the activities?	☐	☐
B4	Do any tools or templates do you foresee as unnecessary /redundant?	☐	☐
B5	Any other tools or techniques that should be included in the methodology?	☐	☐
B6	Has the methodology addressed all the necessary tools required for use in a collaborative research environment?	☐	☐
B7	Can the methodology be a supplement to existing practice in your organization?	☐	☐
B8	Do you think the methodology is easily comprehensible in layman term?	☐	☐

Any comments:

C. USEFULNESS - Will the methodology help to produce better results in project management?

The purpose of this section is to discover if the methodology will assist researchers to better manage their project. Please select and type your answers in the given boxes.

*** Feel free to write your comments in the highlighted yellow textbox.**

	QUESTIONS	YES	NO
C1	Do you think the methodology will consume excessive amount of time and resources?	☐	☐
C2	Do you think the methodology will help researchers to better manage their projects?	☐	☐
C3	Is the structure of the methodology in each activity useful e.g. 'Inputs'; 'Tasks'; 'Toolkits', 'Output' and 'Hints'?	☐	☐
C4	Do you think the methodology is credible for application in the market?	☐	☐
C5	Would you consider using the methodology?	☐	☐
C6	Do you think there are some activities or modules that can be exempted or merged?	☐	☐
C7	Were any of the terms unfamiliar to you?	☐	☐
C8	Overall were you satisfied with the contents and structure of the methodology?	☐	☐

Any comments:

C9. Please **CHOOSE** an answer that best reflects each tools and techniques' usefulness.

	TOOLKITS	LEVEL OF USEFULNESS
1	Project proposal	**Choose an answer.**
2	Expert judgment	**Choose an answer.**
3	Brainstorming	**Choose an answer.**
4	SWOT analysis	**Choose an answer.**
5	Plus/Minus/Interesting tool	**Choose an answer.**
6	7Cs partner selection scoring model	**Choose an answer.**
7	Project initiation document	**Choose an answer.**
8	Design project management team	**Choose an answer.**
9	Project team commitment agreement	**Choose an answer.**
10	Kickoff meeting	**Choose an answer.**
11	Work breakdown structure	**Choose an answer.**
12	Work breakdown structure dictionary	**Choose an answer.**
13	Responsibility assignment matrix	**Choose an answer.**
14	Project schedule (Gantt chart)	**Choose an answer.**
15	Resource plan	**Choose an answer.**
16	Budgetary plan	**Choose an answer.**
17	Issue management plan	**Choose an answer.**
18	Issue log	**Choose an answer.**

	TOOLKITS	LEVEL OF USEFULNESS
19	Risk plan	**Choose an answer.**
20	Risk log	**Choose an answer.**
21	Stakeholder analysis	**Choose an answer.**
22	Communication plan	**Choose an answer.**
23	Quality plan	**Choose an answer.**
24	Quality log	**Choose an answer.**
25	Project minutes	**Choose an answer.**
26	Project progress report	**Choose an answer.**
27	Progress log checklist	**Choose an answer.**
28	Change request plan	**Choose an answer.**
29	Change request log	**Choose an answer.**
30	Review gate process	**Choose an answer.**
31	Project balanced scorecard	**Choose an answer.**
32	Lesson learned report	**Choose an answer.**
33	End project report	**Choose an answer.**
34	Acceptance signoff	**Choose an answer.**

- END OF EVALUATION –

THANK YOU VERY MUCH FOR YOUR COOPERATION, TIME AND EFFORT.
PLEASE SAVE THIS FILE & EMAIL TO May-May.Chin@nottingham.edu.my