MERGING ACADEMIC RESEARCH AND INDUSTRY DEVELOPMENT REQUIREMENTS FOR AN INNOVATIVE CONSTRUCTION MANAGEMENT PRACTICE

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DECLARATION

I declare that this is my own work and this thesis do not incorporate without acknowledgment any material previously submitted for a Degree or a Diploma in any other university or institute of higher learning and to the best of my knowledge and belief, it does not contain any material previously published or written by any other person except where the acknowledgement is made in the text.

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ABSTRACT

This study advances the knowledge in the field of research based innovations, in terms of prerequisites, specific to construction management context. Previously, the enhanced role of academic research in realising innovations through various reciprocals among universities, regulatory bodies, and industries was presented via Triple Helix Model (THM). Successively, the model has been explored to a great extent concerning many economic sectors. In parallel, developing knowledge based construction economies has become a mainstream theory in response to the lack of research activities within the construction organisations. Consequently, a paradigm-shift in the field of built environment research has been called over the last three decades. Yet, construction management indicates weak signs of research-based innovative development, confirming non-presence of the critical requirements of THM operation. However, no study so far has investigated on such requirements, creating a knowledge gap in explaining the inability of academic research fostering construction management innovations. Hence, this research aimed to investigate the Critical Success Factors (CSFs) of merging academic research with industry development requirements to cultivate an innovative construction management practice.

Accordingly, a compressive literature review uncovered theoretical explanations on research problem, forming the conceptual framework for the study. Refining the framework, a field study was conducted, combining inductive and deductive approaches informed by a pragmatist philosophical stance. Research objectives posed, four (04) Research Questions (RQs) with explanatory and exploratory purposes, and therefore, were answered through a mixed method. The perspectives of academia and construction industry of Sri Lanka were initially obtained through surveys. Academic census comprised 49 units and industry survey obtained the views of organisations and practitioners separately, with a 510 unit stratified sample. The findings of the surveys were inductively explored in front of critical cases from industry, and academia through case studies and expert opinions. Quantitative data were analysed statistically, whilst content analysis was performed with qualitative data. The findings were validated externally through opinions of three (03) high-profile experts, each engaged in all three (03) disciplines, academic, industry, and industry regulation.

While each RQ were answered in detail, overall, the findings confirmed the significance of academic research in cultivating an innovative management practice. Yet, the study revealed poor knowledge dissemination and utilisation in the context. Due to poor industry orientation of academic research, and construction industry operating as a Red Ocean, with inherited characteristics of price based competition, leads to a lack of research collaborations. In bridging the gap, the ultimately developed **M**odel of CSFs for **R**esearch Driven **I**nnovations (MRI) for construction management' reveals the CSFs of creating knowledge, consensus, and innovation spaces, with reference to actionable stakeholders. MRI defines the role of academia, regulatory bodies, and construction industry as novelty producers, legislative controllers, and wealth generators, respectively. The paired interactions among the three (03) contenders generate the knowledge infrastructure and political economy for the creation of the consensus space. The consensus space urges establishment of a Knowledge Brokering Hub (KBH) to administer strategic research partnerships between the academia and the industry. Therefore, given that, the knowledge space and consensus spaces are created, an academic research righteously initiated inside the innovation space, executed properly, and disseminated strategically, has the potential to foster innovations in construction management.

Key words: Academic Research; Construction Management Practice; CSFs; Innovation; Research Knowledge Dissemination and Utilisation.

DEDICATION

To my family

in return of departed time, and unconditional love...

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AGM	:	Annual General Meeting
AIQS	:	Australian Institute of Quantity Surveyors
ARB	:	Architects Registration Board
BOS	:	Blue Ocean Strategy
BS	:	British Standards
CCI	:	Chamber of Construction Industry Sri Lanka
CEA	:	Central Environment Authority
CEO	:	Chief Executive Officer
CHPB	:	Centre for Housing Planning and Building
CIDA	:	Construction Industry Development Authority
CNCI	:	Ceylon National Chamber of Industries
CPD	:	Continuous Professional Development
CSF	:	Critical Success Factor
EMS	:	Environmental Management System
ERP	:	Enterprise Resource Planning
GDP	:	Gross Domestic Product
ICT	:	Information and Communication Technology
ICTAD	:	Institution for Construction Training and Development
IFAWPCA	:	International Federation of Asian and Western Pacific Contractors' Associations
IPAC	:	Intellectual Property Advisory Committee
ISO	:	International Organisation for Standardisation
IT	:	Information Technology
IQSSL	:	Institute of Quantity Surveyors Sri Lanka

KBH	:	Knowledge Brokering Hub
MBA	:	Master of Business Administration
MCKU	:	Model - Chain of Knowledge Utilisation
MD	:	Managing Director
MPhil	:	Master of Philosophy
MRI	:	Model of CSFs for Research Driven Innovations
MSc	:	Master of Science
NCASL	:	National Construction Association of Sri Lanka
NCCSL	:	National Chamber of Commerce Sri Lanka
NCE	:	National Chamber of Exporters
NEDC	:	National Economic Development Council
NRC	:	National Research Council
NSF	:	National Science Foundation
NWS&DB	:	National Water Supply and Drainage Board
OBE	:	Objective Based Education
OHSAS	:	Occupation Health and Safety Advisory Service
OPA	:	Organization of Professional Associations
PhD	:	Doctor of Philosophy
PLC	:	Public Limited Company
PMKD	:	Pipeline Model of Knowledge Dissemination
QA	:	Quality Assurance
QMS	:	Quality Management System
R&D	:	Research and Development
RIBA	:	Royal Institute of British Architects
RICS	:	Royal Institution of Chartered Surveyors

ROS	:	Red Ocean Strategy
SAP	:	Systems Applications and Products
SLIA	:	Sri Lanka Institute of Architects
SLAAS	:	Sri Lanka Associate for the Advancement of Science
SLIE	:	Sri Lanka Institution of Engineers
SLNAC	:	Sri Lanka National Arbitration Centre
SLSI	:	Sri Lanka Standards Institution
SPSS	:	Statistical Package for Social Sciences
THM	:	Triple Helix Model
UDA	:	Urban Development Authority
UK	:	United Kingdom
UN	:	United Nations
USA	:	United States of America

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CHAPTER 1 – RESEARCH BACKGROUND

1.1 Introduction

Higher education is becoming a major driver of economic competitiveness in an increasingly knowledge-driven global economy (OECD, 2010). In addition to the primary duty of delivering good quality teaching, universities have another key responsibility, which is to add new knowledge to the wider society through research (Brinkley-Rubinstein, 2015). Specially, higher education institutes, which are involved in industry focused professional education, should have a greater conscientiousness to develop the respective industries through bringing in innovation and change (Nelson, London & Strobel, 2015).

The construction industry is accounting for a sizable proportion of most of countries' Gross Domestic Product (GDP) since considered to be one of the key industries in an economy (Horta, Camanho, Johnes & Johnes, 2013). Today, in a highly competitive world, construction management needs to adapt continuously to complex and changing conditions, to survive and proliferate through innovation (Finkel, 2015). Hence, the higher education institutes in the built environment have a significant role to play in guiding innovations in the construction industry.

Moreover, correlational relationships between innovation and development are seen over international context, recently. For example, in Europe (Capello & Lenzi, 2013), US (Block & Keller, 2015), and Asia (Shin, 2013), issues of knowledge and technology transfer have moved to the forefront of attention in economic, social, and industrial policy. The sources of future development increasingly derive from innovation since attention must be paid to non-traditional sources, which have the potential to become the basis for construction of new business and social models, as well as, the renovation of old ones (Etzkowitz, 2011). Hence, innovations in construction management, driven by academic research, could possibly contribute to the development of the construction industry.

The concept of 'innovation' is variously understood by stakeholders, and its definition is often vigorously debated. Nevertheless, within the construction industry, the definition provided by Slaughter (1998) is broadly accepted (Blayse & Manley, 2004, p.144). Slaughter (1998, p.227) defines innovation as 'the actual use of a nontrivial change and improvement in a process, product, or system that is novel to the institution developing the change'. Innovation in the construction industry can take many forms. At a broader level, OECD (1997) categorises innovation, on the basis of international research across a number of industries; as being either 'technical' or 'organisational'. Technical innovation involves either 'product' or 'process' innovation, whereas organisational innovation includes changes to organisational structure, introduction of advanced management techniques, and implementation of new corporate strategic orientations.

Koskela and Vrijhoef (2001), state that innovation in construction is commonly incremental or modular, where small and significant changes happen as technical innovations, limited to a component inside an organisation. However, Winch (1998), explains such technical initiatives are more of 'top-down', yet 'bottom-up' organisational innovations are rare in the construction industry. Hence, it is vital to study the context, in identifying critical requirements for fostering such 'organisational innovations', where this study defines as 'management innovations'.

In initiating such a move, universities, can be one of the best entities for knowledge leadership, compared to other recently proposed contenders, such as consulting firms (Siegel, Waldman, Atwater & Link, 2003). University's unique competitive advantages are that it combines continuity with change and organisational research memory with new persons, and new ideas through the passage of student generations (Carlot, Filloque, Osborne & Welsh, 2015). Conversely, a consulting company draws together widely dispersed professionals for individual projects and then disperses them after a project is completed, that is when the client's particular problem is solved. Such firms lack organisational ability to pursue a cumulative research programme, as a matter of course (Etzkowitz & Leydesdorff, 2000). Hence, the university can be fairly suggested as a research facilitator in bringing innovative development for competitive construction industry, which needs a dynamic management practice (Latham, 1994).

According to Brown (2005), a number of benefits result from university research activities, which accrue to human, financial and intellectual resources of universities. Such advances will benefit subsequently to the students, and ultimately, to the relevant industries. Moreover, such Research and Development (R&D) activities could take place within construction organisations under a separate department or in separate institutions for more rewarding research interactions. Therefore, it is crucial that academic research of built environment related faculties address construction industry's R&D requirements (Ofori, 2015).

Further, Akintoye (2012) stated that the R&D acts as a valuable input for the construction organisations by developing new products, materials, advanced construction processes, to meet the customer requirements and to address the economic, environmental, and resource constraints, revealing the burdens of management. Hence, construction industry should move beyond the traditional boundaries to adopt new practices arising from R&D activities. However, there is a lack of evidence that construction industry adopt new findings of R&D activities into their practice (Kamal, Kong-Seng & Iranmanesh, 2014).

Pathirage, Amaratunga and Haigh (2005) highlight that, despite the growing importance of R&D, the ignorance of knowledge worker and their skills within the construction context have contributed to a great extent for the under performance of the industry. Further, Kulatunga, Amaratunga and Haigh (2005) identify that the lack of skilled professionals in construction organisations has resulted in reducing the absorption capacity, and thereby, the outcomes of R&D activities are not properly engrossed, and put into practice.

However, relationships between academia and industry are increasingly intimate and commercial. While opportunities are created for each partner, there are also important conflicts of interest issues (William, James, Graem & Surge, 2004). Auxiliary, it has been identified that the academics and the practitioners are both under a pressurised situation with the challenges they face (Singhal, Sodhi & Tang, 2014). Particular challenge will be ensuring that universities maintain their traditional role in public science, while collaborating with a commercial entity with a tradition of proprietary science (William et al., 2004).

According to Steele and Murray (2004), to advance with the developing world, the internal dynamics of construction industry must be such that they can respond to change. R&D activities are important to the construction industry to successfully address the challenges placed on it and to be competitive (Kulatunga, Amaratunga & Haigh, 2009). The construction industry has a unique nature of its own and frequently complained as slow to move ahead from traditional practices. MacLeod (2010) argues that the standard of innovation in the construction industry is claimed as good. Contradictorily, major construction industry reviews in the Europe have identified the need for continuous performance improvement throughout the time (Noktehdan, Shahbazpour & Wilkinson, 2015; Hughes & O'Rourke, 2009; Fairclough, 2002; Egan, 1998; Latham, 1994). Moreover, as per Loosemore and Richard (2015), there is a lack of evidence that construction industry adopting new findings of academic research into practice. Resultantly, there could be many reasons and barriers for the lack of practice of the R&D activities in the construction industry.

Despite the barriers, the construction industry in general faces the challenge of moving away from the traditions and going ahead with current development trends (Akintoye, 2012). In fact, partnerships amongst governments, the economic sector and research universities should grow considerably, to link new knowledge with development goals (Kassel, 2009). Hence, as industry regulator, the government has a responsibility to establish and finance a framework that anticipates emerging needs of the construction industry. Further, government policies should facilitate change, yet should not impose or secure control. In addition, government being a major client, it has a vital role to stimulate innovation by demanding better value and fitness for purpose from public buildings, and particularly to take account of the interests of the eventual users of these buildings (Fairclough, 2002). According to AlSehaimi, Koskela and Tzortzopoulos (2012), the situation dictates the need to enhance the academic researcher-practitioner collaborations for the development of the construction industry. Therefore, a collaboration, where the interests and values of each partner were articulated in advance and conflict of interest issues are resolved before legal, and business arrangements are established in a contract would be essential.

Yet, the socio-economic system that is potentially innovated by the operation remains grounded in a culture, which has to be reproduced in terms of renewing the social systems of coordination (Leydesdorff, 2005). Therefore, in fostering management innovations in construction industry, the linear model of innovation in which, basically, research invents and industry applies in a single directionally, is required to be replaced with an interactive and non-linear model (Godin, 2006), with the new fusion between science and innovation (Bell, 1968). Importantly, Triple Helix Model (THM) of Etzkowitz and Leydesdorff, (2000) interprets the shift from a dominating industry-government duo in the 'industrial society' to a growing triadic relationship between university-industry-government in a 'knowledge society'. The concept of the Triple Helix of university-industry-government relationships was initiated in the 1990s by Etzkowitz (1993) and Etzkowitz and Leydesdorff (1995), includes elements of original works by Lowe (1982) and Sábato and Mackenzi (1982).

THM of Etzkowitz and Leydesdorff, (2000) can be studied at different levels and from different perspectives since the model states that the university can play an enhanced role in innovation, in increasingly knowledge-based societies (Leydesdorff, 2013a). The underlying model is analytically different from the national systems of innovation approach (Nelson, 1993), which considers the firm, as having the leading role in innovation, and from the ''triangle'' model of Sa´bato (1975) in which the state is privileged (Sa´bato & Mackenzi, 1982).

Further, the ability of developing different resolutions of the relations among the institutional spheres of university, industry, and government to generate alternative strategies for economic growth and social transformation is proven by the work of many researchers, i.e. Ranga, and Etzkowitz (2013). Therefore, it could positively assume the application of this model in construction industry context in cultivating research informed management innovations.

In parallel to the debate on international context, the situation in Sri Lankan construction industry would be low responsive to innovation and development with similar or more barriers, considering the developing nature of the country. Yet, the industry plays a major role in national economy, contributing around 8% to the GDP in recent years (Central Bank of Sri Lanka, 2015). According to ICRA Lanka (2011), the Sri Lankan construction sector is likely to grow faster than the broader economy, over recent future. In power, roads, ports, and transportation sectors, there is a considerable investment requirement during the period. The projects are funded by both the government, and foreign development partners. This shows that the sector is growing internally, even though not considered to be a large scale market in international level.

Though, the industry shows quantitative growth, there are challenges to overcome through qualitative development. The industry concerns include high raw-material costs, lack of funds, low supply of high-grade steel, high prices of sand, shortage of skilled workers, delays in land acquisition, and frequent changes in regulations, particularly, in development control and approval processes (ICRA, 2011). The role of R&D in overcoming above barriers is immense, yet, management practices are inferior and innovations are rare at present, as per studies into various management segments, i.e. waste management (Karunasena & Amaratunga, 2016); risk management (Perera, Rameezdeen, Chileshe & Hosseini, 2015); information management (Senaratne & Ruwanpura, 2016), and health and safety management (Vitharana, De Silva & De Silva, 2015) in example. Therefore, studying the requirements of merging academic research and industry development requirements in cultivating an innovative management practice is extensively a timely need of both the local and international contexts.

1.2 Research Problem

The importance of converting construction industry's current survival mode to a sustainable development mode is increasing exponentially, as a key necessity of existence in the modern construction market (Fairclough, 2002). Therefore, a strategic movement is essential, which urges the necessity of innovations to regulate the odds of construction sector development (Thuesen, Koch & Nielsen, 2010). Complementarily, over the last three decades paradigm-shift in the field of built environment research (Brandon, 1982) has been called in developing knowledge based construction economies, as a mainstream theory. The theory has been extensively applied and new paradigms have appeared (Fellows, 2010; Brandon, 2009), yet, the question of integrating the results of such appearances into the practice remains un-answered, as per the argument reasoned in the previous section (refer section 1.1).

Hence, an improved understanding of the dynamic interplay between research, invention, innovation, and economic growth is required, with special emphasis on barriers for academic-industry research collaborations. Further, the potential of bringing innovative development via academic research, as presented in the theory of THM (Etzkowitz & Leydesdorff, 1995) should be investigated to a great extent concerning construction industry, with specific reference to its management practice.

In a process of such, it is of utmost importance to uncover the prerequisites of generating innovative developments, concerning the identical barriers and potential success factors. The requirements identified in the form of Critical Success Factors (CSFs) would be much more user-friendly in implementation, as Rockart (1979) defined CSFs as "areas of activity that should receive constant and careful attention from management". However, no study so far has investigated the field of management and innovation research, to examine the CSF enabling THM (Etzkowitz & Leydesdorff, 2000) operation in construction management context.

Hence, the research problem is framed as, to investigate the CSFs of merging academic research and industry development requirements to develop an innovative construction management practice. The research problem in the broader focus in the form of a preliminary research model is shown in Figure 1.1.

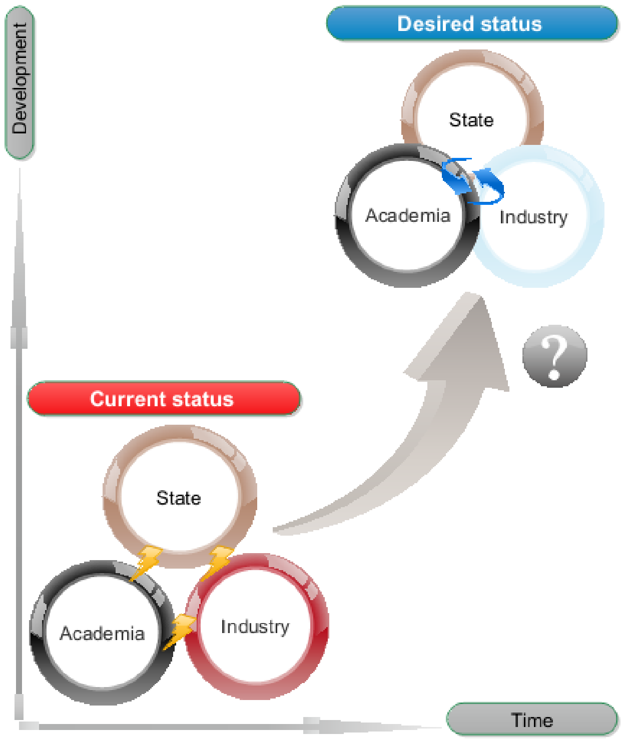


Figure 1.1: An Illustration of Initial Research Problem

The key research problem, which needs to be answered here is: *how a transformation from the 'current state' of research interactions between academia, industry, and state to the 'desired state' should happen?*

The 'current state' represents the separated operation of academia, industry and state (government/regulatory bodies), where no academic research intermingles with the industry needs and the construction industry is not interested in research informed management innovations, whilst the state remains at a neutral legislative stance. Differently, the 'desired state' refers to a hypothetical state, where academia and industry are actively involved research partnerships creating knowledge that would foster management innovations in the construction industry, complemented by the state legislative guidance. Hence, at the 'desired state', the three (03) contenders are evolving through an active THM in spiral developments. However, such transformations necessitate determining CSFs of creating a THM effect in overcoming present barriers. The above model (refer Figure 1.1) was later refined and developed into the conceptual framework of research (refer Figure 2.13), based on the detailed literature review.

1.3 Research Aim

The research aim is to investigate the Critical Success Factors (CSFs) of merging academic research with the industry development requirements to cultivate an innovative construction management practice.

1.4 Objectives of the Research

The following objectives have been developed to achieve the aforementioned aim.

1. Evaluate the significance of research as a duty of the academia in leading an industry towards innovations
2. Critically review the necessity of an innovative construction management practice for the construction industry development
3. Investigate the barriers for research interactions between the academia and the construction industry
4. Determine CSFs for merging the academic research and the industry development requirements
5. Develop a model to demonstrate the CSFs for strategic research collaborations in merging academic research and industry development requirements

1.5 Research Questions

The research problem, with its aim and objectives directed to formulate four (04) Research Questions (RQs), as presented below.

RQ1. Why academic research is significant in cultivating an innovative construction management practice? (Derived from Objective 1)

RQ2. How innovative management practices assist the construction industry development? (Derived from Objective 2)

RQ3. What are the barriers for merging academic research and industry development requirements? (Derived from Objective 3)

RQ4. What are the CSFs for the construction stakeholders in developing an innovative management practice? (Derived from Objective 4)

By synthesising answers for RQ1-4, objective 5 was achieved.

The next section presents an overview of the research design, which discusses the methodological concerns of the process of finding answers to the RQs.

1.6 Research Design

The aim with the identified objectives explored in front of a comprehensive literature survey uncovered theoretical explanations of research problem, forming the conceptual framework for the study. Refining the framework, a field study was conducted, combining inductive and deductive approaches informed by a pragmatist philosophical stance. Pragmatism provides freedom for the researchers in selecting appropriate methods according to the requirement of each RQ (Powell, 2001). Research objectives posed, four (04) RQs with explanatory and exploratory purposes, and therefore, were answered through a mixed method. Mixed method focuses on collecting, analysing, and mixing both quantitative and qualitative approaches, providing a better understanding of the research problem than either of each alone.

Survey strategy is discussed by Fowler (2008) as a strategy with the purpose of producing statistics, that is, quantitative or numerical descriptions about some aspects of the study population. Surveys formed a part of the mixed method in this study, in obtaining perspectives of academia, and construction industry initially. Academic census comprised 49 units and industry survey obtained the views of organisations and practitioners separately, with a 510 unit stratified sample.

According to Yin (2013), case study is an in-depth inquiry in its real setting, which offers an explanation, exploration or description based on the case study actors. Hence, the findings of surveys were inductively explored in front of critical cases from industry and academia through case studies and expert opinions. Accordingly, as detailed in Research Methodology chapter (refer Chapter 3), several research strategies were adapted to answer the RQs. Figure 1.2 presents the use of strategies against each RQ, leading to the final outcome; the developed model - MRI.

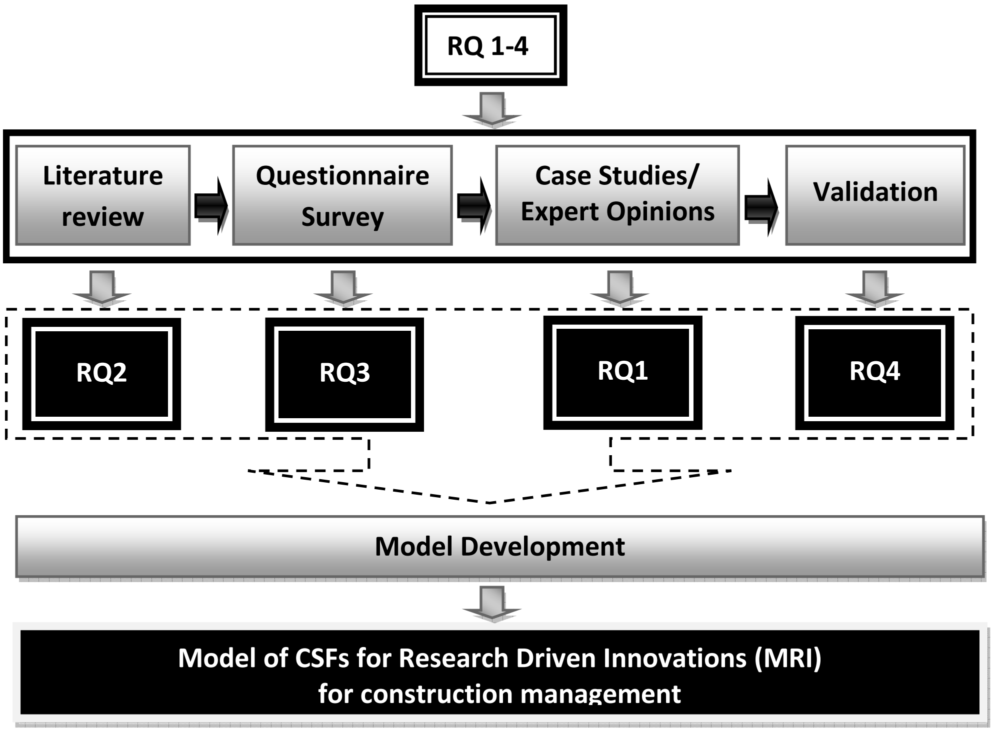


Figure 1.2: RQs Progressing inside Research Design

The collected quantitative data were analysed statistically, whilst content analysis was performed with qualitative data with the use of SPSS and Nvivo softwares, respectively. The findings were validated externally through opinions of three (03) high-profile experts, each engaged extensively in all three (03) disciplines, academic, industry, and industry regulation. The validated findings were presented as a model exposing the CSFs for each stakeholder in developing the spaces required in enabling a THM in construction management practice. Finally, conclusions were drawn, answering the four (04) RQs, methodologically.

1.7 Chapter Breakdown

The breakdown of the thesis, which comprises of six (06) chapters, is presented in Figure1.3.

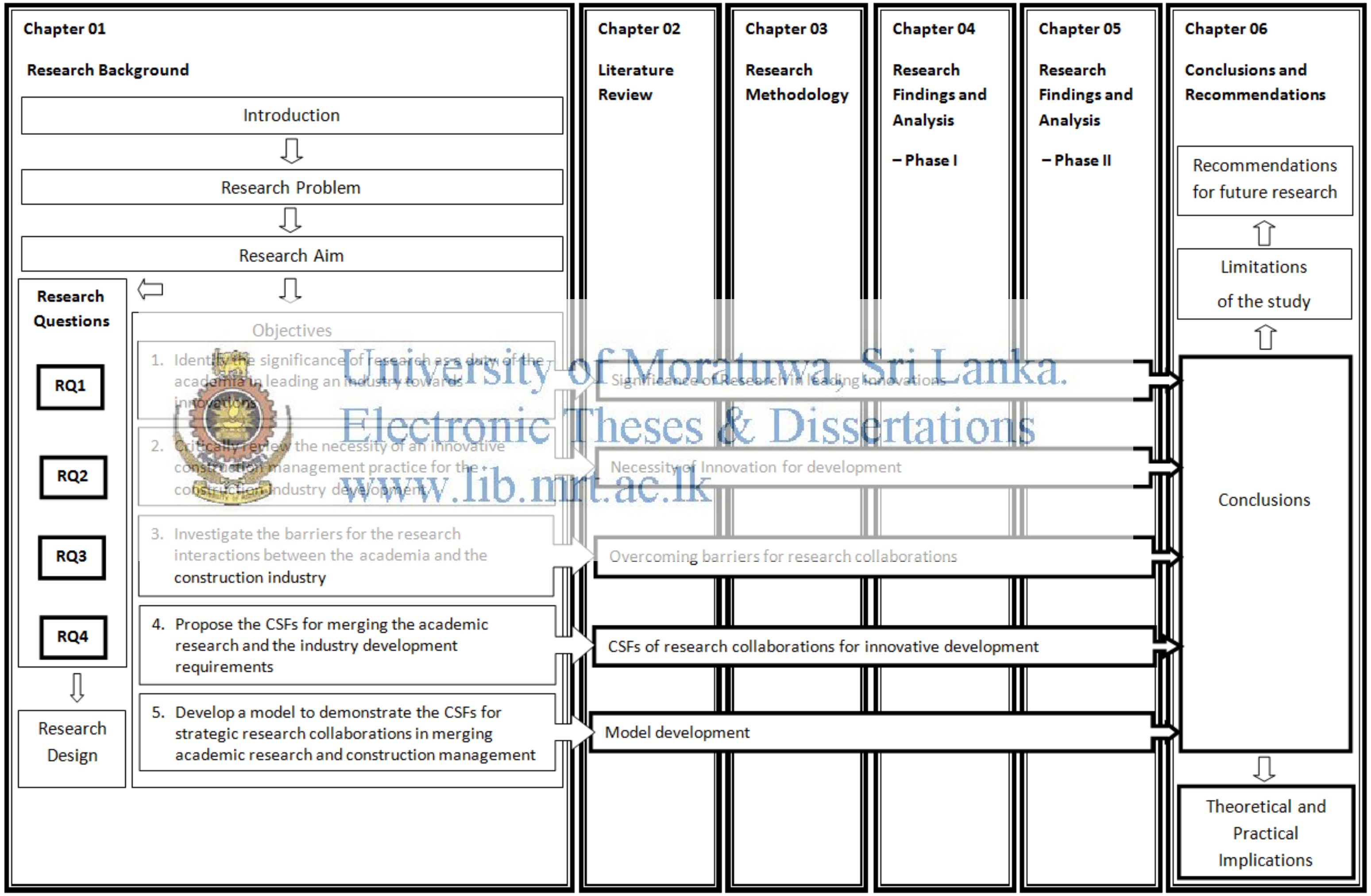


Figure 1.3: Chapter Breakdown

1.8 Summary

This chapter has introduced and discussed the background of the study. The continuous generation of knowledge via academic research, and its capacity to inhibit management innovations in the construction industry was discussed leading to the identification of the research problem. Hence, the research aim was established, together with the objectives to resolve the identified RQs of research in concern. The chapter further presents an overview of the research design. Finally, the structure of the research in brief, was presented based on the chapter breakdown.

The following chapter, Chapter 2 - Literature Review, discusses in detail the existing knowledge base of the research problem, with reference to the key arguments in the fields of research, innovation, and development in built environment.

CHAPTER 2 – LITERATURE REVIEW

2.1 Introduction

Chapter 2 present findings of a comprehensive literature review performed by referring to published materials, including; journals, books, and electronic materials, in exploring the theoretical underpinning of the research problem.

The findings of the literature review are presented in four (04) sub sections: First section discusses the **significance of academic research in cultivating an innovative construction management practice**, and the second section analyses the **relationship between innovative management practices and construction industry development.** The third section explains the **barriers for merging academic research and industry development requirements**, whereas the final section presents insights upon the theoretically suggested **success factors for merging the academic research and the industry development requirements**. Hence, Chapter 2 represents synthesised literature following the aforementioned four (04) sections in order.

2.2 Significance of Academic Research in Cultivating an Innovative Construction Management Practice

This section discuss academic research and its role in creating an innovative construction management practice under four (04) sub sections: These sub sections synthesise literature on significance of higher education institutions in leading innovations, research significance in innovative development as per Triple Helix Model (THM) of Etzkowitz and Leydesdorff (2000), academic research in construction management, and the significance of re-shaping academic research in fostering management innovations.

2.2.1 Significance of higher education institutions in leading innovations

Present day higher education institutions serve as economic catalysts and play the role of an innovation generator (MacDonald, 2013). In parallel, Benítez, Loreto, González and Aranda, (2015) identify universities as social institutions, which promote the construction of social spaces agreeing to social and environmental sustainability. In parallel, the identical reality is proven many different industries such as; pharmaceutical (Toole, 2012): agriculture (Wolf & Zilberman, 2012): manufacturing (Robin & Schubert, 2013): electronics, defense and nuclear technologies (Malva, Lissoni & Llerena, 2013). Therefore, the sector is responsible for educating the next generation of professionals across the range of disciplines. Hence, universities have a significant role and a responsibility in shaping the culture, paradigms, and practices of the professions related to relevant academic disciplines (Fielden, 2008).

Historically, universities were part of religious establishments. Its main role was to teach liberal arts, philosophy, and theology, though some universities became famous for specific subjects (Brezis & Crouzet, 2004). During 19th and early 20th centuries, universities generally became secular and began teaching new subjects, particularly, the sciences, and thus, deviating strongly from its originally served purpose (Bienkowski, Brada & Stanley, 2012).

Though, a university degree was not essential for a career except in few specific professions, yet, academia's main role remained to be providing undergraduates a higher education, which prepares experts for professional duties via teaching (Nicholls, 2014). Centra (1993) defines effective teaching as, "that which produces beneficial and purposeful student learning through the use of appropriate procedures" (p. 42), while Laurillard (2013) highlights the necessity of teaching to extend beyond the specific learning experience to allow learners to apply knowledge in un-familiar situations.

During the later half of the 20th century, a dramatic change took place in higher education. The academic revolution introduced research into the university mission in compatible with teaching (Brezis & Crouzet, 2004). Hence, apart from the primary duty of delivering good quality teaching, universities were assigned with another key responsibility of adding new knowledge to a wider society through research (Altbach, 2013).

‘Research’ is a process of systematic and methodical inquiry and orderly investigation of a subject matter with the purpose of adding new knowledge (Collis & Hussey, 2013). Research as a duty, is an integral part for the career development of academia (Kyvik, 2013), and it accrues to the human, financial and intellectual resources of the university, which subsequently benefit students and ultimately, the relevant industry (Altbach, 2013).

Hence, academics need to conduct research that serves educational purposes and development of the region, and its economy. In scientific research, the tension between basic and applied research is identified as a core issue, thus linking to the “think global, act local” challenge (Kassel, 2009). In fact, Brown and Smith (2013) argue that the research conducted in higher education should be biased towards applied sciences compared to pure sciences. However, Barrett and Barrett (2003) hold the view that researchers should undertake conceptual research, which will ultimately develop to be relevant and useful research outcomes for practice. Such research may not be immediately usable, but will gradually penetrate to the industry in the long run.

The increased salience of knowledge in leading economic development has opened up a third mission: the role of the university in economic development (Breznitz & Feldman, 2012). In the liberal organisation of society, knowledge was first considered as a public good, while economic activities were considered private. The categories became increasingly interchangeable across institutional interfaces with further development over time (Machlup, 2014). Expansion of higher education and academic-research sectors has provided society with a realm in which different benefits can be entertained in a systematic manner (Carnoy et al., 2013). Scientific insights with the potential of being useful in industrial practices, and concerns began to guide the heuristics of scientific research programmes (Irwin, 2013).

Hence, the university was placed as the core institution of knowledge sector (Altbach, 2015). Teaching linked to research, and economic development is a comparative advantage of a university, in comparison with more static industrial, and research institutes. Students represent a dynamic flow-through ‘‘human capital’’ in academic research groups and the turnover of students insures the primacy of the university as a source of innovation (Etzkowitz, 2000). Ultimately, universities become a major driver of economic competitiveness in an increasingly knowledge-driven global economy, which calls for quality teaching, quality researching, and strongly aligned curricula with practice (OECD, 2010).

As presented in Figure 2.1, within the network of communications and expectations, which reshape the institutional arrangements among universities, industries, and governmental agencies, academia has arisen in the institutional structures of contemporary societies (Etzkowitz & Leydesdorff, 1997).

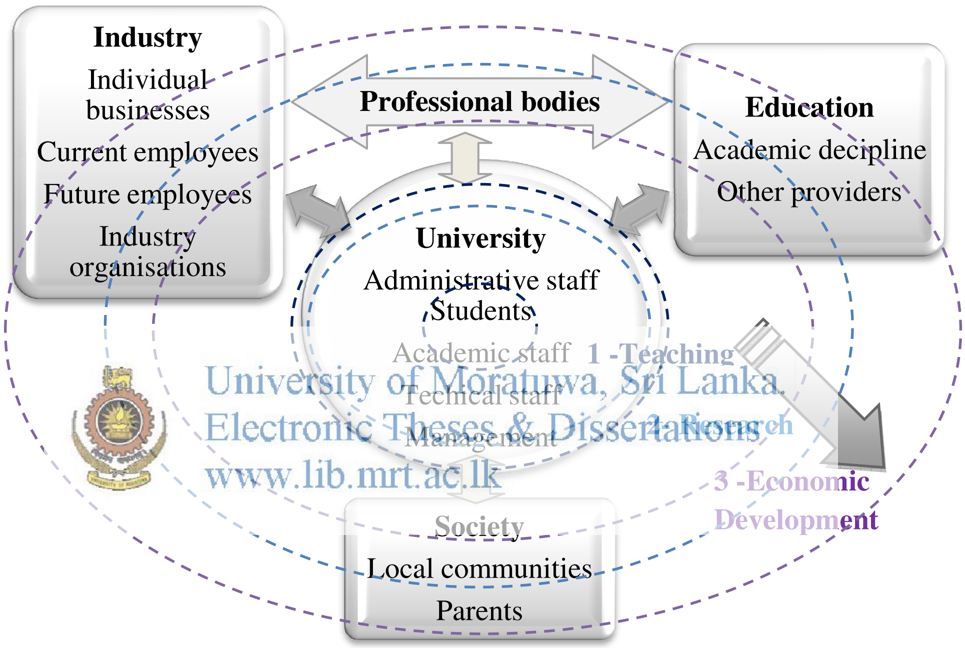


Figure 2.1: Operational Functions of a University

(Source: Adapted from Houston, 2008)

Houston (2008) explains the complexity of interlinked environments and diverse stakeholder expectations in which the universities operate within, as represented in Figure 2.1. Interested parties view the university from different perspectives, such as economic perspectives (employers, industry groups), societal perspectives (families of existing and potential students, community organisations), and educational perspectives (academic disciplines, other education providers), while some interested parties bridge across the environments (e.g. professional bodies bridging educational and economic perspectives), and bridge multiple perspectives and positions. Some external interested parties see the university primarily in local contexts, while others perceive it in national and international contexts.

Hence, universities need to accommodate and respond to external parties and to relevant expectations, while balancing between the three (03) aspects; teaching, research, and contributing to economic development.

Boyer Commission Report (1998) from UK on *Educating Undergraduates in the Research University* found that the universities consider themselves as research-led are heavily involved in linking research and teaching. This is not unique to the UK, but a trend of international relevance. For example, Budwig (2015) addresses this scenario by requesting for significant changes in undergraduate education in the USA; and, Xia, Caulfield and Ferns (2015) explain similar issues in the Australian context. Yet, there is no obligation, whatever for academics to overtly link personal research or industry practices to the areas of teaching, to be considered as good teachers. Nevertheless, it is argued that the improved focus on learning activities positively impacts on the research and teaching relationship. Conversely, expertise in research discipline does not necessarily imply expertise in teaching discipline (Brown & Smith 2013).

The double role of being affiliated to a discipline and involved in a community of practitioners, who are involved in developing teaching and learning, is also problematic, given the pressure of time (Soska & Butterfield, 2013). However, changes in quality assurance mechanisms and funding mechanisms have created negative impacts on the relationship (Senaratne et al., 2005). Since changing definitions of teaching, today, higher education faculties are faced with three (03) core challenges, which have fundamental implications for research and practice as: enhancing prestige and market share, embracing an entrepreneurial mind-set, and expanding interactions and value co-creation with key stakeholders (Pucciarelli & Kaplan, 2016).

Coping with such challenges, the two (02) extremes of research and teaching can bridge with, 'leading economic development' by the scholarship of knowledge dissemination. Hence, universities attempt to balance between the two (02) roles;

being research institutions contributing new knowledge to society, and being effective teaching institutions, which lead economic development (Marozau, Guerrero & Urbano, 2016). Teaching itself could identify as a pathway of dissemination of academic knowledge to the industry practice. As supported by Blackman and Kennedy (2009), university transfer codified knowledge objects from expert to novice. Though, Pinheiro, Benneworth and Jones (2012) suggest more pedagogical research to be carried out, to address the issues of linking teaching and leading economic development.

Therefore, it is clear that the three (03) disciplines, teaching, research, and leading economic development have cohesive interrelationships. However, it is unfair to demand academics to be simultaneously good researchers, good teachers and good practitioners. This requirement is largely challenging to be realised in practice (Perkmann et al., 2013).

Hence, the next section of this chapter synthesise the importance of research for economic development, which would similarly applicable in the dynamic construction industry environment.

2.2.2 Research significance in innovative development as per Triple Helix Model

From the ancient times, the knowledge production function is a structural characteristic of the economy (Schumpeter, 1943). The organised production and control of knowledge for the purpose of industrial innovation has increasingly emerged, as a sub dynamic of the socio-economic system in advanced capitalist societies, over time (Noble, 1977).

The evolution of innovation systems and the current conflicts over which path should be taken in university-industry relations is reflected in the varying institutional arrangements of university-industry-government relations. A specific historical situation labelled as Triple Helix Model I, describes a configuration, where state encompasses, and directs the relations between academia and industry (Etzkowitz & Leydessdorff, 2000) as presented in Figure 2.2.

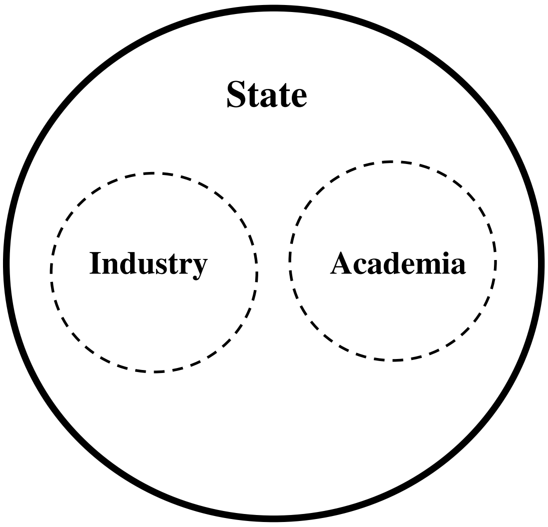


Figure 2.2: An Etatistic Model of University-Industry-Government Relations
(Source: Adapted from Etzkowitz and Leydesdorff, 2000)

However, the Triple Helix Model I is largely viewed as a failed developmental model. With a limited opportunity for ‘‘bottom up’’ initiatives, innovation was discouraged rather than encouraged. Triple Helix Model II (refer Figure 2.3) entails a laissez-faire policy, currently advocated as shock therapy to reduce the role of the state in Triple Helix Model I (Etzkowitz & Leydesdorff, 2000). The second model consists of separate institutional spheres with strong borders, and highly circumscribed relations among the spheres.

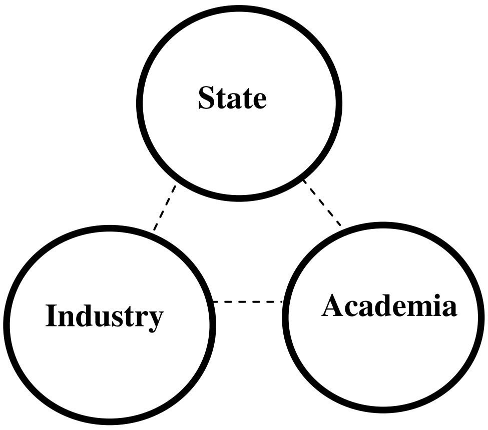


Figure 2.3: Laissez-Faire Model of University-Industry-Government Relations
(Source: Adapted from Etzkowitz and Leydesdorff, 2000)

According to Etzkowitz and Leydesdorff (2000), the final version, Triple Helix Model III (THM), generates knowledge infrastructure in terms of overlapping institutional spheres, each taking the role of the other, with hybrid organisations emerging at the interfaces (refer Figure 2.4).

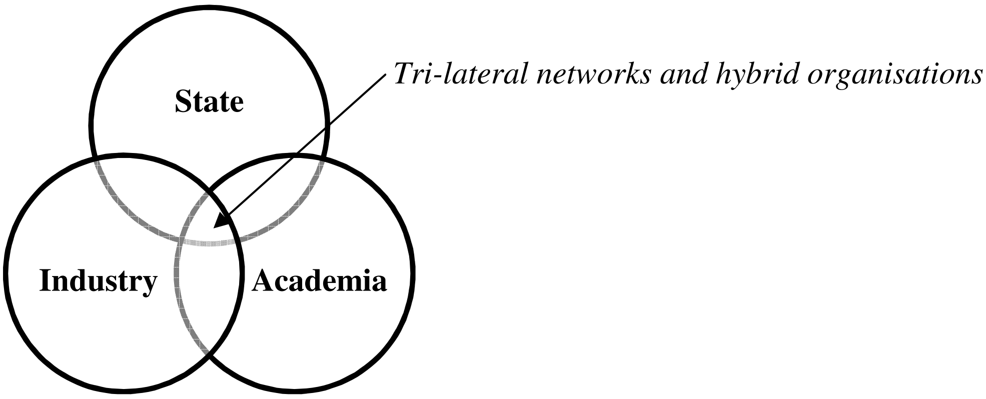


Figure 2.4: Triple Helix Model of University-Industry-Government Relations
(Source: Adapted from Etzkowitz and Leydesdorff, 2000)

Leydesdorff (2013b) states that the three (03) helices are sufficiently complex to understand the social reproduction of the dynamics of innovation. Yet, a relative equilibrium can specify at the interfaces between two selection mechanisms operating upon each other e.g. academic research and construction management practice inside a particular regulatory context. THM, in which each strand may relate to the other two (02) expect to develop an emerging overlay of communications, networks, and organisations among the helices (Leydesdorff, 2013c). When repeated over time, each co-variation can develop into a co-evolution, and a more complex next-order (Etzkowitz & Leydesdorff, 2000).

As presented in Figure 2.5, a system can be generated in a process of mutual shaping among the interactions. Hence, THM of Etzkowitz and Leydesdorff, (2000) focuses on the interactions among various interfaces of the rigidities of the helices organised, dissolved, and reorganised, as structural adjustments to the developments (Freeman & Perez, 1988). Where, the first dimension of THM being internal transformation in each of the helices, such as an assumption of an economic development mission (e.g. construction industry development) by universities (e.g. academic research) with the necessary support from the government/construction industry regulatory bodies. Hence, governments should develop overarching strategic plans, which would help to recognise necessary changes consistent with the needs of the industry practices (Lee, Hwang & Choi, 2012).

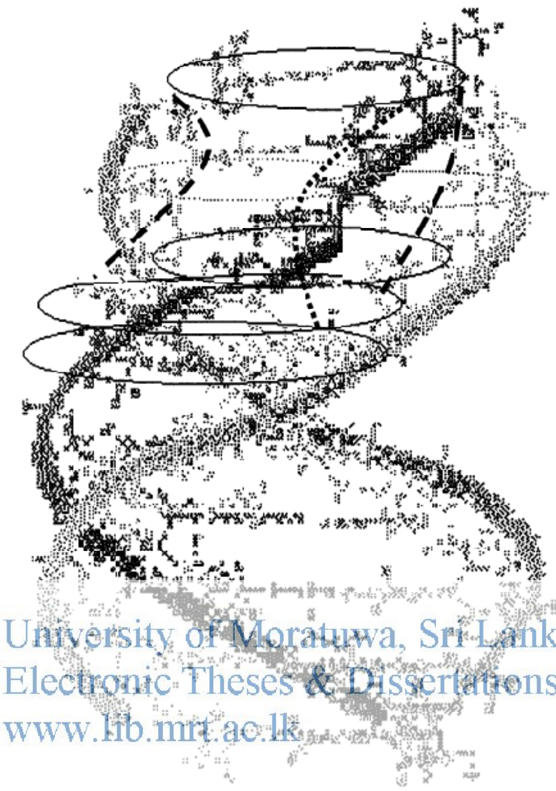


Figure 2.5: Overlay of Communications and Expectations at the Network Level
(Source: Adapted from Etzkowitz and Leydesdorff, 2000)

Resembling most economic establishments, including the construction organisations, presently should try to attain some form of THM with the common objective of realising an innovative environment consisting of tri-lateral initiatives for knowledge based economic development, and strategic alliances among construction firms, and academic research groups. Government should often encourage, but not control these arrangements (Etzkowitz & Leydesdorff, 2000).

THM of Etzkowitz and Leydesdorff, (2000) has read in different ways in various parts of the world with converging institutional spheres of academia, industry, and government (Etzkowitz, 2011). The institutional carriers of an innovation system can expect to entertain a dually layered network: one layer of institutional relations, which constrain the behaviour of each other, and another layer of functional relations, which shape each other's expectations (Leydesdorff, 2010). Yet, in construction management, the latter layer seems under operating, signalling poor THM effects.

Hence, if such model is enabled, it would facilitate recombining sociological notions of earning processing and economic theorising about exchange relations, and insights from science and technology studies, regarding the organisation and control of knowledge production (Soltanifar, 2016) in construction management context. Further, the model can serve as a heuristic (Ranga & Etzkowitz, 2013).

In summary, the abstract and analytical characters of THM (Etzkowitz & Leydesdorff, 2000) would enable explaining the construction management practice transition, towards a knowledge-based self-organising regime. The next section discusses the positives and negatives of contemporary research conducted by the construction management academics, in terms of reaching the expectations of THM.

2.2.3 Academic research in construction management

Research can aid the construction management development in many different contexts: knowledge (contributing to further research), practice, teaching, public policy, and societal. According to Marsh (2010), many researchers attempt to highlight the need to review the manner in which research can more effectively connect to real-world activity and policy setting. Signs of changes to the way, that construction industry operates, and management related research knowledge exchange, are scarce. In particular, the link between academic research and construction management practice is under-developed (Abbott, Aouad & Madubuko, 2008).

Since the impact of research on construction management claimed to be less, communication between the researchers, research funders, and research users should happen in several different ways (Alker, 2008). Still, built-environment researchers are enthusiastic about undertaking research and raising the status via attaining self-set objectives. Yet, to meet with the dissemination requirements, researchers require to follow a proper process from initiation to product dissemination, which comprise several steps. Figure 2.6 depicts the process with the actions taken at each step to meet with such requirements.

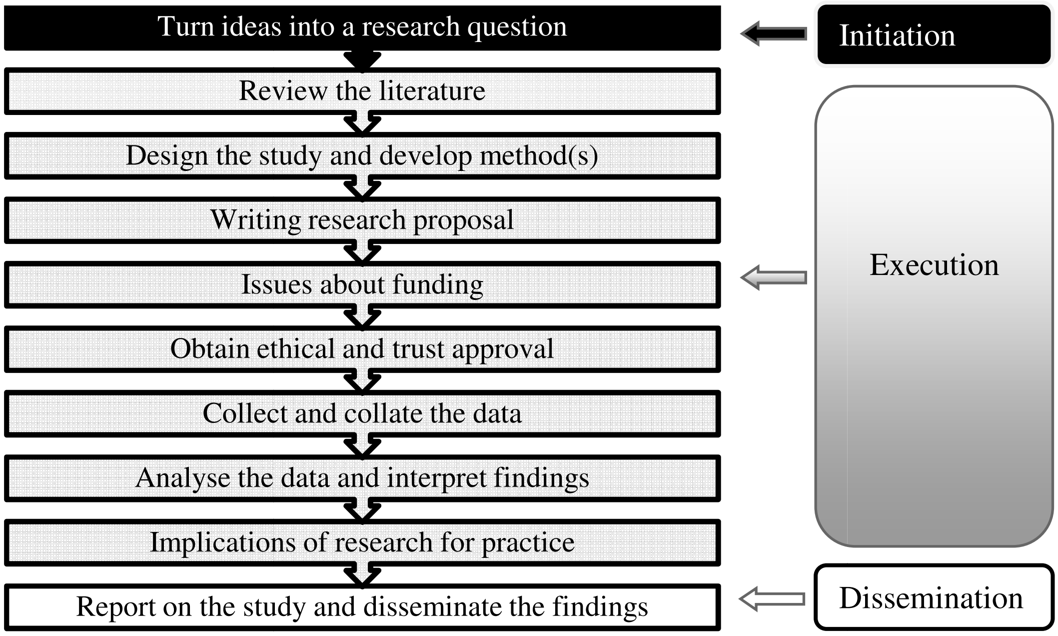


Figure 2.6: Stages of a Research

(Source: Adapted from RD Direct, 2009)

In relation to this study, it is important to examine the barriers and success factors forward to intermingle research and practice at each of the three (03) major stages of a research. Hence, the thesis presents such synthesised arguments in Section 2.4.1, 2.4.2, and 2.5, respectively.

Irrespective of the three (03) basic stages, the research conducted in built environment belongs to many classifications. Some researchers categorise research, based on the method or type of data used, such as experimental research or historical research, while others categories based on the output of research such as: descriptive, exploratory, or causal (Ary, Jacobs, Sorensen & Walker, 2013; van Wyk, 2012). Further, according to Collis and Hussey (2013), research is categorised into two (02) types as conceptual (blue sky/pure) research and applied (down-to-earth) research. Among the categories, Robson and McCartan (2016) argue that the research conducted in higher education should be more into applied sciences, as that offers immediate benefits to the industry, which may be applicable in construction management context as well.

Hence, the next section synthesises the literature related to the significance of re-shaping the research culture of construction management, further exposing possible characteristics of the research type preferred by the construction industry management.

2.2.4 Significance of re-shaping academic research in fostering management innovations in the construction industry

Innovation expects to change both the innovator(s) and the innovated system(s) (Leydesdorff, 2013a). The past decade has provided a significant change in the roles of three (03) strands; academia, industry and government/regulatory bodies. Historically, research institutions were perceived as a source of new ideas and industry offered a natural route to maximise the use of these ideas (Altbach, 2015). The mission of a university remained to provide higher education, which prepares experts for the expected professional duties. Yet, at present, it should also perform research that serves educational needs, and the development of the region and its economy (Brown & Smith, 2013). Moreover, many companies develop open innovation approaches to R&D, combining in-house and external resources, and aiming to maximise economic value of the intellectual property, even when it is not directly linked to the core business. In particular, the industries have begun to treat public knowledge as a strategic resource (Ivanova & Leydesdorff, 2014).

Significantly, a study of Sparrow, Tarkowsky, Lancaster and Mooney (2009) identified that, much of the research and practice of university-industry interaction is rooted in the transfer of research expertise from universities to industry. Learning and knowledge sharing are essential drivers of innovation to organisations, to sustain long-term competitively. However, communicating research outcomes lies at the heart of academic endeavour, because it contributes to improved knowledge and understanding, and guides further research (Carter, 2013). The bigger the project and higher the level of the degree of research, it is more likely that research outcomes would be worth communicating beyond the basic requirements of the broader research community. This may be beneficial to the advancement of research in the particular field of interest and to the academic careers of research graduates (Hays, 2007).

However, according to William et al. (2004) relationships between academia and industry are increasingly intimate and commercial. While opportunities are created for each partner, important conflict of interest issues exist. Conflicts of interest can be deconstructed and reconstructed, first analytically and then perhaps in practice in the search for solutions of problems of economic productivity, wealth retention, and knowledge growth (Godin & Gingras, 2000).

Accordingly, the university is institutionally less powerful than the other two (02) strands. However, the university has specific strengths. It is salient in providing the other two strands with a continuous influx of new discursive knowledge developed through research and new knowledge carriers (Pinto, Fernandez-Esquinas & Uyarra, 2015). Further, the sources of innovation in a THM configuration are no longer synchronised a priori and do not fit together in a pre-given order, but generate puzzles for participants, analysts, and policymakers to solve (Etzkowitz & Leydesdorff, 2000). Hence, the other two (02) strands (regulatory bodies and industry) increasingly and indirectly coopt the university in a variety of ways.

Hence, Schiuma (2012) states, it is evident that research institutions need to play a more active role in the relationship with the industry to maximise the use of research. This new role requires specialist staff to identify and manage knowledge resources with business potential, to take a new idea to market, to acquire resources, and to obtain the interest of adequate buyers.

Specifically, in the construction context, Brandon (1982) has called for a “paradigm shift” in the research and practice of determining building costs; that was one of the first public pronouncements about the drastic need for radical change in how construction processes are researched and practised. At that time, it seemed that the terms were not well appreciated, nor the alleged need particularly clear. However, in the years since Brandon’s call, innovations and “new paradigms” have appeared, but the questions remain, as how far it has come, how much the knowledge has developed, and to what extent have the methods improved to benefit humankind? (Alwan, Jones & Holgate, 2016; Fellows, 2010; Brandon, 2009).

Therefore, in fostering innovation, changes to the systems and the relationships amongst are apparent at the organisational, local, regional, national, and multinational levels (Etzkowitz, 2014a). However, as Leydesdorff (2013a) stated, differentiations achieved historically cannot dissolve at the system's level without costs. A loss of internal complexity, for example, can expect to lead to a loss of ability to handle complexity in the relevant environments.

Table 2.1 below summarises the main factors, which confirms the significance of transferring academic research outcomes to the industry, which were identified through the detailed literature review related to this Section 2.2. The internal and external significance of research considering the universities as the boundary is presented separately.

Table 2.1: Significance of Disseminating Research Knowledge – Academia's Perspective (Refer Appendix - A1for references)

Significance	
Internal Significance	***External Significance***
• Integral part of the career/professional development • Benefits to the human, financial and intellectual resources of the university • Major responsibility • Improves employment skills of the next generation of professionals • Attract new research students • Develop research-led universities • Improve teaching • Guides further research • Serve educational needs	• Development for the region and its economy • Add new knowledge to serve wider society • Bringing in innovation to the industry • Shapes the culture, paradigms and practices of the related professions • Develops industry collaborations • Accommodate and respond to key external parties in reaching their expectations

With that, this section concludes the significance of academic research in directing the industry towards innovative construction management practices. The next section brings arguments to explain how an innovative construction management practices contribute to industry development.

2.3 The Necessity of an Innovative Construction Management Practice for the Construction Industry Development

Since the significance of academic research in cultivating an innovative management practice was identified in the previous section, it is necessary to understand the role of innovation, in the process of development of the construction sector. The sections therefore discuss the argument under three (03) sub-sections as, correlations of innovation and development, innovation for construction industry development, and consequences of construction sector's Red Ocean Strategy (ROS) symptoms and the importance of a Blue Ocean Strategy (BOS).

2.3.1 Correlations of innovation and development

Today it is apparent that the development of science provides much of the basis for future industrial development. Leydesdorff (2015) states that knowledge based developments are discursively reconstructed. As an example, reflections on knowledge production develop in interaction with the diffusion in the market. Nevertheless, the future legitimation for scientific research will be funded at a high level, and increasingly will be the source of new lines of economic development (Etzkowitz, 2014b), which could be similarly applied in the construction industry.

However, a knowledge-based economy operates differently, from a market-based or political economy. Market economy, which is the present days' construction economy, first equilibrates between supply and demand, yet, secondly, political institutions can regulate economic exchange relations. Differently, in terms of a knowledge-based economy, Nation states, "the wealth of a nation no longer depends on its ability to acquire and convert raw materials, but on the abilities and intellect of its citizens" (TFPL, 1999, p. 2). From this perspective, national systems compete in terms of the adaptability of knowledge infrastructure. Moreover, Livingstone and Guile (2012) state the knowledge economy as an emergent reality for many organisations. Knowledge intensive economies can no longer base on simple measures of profit maximisation, which is the current construction industry practice.

Organised knowledge production has more recently added a third coordination mechanism as innovation (Carayannis & Campbell, 2012). Innovation can generate from the synergies amongst opportunities, capacities, resources, and incentives, which change the world (Pavitt, 1984). The infrastructure conditions the processes of innovation, which are within and among the sectors. However, the dynamics of innovation upset the market mechanism (Leydesdorff & Fritsch, 2006). Therefore, in a conversion, construction industry utility functions will have to match with opportunity structures, which are recursively driven by the contingencies of possible innovations (Etzkowitz & Leydesdorff, 1995).

According to Meek, Teichler and Keanrney (2009), countries with robust innovation systems privilege research in a variety of contexts including universities and the private sector. Academic-industry-government relations are emerging from different institutional starting points in various parts of the world, but for the common purpose of stimulating knowledge-based economic development (Etzkowitz, 2011). In recent years, the changing external environment has seen some governments place unprecedented emphasis on research, as a key motor for national development. Concurrently, this has led to new challenges for research management of universities in expanding the research links with industry, commerce, government, and the community at large.

Hence, innovation is increasingly likely to enter the construction industry from outside of the individual firm or even from other institutional sphere such as the university, where the focus of attention is on the original path breaking developments, whether in management or technology (Etzkowitz, 2011). However, evolutionary economists have argued firms as the units of analysis, since firms carry the innovations to compete in markets (Isaksen, 2014). From a policy perspective, national systems of innovation define as a relevant frame of reference for government interventions. Further, policy analysts have argued that systems of innovation can no longer be stabilised nationally, since they remain fundamentally in transition (Cozzens, Healey, Rip & Ziman, 1990).

Moreover, networks are more abstract units of analysis (Novkovic, 2014) since the evolving networks may change the boundaries, while developing (Maturana, 1978). As innovation moves outside of a single organisation, lateral relationships across boundaries, rather than hierarchical bureaucratic structures become more important

(Etzkowitz, 2011). However, to analyse and guide the future development of construction management innovations, a new model of the relationship among the institutional spheres and internal transformation is in need.

Hence, the stages suggested by Etzkowitz (2011) could be used as a good starting point. The theory explains, knowledge-based economic development as a three (03) stage process, where the stages being creation of knowledge space and consensus space, finally leading to an innovation space, as described in Figure 2.7. Therefore, the first step in a three-stage process of knowledge-based economic development is the creation of "knowledge spaces" or concentrations of related R&D activities in a local area (Etzkowitz, 2011). The development of such space is identified as a precursor to knowledge-based regional economic development (Leslie & Rantisi, 2012).

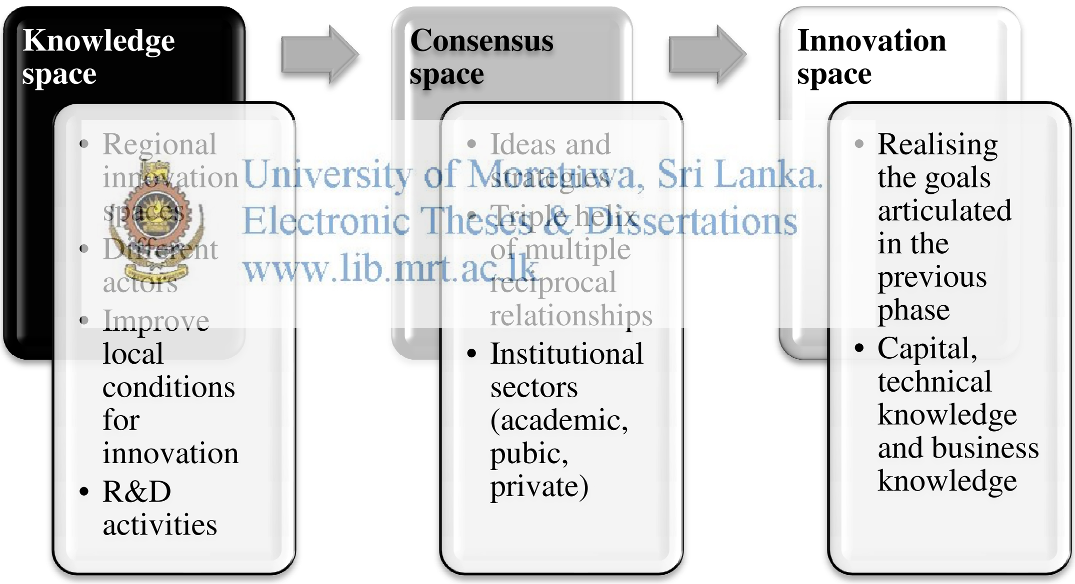


Figure 2.7: Stages of Knowledge-based Economic Development

(Source: Adapted from Etzkowitz, 2011)

According to Etzkowitz (2011), consequence of change in values among promoters of regional economic development, subsidies to firms in creating the conditions for knowledge-based economic development. One indicator of this shift from knowledge space to consensus space is the increased involvement of universities and other knowledge producing and disseminating institutions. The institutes will thereafter lay the foundation for the creation of an innovation space. Therefore, in case of construction industry, the three (03) spaces should be created in moving towards a knowledge economy. Creation of each space will require specific changes, brought to the practice by relevant three stakeholder of the THM operation. Hence, it is of utmost importance for this study to determine the critical requirements of creation of each space in terms of activating a THM operation in construction management practice.

Further to the discussion, next section establishes the specific needs of innovative development for the construction industry.

2.3.2 Innovation for construction industry development

The construction industry is considered as one of the most important industries in the economy. It interacts with almost all fields of human endeavours. The key business practices of construction are in the areas of procurement, partnering, risk management, value management, sustainable construction, benchmarking, supply chain management, whole life costing, health and safety, and lean construction, as identified by SECBE (2010). Therefore, in proposing construction management innovations, changes will be required at all levels of the industry - from the workmen at the construction site to the major societal development programmes (Thuesen et al., 2010).

Currently, the global trends in the construction sector are in many new different directions, as per the strategic plans and studies in several countries such as the UK (Vadera et al., 2008), New Zealand (Crisp, Burghout, Preston & Aitken, 2012), and India (Shah, 2002) (refer Appendix - B). The major directions, therefore, are into; procurement, design, innovation, workforce, better regulations, disaster mitigation, waste, water, material performances, building performance, operating environment, productivity, building better cities and communities, sustainability, professional education, and gender equality.

These trends have helped to polarise the financial and technical superiority of the developed countries and the corresponding inferiority of the developing countries. Hence, construction organisations need to adapt continuously to complex and changing conditions. With that, only they could survive and proliferate through innovation. The internal dynamics of construction management must be such that, they can respond to change by adapting their structure and orientation to reflect (Steele & Murray, 2004). According to Abu Bakar, Yusof, Tufail and Virgiyanti (2016), it is universally recognised that the industry must improve its performance.

It is, therefore, important for the construction industry to move beyond the traditional practices to adopt new management practices arising from R&D activities. There are examples of such successful movements as presented in a study of Davies and Harty (2013), which explains an innovative ICT (Information and Communication Technology) implementation on a large hospital project.

Moreover, considering on recent innovation and development in the construction sector of the Asian region, Andres, Biller, and Dappe (2014) demonstrate the new trends as; urbanisation, globalisation, infrastructure renewal, the burgeoning needs of developing "megacities", and adopting new construction industry strategies to manage the supply side and capture the increased demand, which could become the top priorities for the local context. Thus, knowledge and experience become important intellectual assets being an integral part of the value creation process (Hsu & Sabherwal, 2012). Hence, such particular input should be included in research studies, which aim to develop construction management practice.

Moreover to the benefits, Fulford and Standing (2014) state that effective adoption and diffusion of innovation have the potential to increase productivity of construction industry management. Further, by applying experience and avoiding the same mistakes, design and construction companies can realise cost efficiency improvements, increased design, and performance quality. Bygballe and Ingemansson (2014) state R&D can contribute to finding solutions to the challenges faced by the construction industry. According to Kulatunga, Amaratunga, and Haigh (2005), contribution from R&D to the development of the construction industry is immense, as it enhances the effectiveness of construction organisations and raises the international competitiveness through technological advances and managerial developments. Further, R&D acts as a valuable input to the construction organisation by developing new products, materials, and advanced construction processes, meet customer requirements, and to address the economic, environmental, and resource constraints.

However, the institutional arrangements in construction management should compete in terms of respective successes and failures, when attempting to grasp the fruits of possible innovations (Smith & Leydesdorff, 2014). In the absence of such dynamics, the construction industry is often criticised for being a traditionally bound and conservative industry (Egan, 1998). While this is a major challenge for the construction industry, it also represents a great opportunity for companies in relation to develop new business models, which challenge the competitive logic. This, however, requires distinct business development practices, which aims at escaping the existing institutionalised way of current construction management (Thuesen et al., 2010).

Hence, the above discussed theories conclude, that business development represents an important, but unacknowledged practice for management innovators of the construction industry and suggest, that strategic processes should be facilitated, and subject to more detailed research, to escape the present unhealthy market practices (Thuesen et al., 2010). The investigations upon such unhealthy nature of construction industry revealed the presence of ROS symptoms, as discussed in the next section.

2.3.3 Consequences of the construction sector's Red Ocean symptoms and the importance of a Blue Ocean Strategy

In industry operation, construction companies compete on the overhead rather than the ability to reduce production cost and value creation (Nicolini et al., 2001). Further, the construction management have a reactive approach towards development, where the companies try to follow the development in the market, rather than shaping an own market. Moreover, the management approach towards strategic development is unstructured, undocumented, and non-reflexive (Kim, Yang & Kim, 2008).

These are interpreted as signs of unprofessional management practice in the businesses, which reproduces the existing institutionalised division of labour in the construction industry (Thuesen, Koch & Nielsen, 2010). In essence, it has reduced the construction business to a commodity where many of its customers buy, totally based on the price. This has created a 'bloody price war', which Kim and Mauborgne (2005) refer to as a 'Red Ocean'. 'Red ocean' is defined as an environment, where existing markets have boundaries clearly defined and accepted, when business rules are established (Kim & Mauborgne, 2005).

Hence, the companies within the construction industry are swimming around a 'Red Ocean', where all fight against each other for the good projects (Thuesen et al., 2010). However, the companies can easily survive in this competitive situation, if there is enough food. Yet, as per Kim and Mauborgne (2005), when the projects disappear, the companies will have to cannibalise on each other. Worse, this approach has not produced happy results for clients, either and instead, clients experience cost overruns, excessive change orders, scheduling delays, and performance issues, all of which often lead to litigation (Thuesen et al., 2010).

In contrast, Blue Ocean is a euphemism for uncontested market space (Garrison, 2013). A premise for the development of a BOS of Kim and Mauborgne, (2005), however, requires a conscious approach to business development (Thuesen et al., 2010). Sun Tzu (1964) wrote in *Art of War,* that businesses must out-think the competition instead of attempting to out-muscle. In construction, this means avoiding the low-bid environment (Garrison, 2013). Initially, change of the competitive environment of competing on overhead to competing on the ability to create value for customers and reduce costs means companies will improve the income levels. As more companies are seen beyond the ROS against BOS, the competition in BOS will intensify resulting in lower costs and higher value for consumers (Thuesen et al., 2010). Table 2.2 compare and contrast ROS and BOS.

Table 2.2: Red Ocean Strategy vs. Blue Ocean Strategy

Red Ocean Strategy	**Blue Ocean Strategy**
• Compete in existing market space • Beat the competition • Exploit existing demand • Make the value/cost trade-off • Align the whole system of a company's activities with its strategic choice of differentiation or low cost	• Create uncontested market space • Make the competition irrelevant • Create and capture new demand • Brake the value/cost trade-off • Align the whole system of a company's activities in pursuit of differentiation or low cost

Therefore, the construction management should avoid focusing on doing the construction cheaper, instead, seek ways to do it better and even ensure building the right project. The concept 'BOS' contracting is about how to increase value for the client in such a way, as to differentiate business to eliminate the competition. The approaches are probably company specific, yet, allows contractors and designers to focus on areas, where they have advantages. This allows competing based on value instead of price (Garrison, 2013). In parallel, deriving from the idea of escaping from ROS markets, Kim and Mauborgne (2005) state that BOS creates in a region, where a company's actions favourably affect both its cost structure and its value proposition to buyers. In this way, conscious business development practices have the potential to break the accelerating cost curve of construction (Thuesen et al., 2010).

According to Garrison (2013), there are two (02) different ways to develop a BOS of Kim and Mauborgne, (2005). The first is to create a new industry. Initially, that might seem difficult for contractors. However, time is a critical factor, which influences the value of a client’s investment. By rethinking the construction process, it is possible to increase construction speed significantly. With proper innovations, the construction industry could be re-defined as a totally different industry. However, in construction, more possible practice would be the second way, which is merely to redefine the construction process. In redefining, research and innovations would play a vital role (Garrison, 2013). Since ROS does not facilitate R&D as a value addition, converting ROS into a BOS would be challenging from the onset.

In summary, of the Section 2.3, the construction industry is considered as one of the most important industries in the economy, yet, it faces many challenges with its unique characteristics. Nowadays, one of its' principle challenges is lack of innovation and research. Hence, the significance of research for the construction sector is abstracted from the discussions in Section 2.3 and presented in Table 2.3. The internal significance (in developing individual organisations/practitioners), and external significance (in developing as a sector) of research considering the construction organisations/individual practitioners, as the boundary are presented separately.

Table 2.3: Significance of Research Knowledge Utilisation – Industry Perspective (Refer Appendix – A2 for references)

Significance	
Internal Significance	***External Significance***
• Competitive advantage for sustaining long-term • Guidance for effective human resources management • 'Knowledge economy' being an emergent reality • Continuous performance improvement • Increased profitability • Competitiveness in technological advances • Enhances the effectiveness • Managerial developments • Cost efficiency improvements	• Address the economic, environmental and resource constraints • Understand trends polarising the financial and technical superiority of the developed countries • Finding solutions to the challenges faced by the construction industry • Address the economic, resource, and environmental constraints • To survive and proliferate through innovation • Develop new products, materials, and advanced construction processes • Avoid the industry intellectual drivers' knowledge base getting obsolete • Requirement of commitment to improve the delivery of projects • Deliver better value for money • Increase productivity, design, and performance quality • Update with the global environment • Makes it highly valued by its customers

However, before devising ways for the industry to move to a BOS of Kim and Mauborgne (2005), it is important to identify barriers that keep the construction industry operating in a ROS, hindering the innovative development towards a BOS. Hence, it is necessary to understand the barriers for the research-informed innovations in the construction industry, which are discussed in the next section.

2.4 Barriers for Merging Academic Research and Industry Development Requirements

According to Meek et al. (2009), innovation in developing countries poses very different challenges, in terms of understanding the process and of building systems of innovation. The identical background closely aligns with the specific situation of construction industry nowadays. Such challenges for researchers to bringing in development to the construction management are discussed under four (04) sub-sections, as internal and external barriers for academia, and industry, separately. The boundary, in defining internal and external barriers, was considered as the affiliations (universities for the academia and industry organisations for the practitioners).

2.4.1 Internal barriers for the academia

According to Ordoñez and Serrat (2009), most barriers to research dissemination are psychological or social from the onset. Traditionally, academic researchers and construction industry practitioners do not collaborate closely, in majority of construction research projects. Therefore, successful communication between researchers and research users is crucial for the effective utilisation of research in decision-making in policy, and practice (Alker, 2008). Hair, Wolfinbarger, Money, Samouel and Page (2015) further highlight the importance of successfully communicating the results of research to a wider community beyond immediate research reports, theses, and research products.

Further, due to the challenges of the pedagogical discipline, highly qualified disciplinary specialists might feel incompetent, when they enter in (Havnes & Stensaker, 2006). Moreover, according to Abbot et al. (2008), establishing networks of expertise on research could be a greater challenge for such construction researchers.

Countries with robust innovation systems privilege research in a variety of contexts, including universities and the private sector. Therefore, the changing external environment has seen some governments place unprecedented emphasis on research, as a key motor for national development (Harper, Jones & Marcus, 2013). Concurrently, with democratisation of higher education, universities became heterogeneous not only in their specialisations, but in their quality. Senaratne and Pasqual (2011) stated that, when higher education systems grow and diversify, society is increasingly concerned about the quality of programmes since the knowledge is used in different contexts as: knowledge, practice, teaching, public policy, and societal (Alker, 2008; Marsh, 2010). As a result, Payne (1996) states business colleges and management schools, like other organisations, are under increasing pressure from stakeholder groups, such as students, employers, and accrediting bodies, to demonstrate the relevant quality-oriented processes, and Outcome Based Education (OBE).

Yet, trans-national research opportunities provided or assisted by economically advanced countries might be low in quality, and might exploit those paying for it in many cases; the low and middle income countries have limited capacity for reviewing the quality of programmes and preventing the obvious low-quality programmes from spreading on the territory (Meek et al., 2009).

In addition, the resource pools for research in many low/middle-income countries, even if financially sufficient, might be too small to compete with the larger pools of other countries. Hence, low success in getting a substantial share of research funds from abroad discourages academics (Meek et al., 2009). Over time, funding received from the industry for university research has been marginally low depressing the researchers further. Moreover, tensions arise among academics due to the funding mechanisms, and the iniquity of rewards for research and teaching (Meek et al., 2009).

Due to time pressure, an individual teacher often finds it as difficult to allocate time to be involved in development projects, hence institutions, should prioritise academic duties (Havnes & Stensaker, 2006). For example, Brezis and Crouzet (2004) state that the number of universities and colleges has raised, and the number of students increased even more. Further, Shin, Arimoto, Cummings and Teichler (2015) discuss that, as of the recent policy changes, academics aim for research excellence at the expense of teaching excellence.

Apart from such barriers, where the change necessary should initiate within the individual academic or the institutions, barriers exist which are beyond such control, as discussed in the next section.

2.4.2 External barriers for the academia

Apart from the challenges faced by the researchers as discussed in the previous section, barriers exist beyond the control of individuals' affiliations.

According to Havnes and Stensaker (2006), the emphasis on distributed autonomy in higher education is a barrier to open communication, debate, and critique. Further, increased global competition in higher education and research, and the related information systems on “world-class universities” and indicators of “cutting-edge” research, are more likely to underscore gaps than motivate the less privileged to ‘catch up’. The goals of trans-national education programmes and the paradigms of research might be so driven by the perspectives of economically advanced countries, that the needs of low- and middle-income countries are neglected or even suppressed; this is another challenge for developing countries (Meek et al., 2009).

Frølich, Schmidt and Rosa (2010) further explain the issue as; separation of quality assurance mechanisms for teaching, and research has created critical problems within higher education institutions with respect to choosing a mission and allocation of resources, as research and teaching requires a different type of resources. Heaney and Uchitelle (2004) explain the results created in educational institutions through such dramatic changes as; quality driven initiatives happen at the same time, as universities face with continuing financial demands arising out of diminishing financial support from public sources of finance. Hence, lack of investments in research is a key challenge for researchers. Moreover, the industry is not positioned to make the necessary research investments (Meek et al., 2009).

Conversely, academia has an interest in fashionable management concepts since they have high practical relevance (Volberda, Bosch & Mihalache, 2014). The popularity of fashionable management concepts in fact contrasts with academic discourse, which is virtually ignored by practitioners (Kieser, Nicolai & Seidl, 2015), discouraging the applied research in a way. Differently, changes brought about by pure research will be seen over a long period of time than immediately, at some points. Hence, the researchers argue that the construction industry practitioners often do not entertain innovative research ideas, which require a major change in the industry practices and procedures. This situation dictates the need to enhance the researcher-practitioner collaboration to conduct research on problems, which are vital for the construction industry and to find out adoptable solutions (Walker, 2016).

In addition to these barriers for the academia, there are barriers to industry in attempting to use research knowledge. Such barriers were divided into two (02) segments as; internal barriers and external barriers, where the boundary being an individual organisation/practitioner against the industry as a whole. The internal barriers for the individual organisations/practitioners are discussed below.

2.4.3 Internal barriers for the Industry

Apart from the so-called academia's negative involvement, there is a lack of evidence that construction industry adapts new findings of academic research into their practice (Walker, 2016). Traditionally, it is found that the academic researchers and the construction industry practitioners do not collaborate closely, in most construction research projects. There is a perception among the construction practitioners, that academic research into construction management are not directly usable and valid since they focus on subjects and issues, which are not crucial to the construction industry. Further, this leads to ignorance of good quality academic research (Anumba, 1998). The practitioners also claim that, the academic research results are inapplicable and impractical to use in real- life construction projects (Bigelow, Bilbo & Baker, 2016).

In addition, construction today is a mixture of new materials, processes, solutions, and architectural visions - realised through a specific division of labour and institutionalised roles, such as manufacturers of basic parts, building companies, engineering companies, and architects. Under this existing regime, the value chain is increasingly fragmented. This development has resulted in most businesses, which operate from a cost+ model, making the companies compete on their overhead rather than their core processes (Nicolini et al., 2001).

From a company perspective, the consequence is that they fail to evolve independently, but are enrolled in an institutional developmental, which fixates the company in an institutionalised role. This effect is achieved as the companies build for the same clients, uses advisors, subcontractors, and suppliers are furthermore hired for the same types of employees, with the same competence profile. Consequently, it is impossible for the companies to develop core competencies, but is stuck in a fierce competition on overhead, rather than their ability to reduce costs and create value (Thuesen et al., 2010).

According to Sheffer and Levitte (2012), “integral innovations” that involve new interfaces and/or new integration procedures across the boundaries of firms/professions/trades are adopted far more slowly. Mediating this effect, vertical and horizontal integration of design and construction specialty firms involved in integral innovations significantly increase their rates of adoption. Further, in 2015, Ofori envisaged the requirement of moving for change with a commitment to improve the delivery of projects and the performance of companies. The movement would be a network through, which members could collaborate with each other in developing construction techniques and skills, and exchange ideas for increasing efficiency and quality.

One more reason is lack of interest in investment on R&D by the industry. Privatisation of companies is believed to reduce the resources available for R&D, including collaborations between the industrial companies and university researchers (Meek et al., 2009). Yet, many of these collaborations were not sufficiently market driven and resulted in innovations that lacked a context to be practically applied (Perkmann, 2015).

Conversely, project success depends on the performance of the participants amongst other factors, entrusted to execute the project. Due to the complexity, dynamism, and uncertainty of the construction industry, project team requires to deliver high quality projects at lower costs, in shorter times (Oyedele, 2010; Sears, Sears, Clough, Rounds & Segner, 2015). Since the project teams rarely remain the same from one project to the next, information flow and methods of innovation diffusion are hindered by constantly changing team compositions and lack of teammate-to-teammate familiarity. Multiple, non-hierarchical teams from different organisations find themselves with little incentive to share knowledge or methodologies due to the lack of information technology developments adopted by the construction industry (Sabol, 2007).

Skills agenda is at the heart of current day organisational development. Without sufficient people with the requisite skills, companies will be unable to fulfil their growth potential. There is a global battle for talent, which is becoming more intense. While firms were probably slow to recognise it, the ability to attract, retain, and develop skilled people is increasingly a required core competence (O'Donnell, 2008). Outdated skills of professionals in a particular firm will, therefore, be a strong disadvantage in the highly competitive construction environment.

This emphasises the need for updating knowledge of the workers in line with the new knowledge generation. According to Dragoni, Vankatwyk and Tesluk (2011), the primary challenge lies in the development of basic skills, the procurement and development of strategies and professional leadership, and the protection of experience, which the construction companies are being with poor learning organisational orientation leading to lack of investment in people. Further, lack of resources and people in the industry as highlighted by Loosemore and Richard (2015) could also add to the slow adoption of academic research by the industry.

Lack of training for professionals can be another reason for slow responsiveness. Practitioners require flexible education and training that complements work place experience rather than distracts from professional obligations. Due to innovative development, people have to adapt many changes at a personal and professional level at rapid pace, which increases the need for continuous learning (Ehlen, Van der Klink & Boshuizen, 2005). Hence, the lifelong learning will be a key requirement for construction professionals. According to Amaratunga, Pathirage, Keraminiyage and Thayaparan (2010), it is evidence of a strong connection between the skills and employability. More the skills and knowledge one will demonstrate, more the chances available for him getting employed. Therefore, it is important to focus on matching the skills requirements with the level of skills one possesses, which could be achieved by lifelong learning. However, Wall and Ahmed (2008) point out that, organisations confront increasing costs to train employees in present day high technology environment.

Further, Sexton, Abbott, Barrett and Ruddock (2007) have identified the structure of construction industry seem to inhibit innovation. As an example, UK construction industry is predominantly developed by firms with a less number of people, with limited capacity to innovate due to their management in-abilities, limited resources, and reduced opportunities for supply chain driven innovation, because of their inability to form long-term relationships with other firms. The net effect of this is that, construction firms are commonly characterised as being conservative, risk averse, invest little in R&D, and consider suppliers to be the stimulus of innovation.

As Walker (2016) points out, on the contrary, the researchers argue that the construction industry practitioners often do not entertain innovative research ideas, which require a major change in the industry practices and procedures. Inter-human communication remains failure prone. There is a broad consensus in the literature that successful communication between researchers and research users is crucial for the effective utilisation of research in decision-making in policy and practice (Alker, 2008). Therefore, quality control of communication is vital for developing the knowledge base of the system, and yet, has experienced mainly the misfits between various modes of communication. Thus, dissemination mechanisms selective operations can specify with hindsight on the basis of insights in various disciplines (Friesike, Widenmayer, Gassmann & Schildhauer, 2015), as discussed in this thesis later in Section 2.5.4.

Hence, barriers exist further, which are beyond the control of the industry organisations, which prevent even the interested companies from research based innovations, as discussed in the next section.

2.4.4 External barriers for the Industry

Statistics on the construction industry strengthens the notion of low responsiveness to changes and low development rates compared to other industries (Finkel, 2015; Battelle, 2010; Sabol, 2007; Koebel, Papadakis, Hudson & Cavell, 2004; Fiarclough, 2002). Hence, it is a universally recognised necessity, that the industry must improve its performance (Finkel2015).

In parallel, Ball (2014) argues that the construction industry has considerable barriers to accept innovations in general, mainly due to its culture of conservatism, lack of appropriate leadership, and its timidity in leading the adaptation of new technologies. These issues make it extremely difficult for the construction industry to make significant inroads to invest in the adoption and diffusion of innovation. Further, this is largely driven by technology push rather than demand pull. Construction industry lacking direction and resources to test and implement new research outcomes could contribute to the current gap. R&D has a pivotal role to play here, but the effort needs to be carefully focused on those activities in which, the industry will invest either out of enlightened self-interest or to respond to the demands of clients and government policy.

Although academic research provides useful information, insights, and ideas for improvement, it does not often lead directly to practical advances (Ofori, 2015). BERR (2008) shows that research are not very influential and useful, especially, when less funded and consulted. In fact, NCTM (2010) reveals that the research findings are often published in research journals that are difficult for practitioners to access and reported in an academic style, which makes them difficult to interpret. This gives the feeling that too often the practical implications of academically written research reports are not apparent to practitioners. These urge for a change or a re-shape in academic research culture.

Yet, a study by Koebel et al. (2004) found that almost all types of stakeholders believe it is highly important to adopt new building and construction products, materials, and practices, but in actual situation, a very low usage percentage was recorded. Lack of investment by the industry on R&D is a major hindrance for innovations. NZCIC (2006) explains this as due to the nature of the manner in which the construction services purchased. As per Loosemore and Richard (2015), in construction, the end users of the product will ultimately bear the costs through rent, lease, or purchase, whose business are beneficially or adversely impacted by the effectiveness of the built infrastructure within which they operate. As the construction client base is mostly formed out of relatively uninformed owners, there is little premium possible in prices to fund R&D. Many private owners purchase services relatively infrequently and have no interest in the long-term viability of the industry, whose services they wish to purchase. Moreover, Bettelle (2010) states that the research results on decreasing R&D funding as; even the volatility accompanying the recession has passed, current economic conditions remain fragile.

Further, observations of Dubois and Gadde (2002) indicate that the industry as a whole is featured as a loosely coupled system. Moreover, the adversarial culture of the industry, which ushers in detrimental short-termism and opportunism, manifest in procurement arrangements between project team participants. Hence, industry's short-term focus on achieving project goals is another reason. Loosemore and Richard (2015) highlight lack of innovation as a likely result of low profit levels and clients, who insist on a dominance of lowest-price criteria in awarding contracts. There are many pressures, not least of which is the need for the construction industry to become more profitable and simultaneously deliver better value for money. This represents a significant challenge to the entire construction community, its processes and technologies, and to its clients and customers, who must demand buildings, and, whose economics are considered on a whole life basis.

Further, construction differs from other industries in project-based design and production regime, with a high degree of unique production combined with a significant element of institutional standards and repetition. Furthermore, the products are linked to specific sites and the production team composed uniquely for each project (Thuesen et al., 2010). Finkel (2015) discusses that the construction industry fragments more considerably than many other industries. Because of combination of process fragmentation, product complexity, poor definition of quality attributes, and the "one off" nature of many projects, high level and consistent quality achievement is difficult during design and construction process, particularly in terms of the whole-of-life performance of completed facilities. This dynamism frames the innovation process in contexts, where continuous development is more or less impossible. Consequently, many innovations are confined within a single project (Lock, 2012).

In addition, a study by Robles, Stifi, Ponz-Tienda and Gentes (2014) proved that less innovation adaptation, as a possible reason for lack of productivity improvement of construction labour forces compared to other industries. Even though significant opportunities exist to develop more mature workers, already active in the workforce, yet, there is little evidence of promoting technology-based learning applications in construction related postgraduate course provisions (Alavinia, van den Berg, van Duivenbooden, Elders & Burdorf, 2009). According to MacLeod (2010), in the construction industry, there are a proportion of people who has good to excellent natural ability for innovation, and, who may have trained. Further, services offered by the professional organisations are tacit knowledge intensive in nature since a wide range of professionals involved working as an interdisciplinary team in delivering the construction products (Kuo & Wium, 2014). Yet, the concept of knowledge worker (Green, Newcombe, Fernie & Weller, 2004) has long been ignored within the construction industry, which is considered as one of the labour intensive sectors of the economy among other industries.

In summary, Fairclough (2002) emphasised the influence of innovation on development, where R&D is an important driver of innovation. No valid argument was presented to justify the construction industry being any different, therefore R&D's importance to the construction industry as any other. However, it is not given the same priority as measured in R&D expenditure, as a proportion of turnover. The problem is continuing over time, as discussed. According to Bygballe and Ingemansson (2014), development drives may require changes in the construction sector as R&D activities lead to innovation. However, the pace at which these developments integrate and implement in the sector will be slow. The main barriers of unfolding the potential of these developments are the non-presence of relative advantage, compatibility, simplicity, try-ability and observe-ability. This situation dictates the need to enhance the academic researcher-practitioner collaboration in the construction industry (Lucko & Kaminsky, 2015).

Therefore, the need for sharing knowledge between research institutions and industry has become increasingly evident in recent years. However, relationships between academia and industry are increasingly intimate and commercial. This section reveals that the academia is internally and externally restricted equally as the industry. Barriers identified in this Section 2.4, for the academic and the industry, as discussed above are summarised in Table 2.4 and Table 2.5 respectively.

Table 2.4: Barriers for Research Dissemination – Academia's Perspective (Refer Appendix – A3 for references)

Barriers for Research Dissemination	
Internal Barriers	***External Barriers***
• Research culture of the affiliation demanding to involve in either pure or applied research • Maintaining traditional research culture, while partnering with a commercial industry • Increased work load due to raised number of universities, colleges, and students • Increasing pressure from stakeholder groups upon quality assurance and OBE • Tension due to funding mechanisms • Iniquity of rewards for research and teaching • "Think global, act local" challenge • Time pressure • Poor planning and absence of a proper outcome dissemination strategy • Poor use of communication mechanisms • Low success in getting a substantial share of research funds from abroad • Low success in getting research funds	• Diminishing financial support from public sources for research • Increased global competition in higher education and research • Passive and low opportunity for actual research outcome dissemination • Inadequate quality assurance mechanisms for research • Inadequate allocation of resources for research • Lack of autonomy in higher education • Commercialization of university research • Ignorance of fashionable management concepts by practitioners • Effects of research takes long time to get appear, even if adopted • Low- and middle- income countries inability in reviewing and preventing low quality research programmes • Indicators of 'world-class universities' and 'cutting-edge' research reduces the chances for less privileged universities

Table 2.5: Barriers for Research Knowledge Utilisation – Industry Perspective (Refer Appendix – A4 for references)

Barriers for Research Utilisation	
Internal Barriers	***External Barriers***
• Lack of skilled people to promote innovations • Challenging requirement of adapting to a number of personal and professional changes at a rapid pace • Research outcome capturing is difficult as it is tacit knowledge intensive • Link between R&D and profit levels is not visible • No proper structure to accumulate financial capital to invest in research • Unawareness due to research outcome not reaching the industry • Less knowledge on capacity of research • Competition among construction companies is highly price based • Less incentives for interest on R&D activities • Out-dated skills of professionals failing to match with requirements of innovations • High cost of training employees to match with requirements of innovations • Constantly changing team compositions disturbs information flow and methods of innovation diffusion • Increasing costs to train employees in today's high technology environment • Constantly changing team compositions and lack of teammate to teammate familiarity • Research reported in an academic style making difficult to interpret • Academic research is more focused on subjects and issues, which are not crucial for the industry • Poor organisational learning orientation	• Difficulties in going ahead with current construction industry development trends • Reluctance to invest on research • Ignorance of good quality academic research • Industry lacks leadership to direct towards R&D • Lack of investment on R&D by the industry • Industry mind-set that academic research is not directly usable / valid • Ignorance of the knowledge worker and importance of skills agenda • Educational research does not often lead directly to practical advances • Low attention given to construction product quality • Less funded/consulted research being low influential/useful • Very unique nature of construction industry • Industry is timid in adopting management innovations • Research outcomes are impractical to use in real- life construction projects • Highly fragmented nature of construction industry • Industry is driven by the technology push over the demand pull • Complexity of construction industry production process • Industry's short-term focus on achieving project goals • "One off" nature of many construction projects • Limited resources and opportunities for supply chain driven innovation • Low responsiveness to change • Clients interest of 'lowest-price criteria' to award contracts • Risk averse nature of the construction industry • Slow pace of development in construction sector

Hence, at present, a gap exists between academic research dissemination and research utilisation by the industry due to several reasons arising from both parties. While opportunities are created for each partner, there are also important conflict of interest issues. A collaboration, where the interests and values of each partner are articulated in advance and conflict of interest issues are resolved before legal and business arrangements through established contracts, is the correct path to head off, as discussed next. The next section explores how such collaboration could be built in the construction industry.

2.5 Merging Academic Research and Industry Development Requirements

Based on the literature discussed in the previous section, it can argue that academic research and industry development requirements should be merged. It would be useful for practitioners and policymakers to make better-informed decisions with less speculation, leading to a sustainable innovative development in the sector. In such a process of merging academic research and industry practice, several studies have identified many possible success factors, which need to be addressed, as discussed in this section.

2.5.1 Dynamics of merging academic research and industry development requirements

In innovation literature, various perspectives open windows of appreciation on the dynamic and complex processes of innovation, but from specific angles. The complex dynamics are composed of sub dynamics like market forces, political power, institutional control, social movements, technological trajectories, and regimes (Freeman & Perez, 1988), where this study needs such operations to be clarified specific to the construction industry. The present dynamics of the construction industry has led to a regional lock-in. A breakout of a lock-in may open a window on a new market with a global perspective (Coenen, Moodysson & Martin, 2015).

Yet, there is no scientifically ‘correct’ way to solve problems in a particular industry. Instead, choices emerge in the course of a project because of many different success factors; scientific, economic, political, and even cultural (Nowotny, Scott & Gibbons, 2001). Particularly, when knowledge is increasingly utilised as a resource for the production and distribution of systems, reconstruction may come to prevail as a mode of 'creative destruction' (Luhmann, 1984 cited Etzkowitz & Leydesdorff, 2000).

In such a complex dynamic, the independent variables at one moment of time may become dependent on a next moment, similar to the dynamics of THM (Leydesdorff, 2009). Consequently, the economic and political mechanisms no longer control, but function as selective feedback mechanisms that enable and constrain the development of scientific knowledge (Ivanova & Leydesdorff, 2014).

Hence, different stakeholders (e.g., academia, industry, government) should recombine from their respective perspectives (Leydesdorff, Park & Lengyel, 2014). Therefore, the bilateral relations between government and university, academia and industry, and government and industry should have to expand into triadic relationships among the spheres. The dynamic of society would change from one of strong boundaries between separate institutional spheres and organisations to a more flexible overlapping system, with each taking the role of the other.

However, to describe the mutual interdependence and interaction with respect to knowledge creation, one needs to distinguish these mechanisms first, as presented in Figure 2.8.

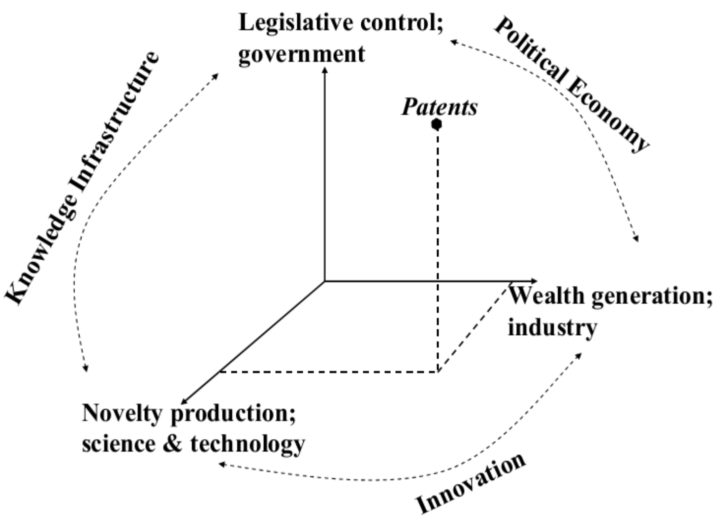


Figure 2.8: Three-dimensional Space of Triple Helix Interactions

(Source: Adapted from Leydesdorff, 2005)

Therefore, three (03) sub-dynamics are reproduced as functions of a knowledge-based economy: wealth generation in the economy, novelty generation through organised science and technology, and governance of the interactions among these two (02) sub dynamics of policy-making in the public sphere and management in the private sphere. The economic system, the academic system, and the political system can be considered as relatively autonomous subsystems of a society, which operate with different mechanisms would be parallel to; construction industry, research academia, and government/regulatory bodies, respectively, in understanding the construction management innovations. Hence, it could be assumed at this point of the study, that the academia, construction industry, and government/regulatory bodies to produce novelty, wealth, and legislative controls in the concerned context of construction management. Interactions between academia and government/regulatory will develop the dimension of knowledge infrastructure, while construction industry and government/regulatory interactions will develop the necessary political economy. Resultantly, the interactions between the academia and industry will develop into innovations in construction management practice. However, patenting the knowledge would be in question since the management knowledge is mostly intangible.

Hence, the university should need to be a firm founder through incubator facilities, industry as an educator through company universities, and government as a venture capitalist through the research and other programmes (Etzkowitz, 2014a). Governments also must encourage collaborative R&D among firms, universities, and national laboratories to address issues of national competitiveness (Etzkowitz & Leydesdorff, 2000). Therefore, three (03) interacting sub dynamics can expect to generate hyper cycles on top of the business cycles, election cycles, and paradigm changes (Leydesdorff, 2010).

Institutional functionality in a knowledge-based economy also implies reaching across institutional borders based on expectations about, how the environments may change, when providing opportunities for innovation. Therefore, the construction industry has to assess in 'what way' and to 'what extent' they decide to internalise R&D functions. Universities could position themselves in markets, both regionally and globally. Governments may make informed trade-offs between investments in industrial policies. Managing these interfaces is both an economic imperative and a political challenge, yet knowledge-intensive in elaboration (Leydesdorff, 2005).

In addition, the dynamics can become self-organising because the incentives for change can come from different sources and operating environments. The driving force of the interactions can specify as the expectation of profits. However, 'profit' may mean different things to various contenders involved in the process of sector development (Worasinchai, Ribière & Bechina, 2009). Therefore, the investment from each contender to the THM would need to be agreed in front of proper agreements, when establishing co-evolutions in a business context like construction, as suggested by Pavitt (1984) for general context.

Within the context of the above discussion of the dynamics of such a merger, it is observed that partnership arrangements are the way forward between the concerned parties. In fact, partnerships amongst governments, the economic sector, and research universities should grow considerably, to ensure that new knowledge becomes linked to development goals (Kassel, 2009) in the construction context. However, at present, the relationships between academia and industry are increasingly intimate and commercial. While opportunities are created for each partner, there are also important conflict of interest issues. Particularly challenging is ensuring that universities maintain their traditional role in public science, while collaborating with a commercial entity with a tradition of proprietary science (William et al., 2004). A collaboration, where the interests and values of each partner were articulated in advance, and conflict of interest issues were resolved before legal and business arrangements established via contract is the correct path to head off. The next section discusses how the academic research could be reshaped for such a collaborative environment.

2.5.2 Reshaping academic research to create a merge

The most common claim by practitioners is that academic research is not directly usable by the industry. To overcome this issue, academic research could be made more useful if its structure and organisation were better linked to the practical needs of the industry.

EN (2011) suggests improvements for future academia-industry collaborated research programmes in four (04) ways. Firstly, it is required to clarify objectives, while maintaining flexibility to respond to emerging policy needs. Secondly, it is required to reduce complexities of research funding: research and innovation funding should provide more added values, increase its leverage effect on other public and private resources, and be used more effectively to support the strategic alignment and pooling of national and regional funds to avoid duplication. Further, timely grants should lower administrative burdens and thirdly, it is required to broaden participation in programmes. The ultimate users of innovations should be involved much earlier in the process to accelerate and broaden the exploitation of results to encourage greater public acceptance. Finally, increasing the competitiveness and societal impact is essential. This would require better uptake and use of results by companies, investors, public authorities, other researchers, and policy makers.

In addition, academics should treat research as a value creation process by being ethical (Le & Bronn, 2007). However, research should focus not only to overcome global challenges, but also to improve individual industries. Therefore, it is suggested that research programmes should be judged not just by the quality and quantity of science produced, but by the industry impact and tangible benefits resulting from the research (Kassel, 2009). The institutions have already started to implement evaluation mechanisms to identify and promote such overall performance in developed counties (OECD, 2010). Hence, effective research knowledge dissemination processes in creating such an impact are of utmost importance, as discussed in the next section.

2.5.3 Research knowledge dissemination process

Knowledge dissemination, in general, can view as a sub process of knowledge management and it mainly refers to knowledge transfer to wider communities. Dissemination is the interactive process of communicating knowledge to target audiences so that it is used to lead innovations. The challenge is to improve the accessibility of desired knowledge products by those who are intending to reach. This means ensuring physical availability of the product to a large proportion of the target audience, as possible and making the product comprehensible to those who receive it (Ordoñez & Serrat, 2009).

As such, simply initiating the dissemination mechanisms is insufficient. The transfer needs to adopt an end-user perspective. Such end-user perspectives are evident in reaching higher stages of the Model - Chain of Knowledge Utilisation (MCKU) of Alker (2008) (refer Figure 2.9).

Reception:	Research received by an individual and lands on the desk, but the findings might never be read
Cognition:	Research is read and understood
Reference:	Research changes way of thinking – provokes a shift in an individual's "frame of reference", for example in terms of defining key problems and priorities
Effort:	Research has shaped action; some effort has been made to get the findings adopted, even if this is ultimately unsuccessful
Adoption:	Research has had a direct influence on the actual policy
Implementation:	While research may have been used to develop policy, at this stage it has also been translated into practice on the ground.
Impact:	Utilisation of research, when the implemented policy is successful in producing tangible benefits to the citizens.

Figure 2.9: Stages of Model - Chain of Knowledge Utilisation

(Source: Adapted from Alker, 2008)

Hence, the MCKU identifies seven (07) stages, which research dissemination efforts could result beginning from merely reaching the target audience, to producing tangible benefits to the relevant knowledge users. The model, therefore, suggests academic researchers in built environment to make efforts in reaching higher stages in order to facilitate utilisation of knowledge in cultivating innovative management practice in the construction industry.

In parallel to above MCKU, Alker (2008) has produced another model called 'Pipeline Model of Knowledge Dissemination' (PMKD), which explains the different stages of practitioners' use of research, as presented in Figure 2.10. PMKD suggests that research knowledge dissemination could be positioned in seven (07) stages, starting from awareness, to being adhered. In between, some research outcomes reach the levels, acceptance, and local application, accepted as practically feasible, and get into action, and the adoption. Deeper in the pipe, the success is higher in terms of dissemination of knowledge.

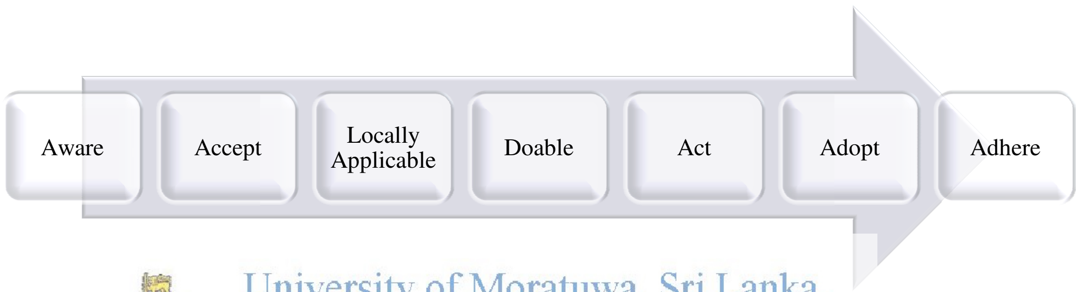


Figure 2.10: Stages of Pipeline Model of Knowledge Dissemination

(Source: Adapted from Alker, 2008)

According to Ordoñez and Serrat (2009), certain efforts to disseminate knowledge products are earnest. However, the low impact of most research is mainly attributable to poor planning and the absence of a proper dissemination strategy. It is, therefore, necessary for research academics in built environment to have a planed dissemination process, which is interactive, allowing feedback from audiences in a cyclical model of communication flow.

Further, in a specific context, the processes at different levels and in different dimensions develop concurrently, asynchronously, and in interaction with one another. The horizontal differentiation among the coordination mechanisms is based on the availability of different codes for the communication (Leydesdorff, 2010). Hence, there is a need to identify the ways and methods to link researchers, practitioners, and research funders with effective communication channels (Alker, 2008). BERR (2008) highlights the need of research funders taking the first step in aligning researchers and construction decision-makers. However, as Panda and Gupta (2014) argue, the impetus for these changes must initially come from the research community.

As emphasised in the above discussion, dissemination can be effective through different communication channels at different stages and for different purposes. Therefore, it is important to seek for available research knowledge dissemination mechanisms, which can be utilised by research academics in the built environment in favour of the construction industry.

2.5.4 Research knowledge dissemination mechanisms

Dissemination mechanisms are the different media or types of outputs produced by research programmes. According to RD Direct (2009), a research communication strategy can comprise active and passive dissemination activities. Passive knowledge dissemination is mainly untargeted, including unplanned ad-hoc forms of communication, or disseminating knowledge through publications in academic journals. Yet, active dissemination is characterised by tailoring research findings to a target audience with a dynamic flow of information from the source to increase the uptake of research in policymaking.

Table 2.6 presents some common mechanisms used for research knowledge dissemination. Further, they are categorised into seven (07) groups based on the way of initiation of dissemination mechanism, for ease of reference.

Table 2.6: Research Knowledge Dissemination Mechanisms

Knowledge Dissemination Mechanism		**Research References**
a) Write–ups of individual research	• Research reports • Working documents • Manuals • Publications • Others (Brochures, Flyers, Drawings and Posters)	[1], [2], [3], [4], [5], [6]
b) Collections of written research	• Academic journals • Professional journals • Libraries	[1], [6], [7]

Knowledge Dissemination Mechanism Cont.		Research References
c) E- transfer	• Networking • Internet, intranet and e-mail • Discussion forums • Video conferencing	[6], [8]
d) Public awareness	• Promotional campaigns • Press releases, TV, Radio	[1], [6]
e) Research related gatherings	• Conferences • Workshops and seminars • Training programmes • Continuous Professional Development (CPD) programmes, Lectures and Demonstrations	[1], [2], [6], [8], [9]
f) Collaboration with the government	• Participating in policy making and Policy Briefs • Partnerships (Public-private, Strategic) • Official Reports	[1], [2], [5], [6]
g) Collaboration with the industries	• Contracts with industry • Products, Services and Consulting • Knowledge brokers and Simulations • Entrepreneurships • Practitioners engaged in research	[1], [2], [5], [6], [8], [10]

[1] Alker (2008); [2] Aouad, Ozorhon & Abbott (2010); [3] Maqsood, Walker & Finegan (2007); [4] Marsh (2010); [5] Meek et al. (2009); [6] Ordoñez & Serrat (2009); [7] Jain & Nfila (2011); [8] Karnnien & Lemola (2006); [9] Ward (2003); [10] Wood, Beckmann & Birney (2009)

The below section presents in-depth discussions on above mechanisms, based on the given categories.

a. Write–ups of Individual Research

Individual research write-ups are available in different forms. These are written for the academic purpose of research. Research report is a carefully structured write-up, which clearly states the purpose, findings, and relevance of research activity. A report may be written for a range of reasons and for a variety of audiences. Therefore, its length, style, and detail tend to vary greatly (RD Direct, 2009). This report is typically read by other researchers, and provides evidence that the research was soundly conducted. Working documents, manuals, and various publications are prepared based upon individual research, and publication is a common mechanism for knowledge dissemination used by many researchers.

Other mechanisms like brochures, flyers, drawings, and presentations, convey research findings more user-friendly. Pfister and Eppler (2012) explain the worth of drawings and posters in terms of effective knowledge dissemination. It is proved that the drawing on memory performance is as effective as twice without a drawing. Individual research write-ups are strong in content but the problem here is some mechanisms focus more on the research itself but not the audience.

b. **Collections of Written Research**

Apart from individual write-ups, research outcomes are available as packages. Academic journals, professional journals, and libraries would provide the opportunity to instantly access many research outcomes. Many publishers are involved in research publications; for an example, Emerald, alongside other scholarly publishers, is an intermediary or “translator,” capturing, evaluating, organising, and disseminating research output. The scholarly publishing process has been established for centuries, and has successfully managed the process of highlighting important research to the wider world. This has in turn contributed to the development of business, science, industry, and culture (Marsh, 2010). Few examples of major journals published by such publishers in the construction management context are, Construction Management and Economics, Engineering, Construction and Architectural Management, and International Journal of Project Management.

Moreover, Jain and Nfila (2011) state, libraries and information centres exist to provide access to all types of information, in all different formats, to all individuals to support teaching, learning, research, sharing of knowledge and skills, and sharing of information to achieve participative democracy and national development.

c. **E- transfer**

E-transferring is a popular mechanism in knowledge dissemination. Networking allows groups of people of different skills, experience, and background to work together closely without disturbed by the physical distance (Ordoñez & Serrat, 2009). E-mails, internet, and intranet are peer-to-peer applications that allow users to communicate in a fast and effective manner. Discussion forums on the other hand are an effective mechanism for capturing and sharing knowledge. Further, multi-media tools such as video conferencing support interactive meetings between knowledge deliverer and capturer.

d. **Public Awareness**

The focus here is on 'dissemination' and interaction with the 'general public'. Activities as; open days, science fairs, and involvement in the general press and science journals for the public, involvement in different media, and interactive websites, can use as effective mechanisms to disseminate knowledge. Besides, these structural investments, some involve themselves in a given social and cultural events such as, expos and urban development projects (Meek et al., 2009).

e. **Research Related Gatherings**

Conferences, workshops, and professional development gatherings of colleagues are events, where participants can construct their own personal knowledge through scientific knowledge disseminated. Simultaneously, it provides an excellent opportunity to enhance knowledge further gained through socialisation with other experts and knowledge carriers attending the conference. Figure 2.11 highlights the related processes, values, and beliefs usually exist in organisations in terms of sending participants for conferences. The story in the picture concludes, how dissemination occasion could help thought provoking, yet, the interest of the industry in understanding value addition through participation is still in need of guidance. Further, development and promotion of training in innovation, as a discipline in its own right is considered under this category. Aouad et al. (2010) suggest familiarity and trust, establish through training activity. It can lead to a better understanding of university capabilities and the consequent identification of a university, as a partner in solving pressing business problems.

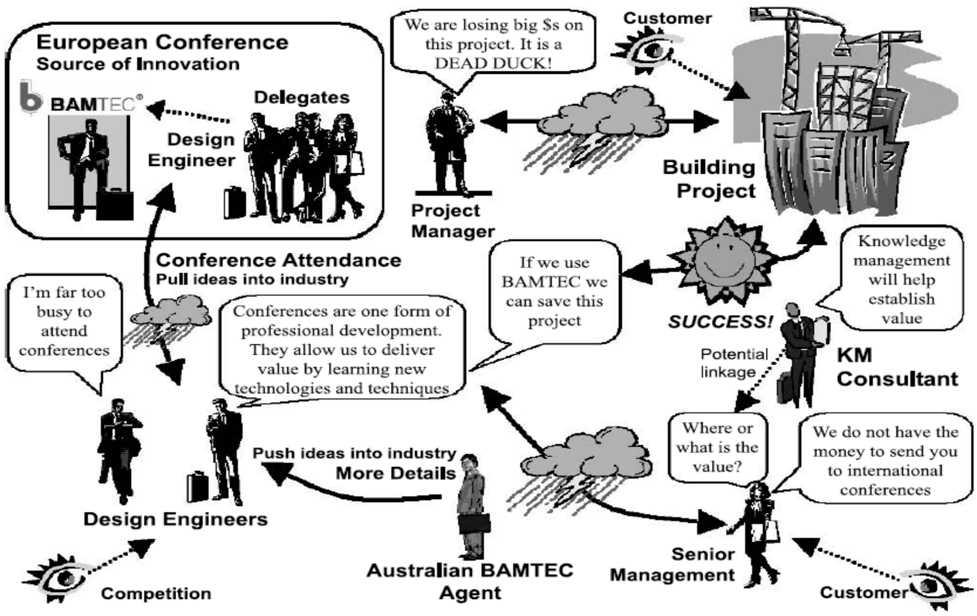


Figure 2.11: Knowledge Dissemination at Conferences

(Source: Adapted from Ward, 2003)

Madden and Mitchell (1993) defined CPD; as the maintenance and enhancement of knowledge, expertise, and competence of professionals throughout their careers, according to a plan formulated with regard to the needs of the professional, the employer, the professions, and the society. Many managers belong to professional bodies, who seek to encourage or require members to demonstrate evidence of continuing professional development (Jones & Robinson, 1997).

f. Collaboration with the Government

The focus here is the 'public service' dimension of research activities. Meek et al. (2009) suggest it is important to complement contracts by non-market relations, which are often critical on social and cultural dimensions. Therefore, policy briefs prepared for the senior policy makers in ministries. According to Postlethwaite (2005), it is in the form of an executive summary of about five (05) or six (06) pages. It reports major findings succinctly and explains in simple terms, the implications of the findings for future action and/or policy. The emergence of public-private research partnerships reflects a fundamental change in the way in which knowledge is generated and applied and changes in approaches to the management of industrial R&D (Howard Partners, 2003 cited Meek et al., 2009).

g. Collaboration with the Industries

According to Beath and Siegel (2002 cited Meek et al., 2009), university-industry partnerships appear to accelerate technological diffusion. It seems that the quality of the relationships and the free flow of information, are as important equally as the actual commercialisation of a research product. Interactive partnerships are becoming more the norm, rather than simple contractual publications. Knowledge co-production and circulation of industry happens through the contracts with the industry. Increasing the demand for university engagement should be the underpinning activity of an innovative platform (Aouad et al., 2010).

However, several commentators have argued that a major drawback to greater commercialisation of university research is the threat it poses to "open science" and academic freedom. However, there has been a growing trend for joint publications between university researchers and those based on industry and government, which appears to have actually increased the significance of university researchers' contribution (Meek et al., 2009).

In addition, a knowledge broker is a person or a business that examines disseminated information and knowledge for clients and prepares usable, targeted synthesis for the client. This primary package research results to be easily understood by and applicable to decision-makers (Alker, 2008). Further, the traditional task-specific simulations focus on the development of domain-specific knowledge. The set of new leadership simulations, however, aims at the development of greater levels of flexibility, that has direct implications for the effectiveness of simulations in training and development (Wood et al., 2009). This could apply into the social research knowledge dissemination as well.

According to Aouad et al. (2010), embedding researchers within companies, as part of existing research activity, is another method of universities emerging themselves within business contexts and problems. In this way, long-term collaboration is agreed with the recognition that the university and companies are strategic partners (Meek et al., 2009). Practitioners engage in research transfer embodied knowledge in postgraduate research activities to the industry through employment. This screens the transfer of competences trained through research to industry (Meek et al., 2009). Further, Jones and Robinson (1997) state the advantage of knowledge dissemination, as an increasing recognition of the contribution, which the effective management of human resources can make to the competitive advantage of organisations.

As discussed above, many diverse dissemination techniques are available. However, when selecting a dissemination mechanism by an individual researcher, it would be better if one can have an overall picture upon the pros and cons of all possible methods. To support this, Aouad et al. (2010) have created a linear model of dissemination mechanisms (refer Figure 2.12), which represents the university involvement ahead of company engagement in the UK context.

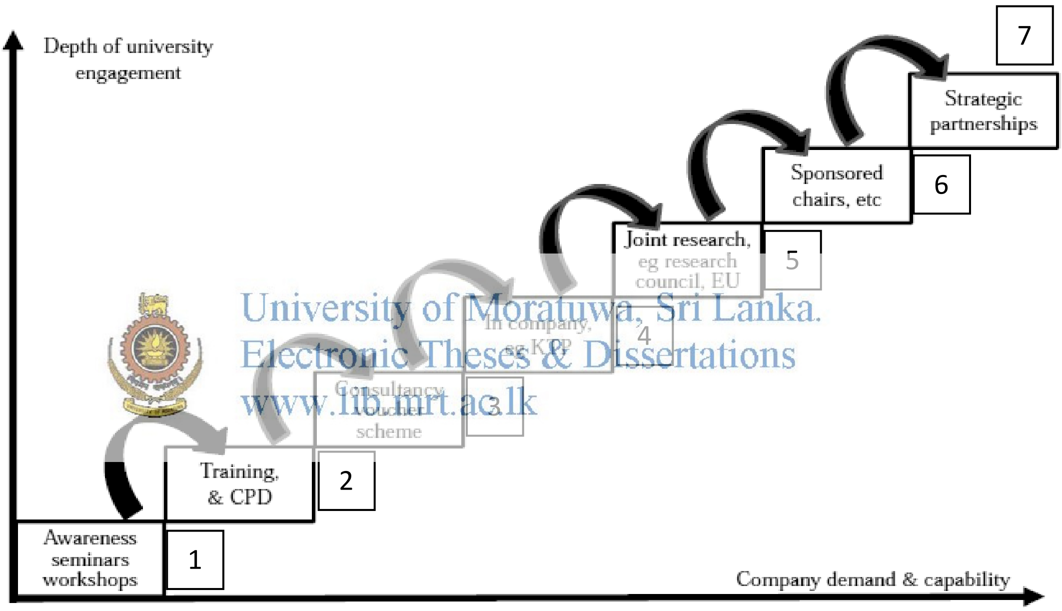


Figure 2.12: University–Industry Involvements in Knowledge Dissemination Mechanisms

(Source: Adapted from Aouad et al., 2010)

Strategic partnerships are identified as the method, which has the highest involvement from both sides, while seminars and such gatherings positioned at the very bottom. When relating this to the research utilisation stages of PMKD of Alker (2008), discussed in Figure 2.6, it could relate the first stage of awareness to the method (d) on public awareness. Similarly, stages two to four (2-4) can relate to the method (e) on research related gatherings. Finally, stages five to seven (5-7) can relate to the methods (f) and (g) on research collaborations with government and industry. It is apparent that the first two (02) dissemination methods to write-ups and written research are of least impact to an industry and not even included in the model.

Many other parameters such as cost, quality, and time need to be considered, when a dissemination mechanism for individual research is selected. Table 2.7 presents an analysis of the seven (07) dissemination methods discussed above, in terms of such parameters based on the references cited in Table 2.6.

Table 2.7: Analysis of Different Knowledge Dissemination Mechanisms

Dissemination Mechanism	Advantages												Dis-advantages								
	User-friendly	Audience Specific	Structured	Academic	Methodological	Understandability	Low Cost	Purposive	Wide audiences	High Influence	Convenient	Immediate Impact	Thought Provoking	Limited Audience	Expensive	Readability issues	Reliability Isuues	Needs Creativity	Poor Focus	Wrong Interpretations	Not Popular
a) Write –ups of individual research																					
Manual	√	√	√					√		√				√	√						√
Working document		√						√		√				√	√						
Research report		√	√	√	√	√		√						√	√	√					
Publications		√	√	√	√			√						√	√	√	√				
Others (Brochures, Flyers, Drawings and Posters)	√					√	√	√	√	√	√	√						√			√
b) Collections of written research																					
Academic, refereed journal		√	√	√	√					√				√	√	√	√				
Professional journal		√	√		√										√	√	√				
Libraries	√			√		√	√	√	√	√	√										
c) E- transfer																					
Discussion forums	√					√	√	√	√	√	√	√					√				√
Networking		√				√	√				√			√			√				√
Internet, intranet and electronic mail	√					√	√		√		√	√					√		√		
Video conferencing	√	√				√	√	√		√	√	√		√	√						√
d) Public awareness																					
Promotional campaigns	√					√		√	√	√	√	√			√		√		√	√	√
Press releases, TV, Radio	√						√	√	√	√		√			√		√	√	√	√	√

Dissemination Mechanism Cont.	Advantages													Dis-advantages							
	User-friendly	Audience Specific	Structured	Academic	Methodological Soundness	Understandability	Low Cost	Purposive	Wide audiences	High Influence	Convenient	Immediate Impact	Thought Provoking	Limited Audience	Expensive	Readability issues	Reliability Issues	Poor Focus	Needs Creativity	Wrong Interpretations	Not Popular
e) Research related gatherings																					
Conference, workshop, seminar	√	√	√	√	√	√					√		√		√						
Training programmes		√	√			√		√		√	√		√	√	√				√		√
CPDs, lectures and demonstrations		√	√	√	√			√			√		√						√		
f) Collaboration with government																					
Participating in policy making and Policy Briefs		√	√		√			√		√			√	√							√
Partnerships (Public-private, Strategic)	√	√	√	√	√	√	√	√		√			√	√							√
Official reports		√	√		√			√		√			√	√	√						
g) Collaboration with industry																					
Knowledge brokers and Simulations	√	√	√	√	√	√		√		√	√	√	√	√							√
Contracts with industry	√	√	√	√	√	√		√		√	√	√	√	√							√
Products, Services and Consulting	√	√	√	√	√	√		√		√				√	√						√
Entrepreneurships	√	√	√	√	√	√		√		√		√		√							√
Practitioners engage in research	√	√		√	√	√	√	√		√		√	√		√		√		√		√

Overall, it is noted that in individual write-ups, the content is in high quality, but the effectiveness in terms of dissemination is quite low. Collections of research work also provide a better arena for wider knowledge, but, rather high in terms of cost. E-transfer, therefore, is a good solution due to its low cost. However, the quality of such outcome sometimes can be questionable. Public awareness is another important mechanism to improve the knowledge of wider society, which would create paths for research funding. However, low level of focus is the major disadvantage. Research related gatherings are strong in disseminating knowledge to an interested set of knowledge clients. Nevertheless, lack of interest from the industry due to time and cost constraints hinders the effective dissemination. Collaborations with governments create a direct access to involvement in decision-making, which can identify, as an important step of effective use of knowledge. However, such opportunities are low in developing countries. Collaborations between academia and industry provide a good background condition for dissemination of knowledge.

In summary, each method calls for its own format, means of dissemination and includes both, proactive and reactive channels. However, the dissemination techniques are more likely to succeed, when packaged and information content is aligned with the target audience, which is suggested as a success factor for academic researchers in the construction management context.

2.5.5 Establishing research knowledge disseminating strategy for the construction industry

There is a broad consensus in the literature, that successful communication between researchers and research users is crucial for the effective utilisation of research in decision-making in policy and practice. Even though the research culture within most universities in the world has improved to a substantial level, the level of knowledge dissemination, yet, demands more attention (Ward, 2003).

Therefore, it would be helpful to have a dissemination plan for any research from the beginning onwards. Ordoñez and Serrat (2009) have come up with useful steps as: setting the objective of dissemination, identifying what knowledge product one proposes to disseminate, identify target audiences, clarify benefits to users, define dissemination methods and related activities, decide timescales and responsibilities, set targets, be mindful of cost, and to have an evaluation criteria for the success, as of such a plan.

Describing these steps of a research dissemination plan, Ordoñez and Serrat (2009) mentioned that dissemination is only achievable and successful if, from the outset, there is a shared vision and common understanding, what one expects to disseminate together with a way of describing that to the benefiters. It is important to identify clearly, the target audience and to map it to one of the categories in the awareness, understanding, and action to be taken. Since target audiences tend to be many, it is best to concentrate with whom, at the very least, needs to be informed, and then prioritise for awareness, understanding, and action. Next, it is essential to think about, what benefits the knowledge product will offer. One must then examine the knowledge product and think of how it might be presented, as a benefit and solution to users. Moreover, dissemination exercises have milestones that must be realistic, identified, and set early. Such actions would guide academic researchers to deliver research outcome to the construction industry more effectively.

In addition to a dissemination plan with such useful steps, several other actions could support dissemination successful. Table 2.8 provides such actions, which could improve the level of knowledge dissemination between academia and industry.

Table 2.8: Further Actions for Successful Dissemination

Actions to be taken by Academia	Actions to be taken by Industry
• Balance the characteristics such as teachability, complexity, and specificity of research (Bogers, 2011)	• Involve senior management and make them aware of the benefits that external knowledge may bring to the organisation, in order for them to budget, develop frameworks, and find innovation opportunities (Ward, 2003)
• Use a variety of dissemination techniques such as written, graphical, electronic, print, broadcast, and verbal media (Ordoñez & Serrat, 2009)	• Encourage and reward research utilisation practices such as research-informed decision-making, considerations in job descriptions and staff appraisals, and selection procedures (Alker, 2008)
• Provide summary documents, letters of thanks, and newsletters to study participants (Ordoñez & Serrat, 2009)	• Organise seminars with employees returning from a conference to share and transfer knowledge to other employees (Ward, 2003)
• Improve trust upon research findings (Bogers, 2011)	• Capacity building to access and use research (Alker, 2008)

Actions to be taken by Academia Cont.	Actions to be taken by Industry Cont.
• Use effective quality control to ensure that the information content is accurate, relevant, representative, and timely (Ordoñez & Serrat, 2009)	• Evaluate and publish, how new knowledge has contributed to improve performance at the personal and/or organisational level, thus there is an explicit cause-and-effect link between being open to knowledge-pull and adopting an innovation (Ward, 2003)

However, the suitability and practicality of above actions still need to be evaluated in Sri Lankan construction context. Once a proper dissemination plan with the key actions is set, it would draw on existing capabilities, resources, relationships, and networks to build new capabilities, resources, relationships, and networks, target audience needs. In addition to such a plan that identifies the resources required for implementation and provide a framework for monitoring and evaluation, it should explain, how one would know the success of dissemination activities.

In summary of Section 2.5, academic research output in built environment consists of cognitive and affective, as well as behavioural components. There is a broad consensus in the literature that successful communication between researchers and research users is crucial for the effective utilisation of research in decision-making in policy and practice. It is argued that, academic researchers and construction industry practitioners do not collaborate closely in the construction sector. The need for sharing knowledge between research institutions and industry has become increasingly evident in recent years. Knowledge management literature brings insights into understand dissemination of research knowledge into the industry. It revealed that, even though, the efforts to disseminate knowledge products are earnest; there is a low impact, which is mainly attributable to poor planning and the absence of a dissemination strategy. Hence, the common dissemination mechanisms were analysed for their impacts in this section.

Finally, it was identified that the dissemination techniques are more likely to succeed when used as packages and information content is aligned with the target audiences. Therefore, it would be helpful to have a dissemination plan for any research from the beginning onwards. Further, some additional actions, which could improve the level of knowledge dissemination between academia and industry, were also suggested as strategic changes. Moreover, the identified success factors for academic-industry merge inside the discussions in Section 2.5, in three segments as for (a) academia, (b) industry, and (c) academic-industry collaborative implementation are presented in Tables, 2.9, 2.10, and 2.11 respectively, in summary.

Table 2.9: Success Factors for Academia in Research Knowledge Dissemination (Refer Appendix – A5 for references)

a) Success Factors for Academia		
Success Factors of Research Initiation	***Success Factors of Research Execution***	***Success Factors of Research Dissemination***
• Create new knowledge linked to development goals • Select research more biased towards applied sciences • Undertake conceptual research with the ability to gradually penetrate to the industry • Give the correct priority to the research • Establish networks of expertise on research • Select research more related to the teaching discipline of the academic • Align research culture with the changing industry behaviour • Play a more active role in relationship with industry • Focus not only on global challenges, but also on individual industries • Add a dissemination plan into initial academic research proposals • Consider end-user perspective in planning knowledge dissemination	• Maintain required quality of research • Send newsletters to study participants • Balance teach-ability, complexity and specificity of research • Follow a clear method based on research methodology • Include summary documents • Establish academic research development centres • Send affiliation authorized thanking letters to study participants • Reduce complications and administrative burdens of research funding • Treat research as a value creation process by being ethical	• Use multiple dissemination techniques • Allow for feedback from audiences • Recruit specialist staff with business potential to manage knowledge resources • Put stronger efforts to communicate outcomes of higher level research to a broader community • Ensure availability of the product to the target audience • Present research outcome as a benefit or a solution to a problem • In dissemination, tailor research findings to a target audience to increase use of research in policy making

Table 2.10: Success Factors for Industry in Research Knowledge Utilisation (Refer Appendix – A6 for references)

b) Success Factors for Industry	
Success Factors to be implemented as organisations/individuals	***Success Factors to be implemented as an Industry***
• Change internal dynamics of construction organisations to be able to respond to change • Use research literacy as a criterion for staff appraisal • Combine in-house and external resources • Aim to maximize economic value through intellectual property rights • Ask project managers to identify and report on innovation opportunities • Increase senior management's awareness on benefits of external knowledge can bring to organisation budgets • Reward research-informed decision-making • Promote the concept of 'knowledge worker' • Organise events with employees returning from a conference to share knowledge to other employees • Develop a mechanism to identify important innovative management practices from research • Offer chances to attend conferences as a reward for deserved employees • Share how new knowledge has contributed to improved performance to create an explicit cause-and-effect link within the organisation	• Develop approaches to promote R&D • Encourage industry to use research as a strategic resource • Direct industry in capacity building to access research • Encourage industry investments on research • Develop more innovative management friendly procurement methods • Increase the ability to attract, retain, and develop skilled people • Move beyond the traditional practices to adopt new practices • Include research soundness into job-descriptions • Develop strategic and professional leadership for research and development through industry professional bodies • Create networks with other/foreign industries to collaborate in developing construction management skills • Update knowledge of the workers in line with the new knowledge generation

Table 2.11: Success Factors for Academic - Industry Research Collaborations (Refer Appendix – A7 for references)

c) Success Factors to be implemented Collaboratively
• Resolve conflict of interest issues before legal and business arrangements • Introduce incentives to motivates staff and institutional leaders to participate in, or initiate, research collaborations • Direct student research more into actual issues in the industry • Increase communication between researchers, research funders and research users • Review how research can be more effectively connected to real-world activity and policy setting • Judge research programmes by industry impact and tangible benefit • Promote joint publications between university researchers and practitioners in industry and governing bodies • Practice the concept of knowledge brokering • Embed researchers within companies, as part of existing research activity • Create strategic partnerships - formal alliance to help each other in achieving aims which cannot be achieved alone • Promote collaborations amongst governments, economic sector and research universities to link knowledge to development goals • Enhance researcher-practitioner collaboration to conduct research on vital problems to find adoptable solutions

2.6 Conceptual Framework

The literature findings described within several sections in this chapter are combined through a conceptual framework (refer Figure 2.13) that will eventually guide the empirical phase of the study. There were three (03) main theories identified as significant through the literature review; namely, the THM (Etzkowitz & Leydesdorff, 2000), MCKU and PMKD (Alker, 2008), and ROS and BOS (Kim & Mauborgne, 2005).

THM of Etzkowitz and Leydesdorff, (2000) explains the process of innovative development of a sector. The three (03) main players of such development are academia, industry, and the regulatory bodies, who provide necessary knowledge infrastructure, wealth generation, and political economy of innovative development (Leydesdorff, 2005). The three (03) spheres may stay separated at the starting point (current state), yet with time they may evolve into an overlapping interconnected overlay (desired state) with the creation of the necessary spaces knowledge, consensus, and innovation (Etzkowitz, 2011) generating the helixes of development. Yet, the identical operations just do not happen in the context of construction due to inherent characteristics of the construction industry and related research academia's poor knowledge dissemination strategies. ROS and BOS of Kim and Mauborgne, (2005) explain the deterrents that keep the construction industry in the nature of a Red Ocean and gives signals on the necessary changes in becoming a blue ocean. This process and the results together promote more research utilisation to make construction management practice more innovative. Consequent changes required in research dissemination are equally important. PMKD of Alker (2008) shows the forefront stages that construction management researchers should reach.

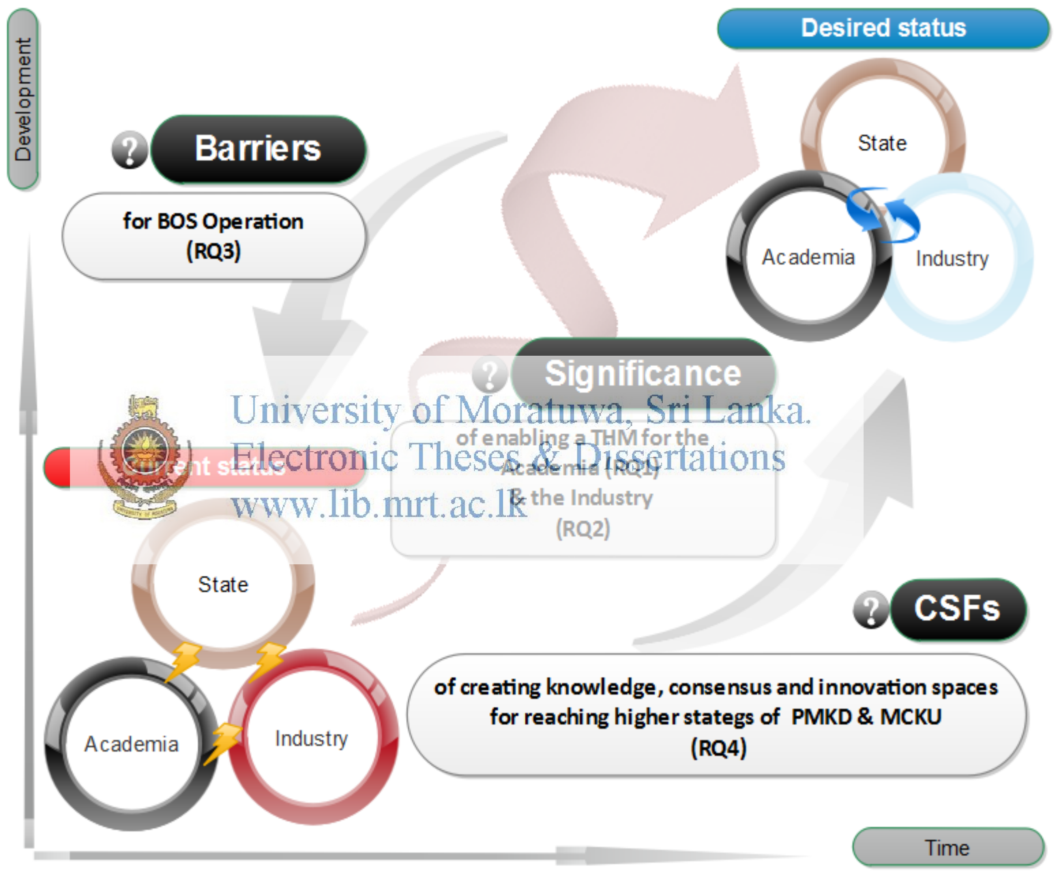


Figure 2.13: Conceptual Framework

Aligning with THM of Etzkowitz and Leydesdorff, (2000), the literature review established the significance of the academic research for innovative construction management practice (refer Section 2.1). 'Significance' was identified in two (02) separate directions, as the significance of the research knowledge transfer from academia's perspective, and from industry's perspective (refer Tables 2.1 and 2.3), in answering RQ1 (Why academic research is significant in cultivating an innovative construction management practice?), and RQ2 (How innovative management practices assist the construction industry development?). Confirming the presence of ROS of Kim and Mauborgne, (2005), literature review identified a number of barriers from the industry (refer Sections 2.4.3, 2.4.4, and Table 2.5). In addition, several barriers were identified for academia, which limits the research dissemination opportunities (refer Sections 2.4.1, 2.4.2, and Table 2.4), which partially answered RQ3 (What are the barriers for merging academic research and industry development requirements?).

Apart from locating the stakeholders of innovative construction management inside the theoretical mapping, determining the CSFs (areas of activity that should receive constant and careful attention from management) for each stakeholder in performing expected roles is equally vital. Hence, most importantly, in achieving the research aim, the success factors for the academia and industry were revealed, which requires in reaching higher stages of PMKD of Alker (2008) (refer Figure 2.10). Further, some steps were needed to be implemented by the two entities together. The success factors for the academia were categorised into three (03), as implemented at the initiation, during the research, and at the stage of research knowledge dissemination (refer Section 2.5. and Table 2.9). Further, for the industry practitioners, several success factors were identified (refer Section 2.5 and Tables 2.10), while another set of success factors, which should be implemented by both parties together (refer Section 2.5 and Tables 2.11).

Since several actions and success factors were identified here, it was important to analyse them to identify the CSFs in answering RQ4 (What are the CSFs for the construction stakeholders in developing an innovative management practice?) under the Sri Lankan construction industry, on which this study is placed. Hence, the empirical phase (the methodologies that govern this research are presented in the next chapter) directed identifying the CSFs of merging academic research and industry development requirements for an innovative construction management practice.

2.7 Summary

This chapter highlights the findings of the literature review. In the process of revealing the theoretical underpinnings of research problem, Chapter 02 answered the RQ2 in completing the second objective of the research, which is to critically review the necessity of an innovative construction management practice for the construction industry development. Whilst, the rest of the RQs were also partially answered revealing theories to strengthen the concerns of 'research significance in leading innovations', 'barriers for research interactions between the built environment researchers and construction industry', and 'success factors of research collaborations'. The overall discussion guided the development of the conceptual framework of the study, ultimately. Hence, in the next chapter, Chapter 03 presents the methodological concerns, in developing the finding of the study into conclusions.

CHAPTER 3 – RESEARCH METHODOLOGY

3.1 Introduction

Research design is important and requires rationalisation autonomously of research output. Chapter 03 is therefore concerned with methodological choices, and its' impact on the processes, and outcome of the research. The chapter, therefore, presents the research's philosophical stance together with the logical explanations, supported by the theories of research methodology. Further, Chapter 03 also concerns on the practical field study process in data collection, and the respective analysis of data following scientific paths for arriving into conclusions.

3.2 Research Philosophy

A number of studies (e.g. Bryman, 2015; Saunders, Lewis & Thornhill, 2015; Kagioglou et al.,1998: Guba, 1990; Guba & Lincoln, 1989) have used different descriptors, categorisations and classifications of research paradigms, and philosophies in relation to research methods with overlapping emphasis, and meanings. In aggregate, the term 'research philosophy' relates to the development of knowledge and the nature of the knowledge developed (Saunders, Lewis & Thornhill, 2012). According to Ormston, Spencer, Barnard, and Snape (2014) research philosophy answers the questions 'what?', 'how?' and 'why?' in terms of the research process itself. Moreover, Johnson and Clark (2006) note, researchers should be aware of the philosophical commitments make through the choice of research strategy since this has significant impact on, what it is doing, understood, and investigated.

The process of understanding requires peeling a number of layers in the 'research onion' of Saunders, Lewis and Thornhill (2009) as presented in Figure 3.1. The model engages a comparative superiority against the 'nested approach' of Kagioglou et al. (1998), with its number higher number of layers in defining research methodology of a particular research. The most external layer specifies the philosophy of a research, which could be falling into one of the stances of positivism, realism, interpretivism or pragmatism. The different philosophies are created, as of different interpretations on the three (03) basic assumptions; epistemology, ontology, and axiology.

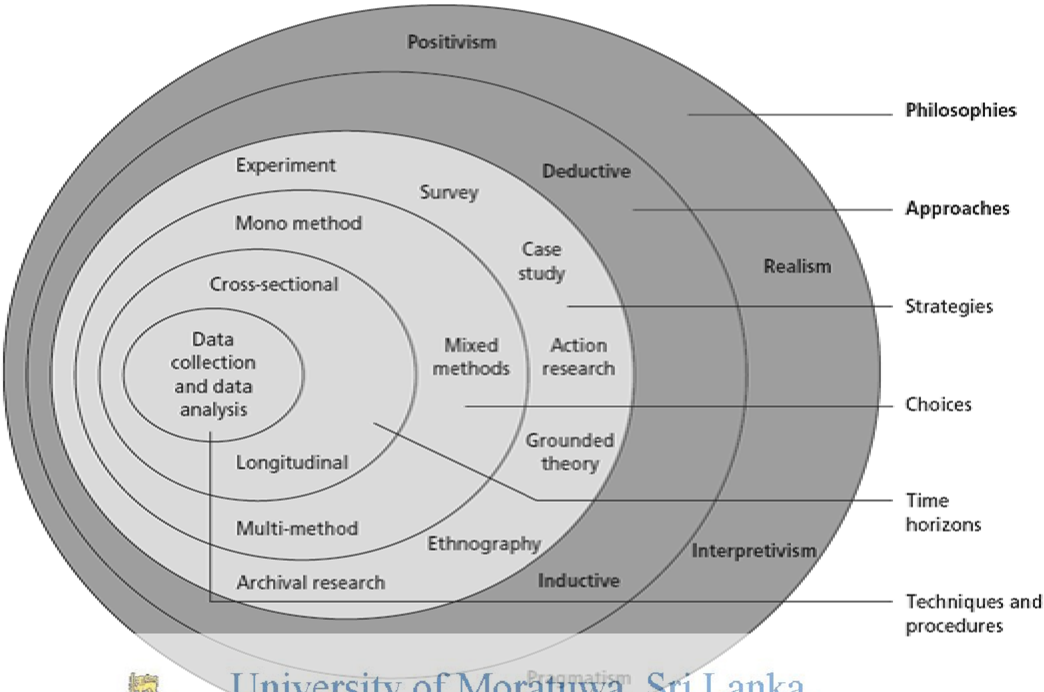


Figure 3.1: The Research Onion

(Source: Adapted from Saunders et al., 2009)

‘Ontology’ is concerned with the nature of reality. There are two (02) aspects of ontology as, ‘objectivism’ and ‘subjectivism’. ‘Objectivism’ portrays the position, which social entities exist in a reality external to social actors concerned with their existence. ‘Subjectivism’ holds the view, which social phenomena are created from the perceptions, and consequent actions of those social actors concerned with their existence. ‘Epistemology’ concerns about, what constitutes acceptable knowledge, in a field of study (Saunders et al., 2015). According to Heron (1996), ‘axiology’ is a branch of philosophy, which studies judgments about value. Table 3.1 presents a comparison between the philosophies in front of the three (03) basic assumptions.

Since, the philosophical stance of natural scientist most probably falls into positivism, the end products of such research are law-like generalisations (Ormston et al., 2014). The philosophy of realism states; there is a reality quite independent of mind, which is explained in two (02) ways as; direct realism, and critical realism (Phillips, 1987). Interpretivism, involves researchers to interpret elements of the study, thus 'interpretive researchers assume that access to reality is only through social constructions, such as; language, consciousness, shared meanings, and instruments' (Myers, 2008, p.38). Differently, pragmatism argues that the most important determinant of the epistemology, ontology, and axiology is to be adopted as per RQs (Saunders et al., 2012).

Table 3.1: Comparison of Research Philosophies

	Ontology	**Epistemology**	**Axiology**
Positivism	External, objective and independent of social actors	Only observable phenomena can provide credible data, facts	Value-free
Realism	Objective	Observable phenomena provide credible data, facts	Value-laden
Interpretivism	Socially constructed, subjective, may change, multiple	Subjective meanings and social phenomena	Value-bound
Pragmatism	External, multiple, view chosen to best enable answering of RQ	Either or both observable phenomena and subjective meanings can provide acceptable knowledge dependent upon the RQ	Values play a large role in interpreting results, the researcher adopting both objective and subjective points of view

(Source: Adapted from Burrell & Morgan, 1982)

Pragmatism, therefore, grants freedom to use any of the methods, techniques, and procedures, typically associated with quantitative or qualitative research, appropriately. Moreover, the pragmatism recognises every method’s limitations, hence, the possibility of operating with different approaches complement each other. Therefore, the research has taken a pragmatic stance, which involves using methods that appears best suited to the research problem, avoiding the philosophical debates of one true philosophy for all instances. Pragmatist philosophic stance to the research allowed the study to generate CSF of merging academic research skeptically in a systematic way. The initial deductive approached Phase I allowed to identify the most related factors to the context out of the suggested factors in the literature review, whereas this could have been the final outcome, if the study has taken a positivist approach. With pragmatist philosophical stance, the results of Phase I were further explored in Phase II which was conducted with an inductive approach. Hence, it allowed developing in-depth analysis into most related factors, whereas interpretivist philosophical stance would have only allow to develop discussions upon all factors identified in literature with equal gravity. In addition to this advantage, pragmatism allowed to take different approaches for different research questions as per the requirement of the research. Hence selection of pragmatist philosophic stance has provided a firm ground for the study while adding value to the research with its inherited characteristics.

3.3 Research approaches

Many authors define 'research approach' in different ways, for an example, Creswell (2013) considers the three (03) approaches available as; quantitative, qualitative and mixed method. Saunders et al. (2009) define available approaches as; deductive approach and inductive approach. Deductive approach develops a theory and/or hypothesis and designs a research strategy to test the hypothesis. Inductive approach collects data, and develops theory, as a result of data analysis.

Deduction is the dominant research approach in the natural sciences, where laws present the basis of explanation, allow the anticipation of phenomena, predict the occurrence, and, therefore, permits to be controlled (Ormston et al., 2014). Induction is concerned with the context in which events are taking place (Saunders et al., 2015). Therefore, the study of a small sample of subjects might be more appropriate to follow an inductive approach. Researchers in this tradition are more likely to work with qualitative data, and use a variety of methods to collect those data, to establish different views of a phenomenon (Easterby-Smith, Thorpe, Jackson & Lowe, 2008).

In a comparison between the two (02) approaches in terms of time, by Saunders et al. (2012), it is suggested deductive research can be quicker to complete, albeit that time must be devoted to setting up the study prior to data collection, and analysis. In contrast, inductive research can be much more protracted. Further, deduction is a low-risk strategy, though, that there are risks such as non-return of questionnaires. In using the inductive approach, it is required constantly to live with the fear of no useful data patterns and theory will emerge. Instead, it is possible to combine deduction and induction, within the same piece of research, and it is often advantageous (Bryman, 2015). Saunders et al. (2015) define such combination as ‘abductive approach’.

Therefore, this particular research takes and abductive approach, where the research is initially into deduction, and there on moves into induction, under a pragmatist philosophical stance. The operational design of this particular research, based on the discussed philosophical foundation, is presented in the next section.

3.4 Research Design

According to Saunders et al. (2012), the design of a research defines the purpose, strategies, methods, and the time horizons related to the research. Hence, this section discusses the available options under each parameter, together with the rationalisation of the ultimate selections for the study, in four (04) sub-sections.

3.4.1 Purpose of a research

The design of a research is derived considering the purpose of the RQs since research strategies depend on the purpose of the research. This research comprises of four (04) RQs, presented as follows;

RQ1. Why academic research is significant in cultivating an innovative construction management practice?

RQ2. How innovative management practices assist the construction industry development?

RQ3. What are the barriers for merging academic research and industry development requirements?

RQ4. What are the CSFs for the construction stakeholders in developing an innovative management practice?

According to the purpose of RQs, research can be identified in three (03) categories as; descriptive, exploratory, and explanatory research (Saunders et al., 2009). Descriptive research portrays an accurate profile of persons, events or situations (Jackson, 2015). According to Saunders et al. (2015), descriptive research may be an extension, forerunner or a piece of exploratory research. Furthermore, if a research project utilises description, it is likely to be a precursor to explanation, and such studies are known as 'descripto-explanatory studies'. "An 'exploratory' study is a valuable means of finding out; 'what is happening', to seek new insights, to ask questions, and to assess phenomena in a new light" (Robson, 2002 p.59). Besides, studies that establish causal relationships between variables may be termed as 'explanatory research' (Saunders et al., 2012).

The four (04) RQs of this particular study were initially served on the basis of explanatory research, where they tried to find out the relationship between the variables; academic research and innovations, innovation and development, barriers and research interactions, and success factors and research interactions of such interactions. In the next stage, the research was developed into a stage with an exploratory purpose, as the initial basis was further explored in the light of the discussions in practical context, related to RQ1, RQ3 and RQ4.

3.4.2 Research strategies

According to Saunders et al. (2009), the choice of a research strategy is guided by; RQs and objectives, the extent of existing knowledge, the amount of time and other resources available, and a researcher's own philosophical underpinnings. Therefore, the research strategy should be appropriate to its purpose (Johannesson & Perjons, 2014).

According to the existing research methodological theories, there are seven (07) research strategies, which are presented with their main characteristics, in Table 3.2. The strategies are presented in two (02) categories, as per appropriateness and inappropriateness for this particular research according to the characteristics, where negative characteristics are italicized.

Table 3.2: Evaluation of Research Strategies

Characteristics of Appropriate Research Strategies	
Survey* [1]	**Case study* [1], [2], [3]**
• Associated with deductive approach • Answer who, what, where, how much and how many • Allow collection of a large amount of data from a sizeable population, economically • Can be used to suggest possible reasons for particular relationships between variables and to produce models • Generate findings that are representative of the whole population • Used for explanatory and descriptive research • Popular strategy in business and management research • Collect quantitative data	• For empirical investigation of a particular contemporary phenomenon within its real life context, using multiple sources of evidence • To gain a rich understanding of the context of the research and the processes being enacted • Generate answers to the question 'why?' 'what?' and 'how?' questions • Challenge existing theory and provide a source of new RQs • Most often used in explanatory and exploratory research

Characteristics of Inappropriate Research Strategies				
Action research* [1], [4], [5], [6] , [7], [13]	**Grounded theory* [1], [8], [9], [10]**	**Experiments* [1], [11]**	**Archival research* [1], [12]**	**Ethnography* [1]**
• Concerned of organisational issues • Combines both data gathering and facilitation of change	• Theory building' through a combination of induction and deduction • To predict and explain behaviour	• Answer 'how' and 'why' • *Owes much to the natural sciences* • *Study causal links*	• *Makes use of administrative records and documents as the principal source of data*	• *Describe and explain the social world* • *Rooted firmly in the inductive approach* • *Time consuming*
• Iterative process • Development of theory • 'How' questions	• Explore business and management issues • *By its nature it is 'messy*	• *Not feasible business management research* • *Low external validity*	• *RQs focus upon past and changes over time*	• *Not a dominant research strategy in management research*
• *Difficulty of transfer of knowledge gained from one specific context to another*				

***References - [1]** Saunders et al. (2009); **[2]** Yin, (2013); **[3]** Morris & Wood, (1991); **[4]** Coghlan & Brannick, (2014)**; [5]** Barnett, (2016)**; [6]** Somekh, (2005); **[7]** Eden & Huxham, (1996); **[8]** Glaser & Strauss (1967); **[9]** Khan, (2014); **[10]** Suddaby, (2006); **[11]** Hakim (2000); **[12]** Gidley, (2004), **[13]** Azhar, (2007) Both, survey and case study strategies show a lot of positive signs in being suitable research strategies for this particular research. Surveys are generally used in research with positivist philosophic stance, while case studies are frequently used in interpretivist research. Using a mix of survey and case studies was accepted in pragmatist philosophic view since the focus under this philosophy is to select the best strategy which serves the RQs. Since the research required deduction followed by induction in clearing the RQs, two (02) phases were designed accordingly. Therefore, the process of collecting field data, with regard to the RQs, was conducted in two (02) phases. Figure 3.2 presents the data collection process in terms of use of research strategies.

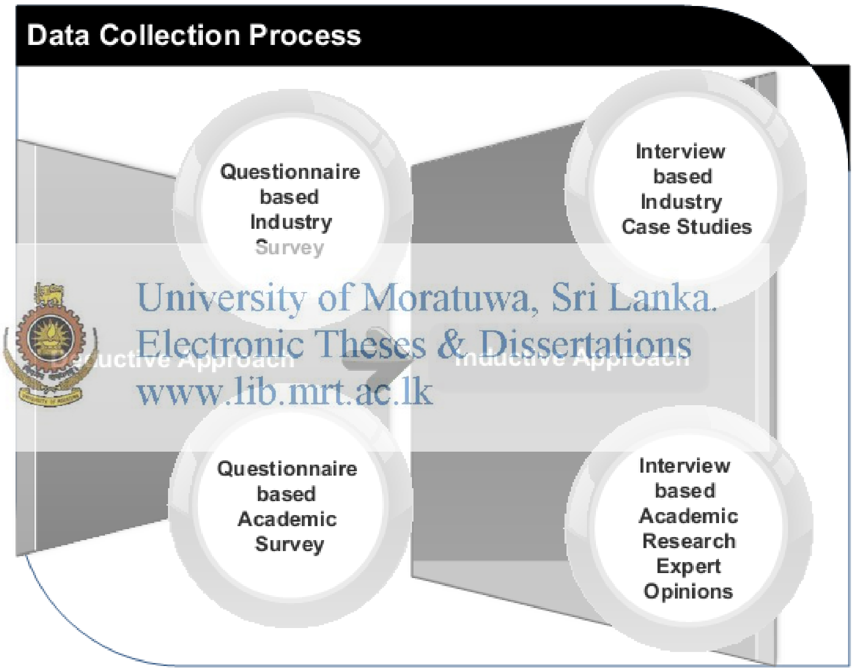


Figure 3.2: Data Collection Process

Findings of such two (02) phases are presented separately in two (02) separate chapters (Chapter 04 and Chapter 05), where Chapter 04 presents the findings of the deductive approached Phase I and Chapter 05 presents the findings of the inductive approached Phase II.

Hence, survey strategy is selected as the means for finding answers to the RQs, which requires theory testing of Phase I, which was followed by a qualitative interview based case studies, and expert opinions in Phase II of the data collection, to explore further on the key facts identified through Phase I.

However, action research and grounded theory, also shows positive signs, as suitable strategies, yet, heavily impacted by negative signs. These strategies are more into induction, claimed to be highly time consuming, and the knowledge created are difficult to generalise. 'Experiments' as a research strategy is more useful in natural sciences. Archival research and ethnography strategies have deviated capacities from this particular research study’s needs. Hence, those strategies were not utilised in this research.

3.4.3 Research methods

Saunders et al. (2009) developed a hierarchy of research choices allowing understanding the various configurations of research methods, as given in Figure 3.3.

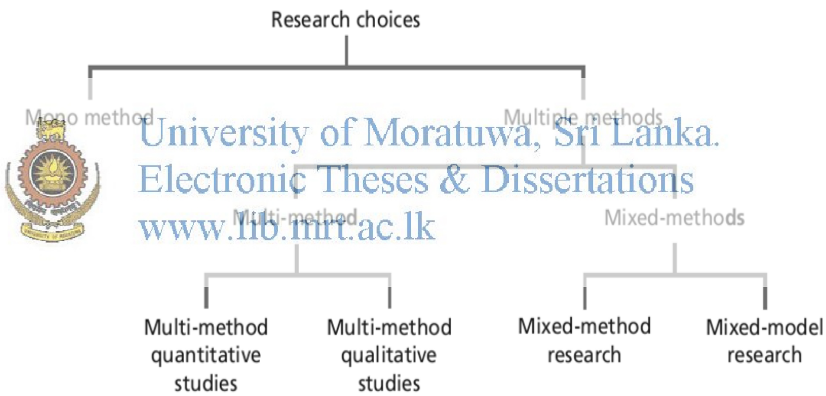


Figure 3.3: Research Choices

(Source: Adapted from Saunders et al. 2009)

'Mono method' follows a single data collection technique and corresponding analysis procedures. 'Multiple methods' allow researcher to use more than one (01) data collection technique, and analysis procedures to answer RQs. This method is increasingly advocated within business and management research (Curran & Blackburn, 2001). Further, Saunders (2011) argues that multiple methods are useful, as they provide better opportunities to answer RQs, and allow better evaluation. According to the requirements of the RQs, multiple methods of data collection were utilised in this research.

Under 'multiple method', researchers either can conduct 'multi- method' research or 'mixed method' research, depending on the requirements of RQs. ‘Multi-method’ refers to the combinations, where more than one (1) data collection technique is used with associated analysis techniques, but this is restricted within either a quantitative or qualitative world view (Raftery, McGeorge & Walters, 1997). According to Saunders et al. (2015), ‘mixed method’ is the general term used, when both quantitative and qualitative data collection techniques and analysis procedures are used in a single research, which was followed in this research.

Mixed method was used in this research for the purposes of triangulation, facilitation, complementarities, generality, and to study different aspects. However, different quantitative and qualitative data collection techniques, and analysis procedures, have their own strengths and weaknesses (Smith, 1981). There is an inevitable relationship between the data collection technique and the results obtain. Since all different techniques and procedures will have different effects, it is sensible to use different methods to cancel out the ‘method effect’, leading to a greater confidence in making conclusions.

3.4.4 Time horizons

Research is categorised based on the time horizons as; ‘cross-sectional studies’ and ‘longitudinal studies’. Cross-sectional research study of a phenomenon/phenomena at a particular time, which is the case of this particular research study. In contrast, Adams and Schvaneveldt (1991) state that, observing people or events over time; enable a measure of control over variables being studied, provided that they are not affected by the research process itself, which is known as a longitudinal study. However, it is identified that most research projects undertaken for academic courses are necessarily time constrained, and therefore, comes as cross sectional studies (Saunders et al., 2012).

In terms of the research design in summary, this particular research poses the qualities of explanatory and exploratory research. Hence, questionnaire based surveys, interview based case studies, and expert opinions were conducted in data collection. Thereafter, multiple data analysis methods were used to analyse the data, following the mixed method. The research was conducted as a cross-sectional study.

Table 3.3 presents research design in relation to the RQs, in summary.

Table 3.3: Research Design

Research Questions	**Research Design**			
	Purpose	**Strategy**	**Method**	**Time Horizons**
RQ1	Explanatory Exploratory	Literature Survey Survey Expert Opinion	Mixed Method	Cross-Sectional
RQ2	Descriptive	Literature Survey	Mono Method	Cross-Sectional
Research Questions	**Research Design Cont.**			
	Purpose	**Strategy**	**Method**	**Time Horizons**
RQ3	Explanatory Exploratory	Literature Survey Survey	Mono Method	Cross-Sectional
RQ4	Explanatory Exploratory	Literature Survey Case Studies Expert Opinion	Mixed Method	Cross-Sectional

3.5 Sampling and Data Collection

This section presents the sampling and data collection procedures of the research in detail, in two (02) sub-sections as; selecting samples and sampling techniques, and data collection techniques. Proper sampling and data collection is critical in generalising created knowledge. The methodological discussion, therefore, rationalises the logical selection of relevant techniques, according to the requirements at various stages of the study.

3.5.1 Selecting samples and sampling techniques

With the finalised research design, it was necessary to decide upon the operational aspects of the selected strategies; surveys and case studies. Hence, the populations of related surveys with academia, construction organisations, and practitioners were examined.

The sample frame of the academic sampling is considered as, the academic researchers, who is conducting research in the construction management field. Individual academic was the unit of analysis for the research. The population contained a total number of 51 academics, who is working at twelve (12) departments of studies, belonging to both state and private sector universities. Sample frame for the industry sample is the construction contracting organisations with Construction Industry Development Authority (CIDA - former Institution for Construction Training and Development: ICTAD) grading C3 and above, and the construction industry practitioners with architecture, engineering or quantity surveying chartered qualifications. Hence, industry survey comprised of two (02) sub surveys. The first segment of the survey was conducted using the CIDA grading C3 and above contracting firms in order to capture the organisational view. The population comprised of 120 units. An organisation was considered as the unit of analysis. The second segment of the survey was conducted to capture the individual industry practitioner view. An individual practitioner was considered as the unit of analysis.

Figure 3.4 presents the cross-section of such populations under study.

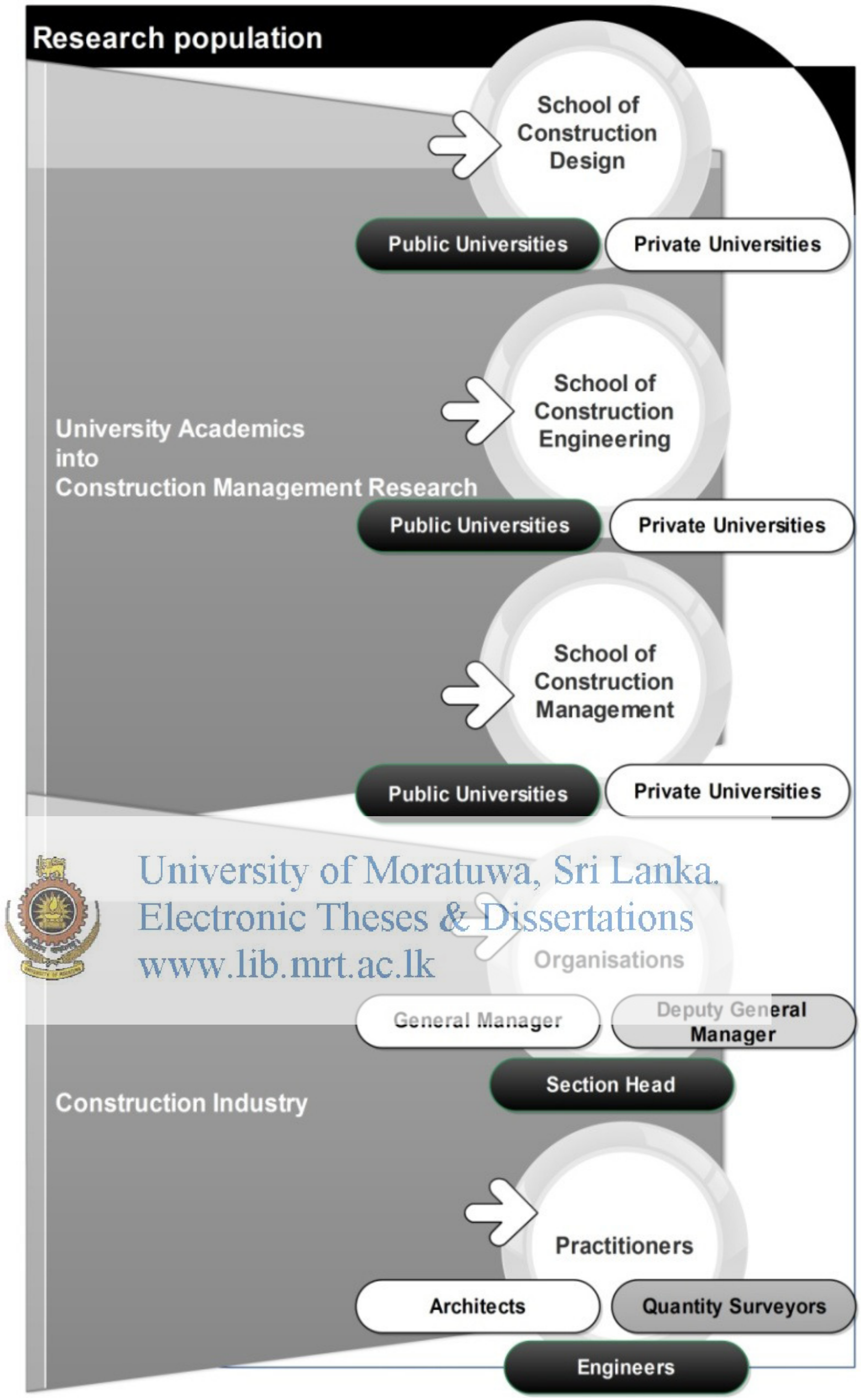


Figure 3.4: Research Population

In terms of data collection Phase I (survey), the academic population consisted only of 49 units, therefore, conducting censes was statistically advised. Hence, the questionnaires were delivered to the whole population. Finally, 30 duly completed questionnaires were collected back with a response rate of 61.22%, after investing a considerable time. Table 3.4 presents the cross-sectional statistics of the survey group in focus.

Table 3.4: Cross-sectional statistics of the Academic Survey Focus Group

Academic Cluster	**Construction Design**	**Construction Engineering**	**Construction Management**	**Total**
Population	12	22	15	49
Sample	12	22	15	49
Response Rate	66.67%	50.00%	73.33%	61.22%
Responsive Sample	8	11	11	30

Industry organisation and practitioner populations contained a large number of units. Further, in data collection Phase II (case studies/expert opinions), it further urged the necessity to go for sampling to collect qualitative data. Sampling provides a valid alternative to a census, when it is impracticable to survey the entire population due to various constraints (Saunders et al., 2009). Further, Henry (1990) argues that, using sampling makes a higher overall accuracy than a census, as more time can be spent designing and piloting the means of collecting data, and detailed information.

Sampling techniques are in major two (02) categories as: probability and non-probability sampling. Probability sampling supports estimating characteristics of the population statistically, which is commonly associated with survey-based research strategies. It was claimed that larger sample sizes lower the likely error in generalising to the population, which is in line with the central limit theorem and law of large numbers (Saunders et al., 2015). However, Stutely (2003) advices on a minimum number of 30 from each category within overall sample, as a rule of thumb for statistical analyses, which was followed in this study.

In selecting the most appropriate sampling technique, there are five (05) main techniques as: simple random; systematic; stratified random; cluster and multi-stage, with different characteristics. Figure 3.5 presents a classification of sampling techniques

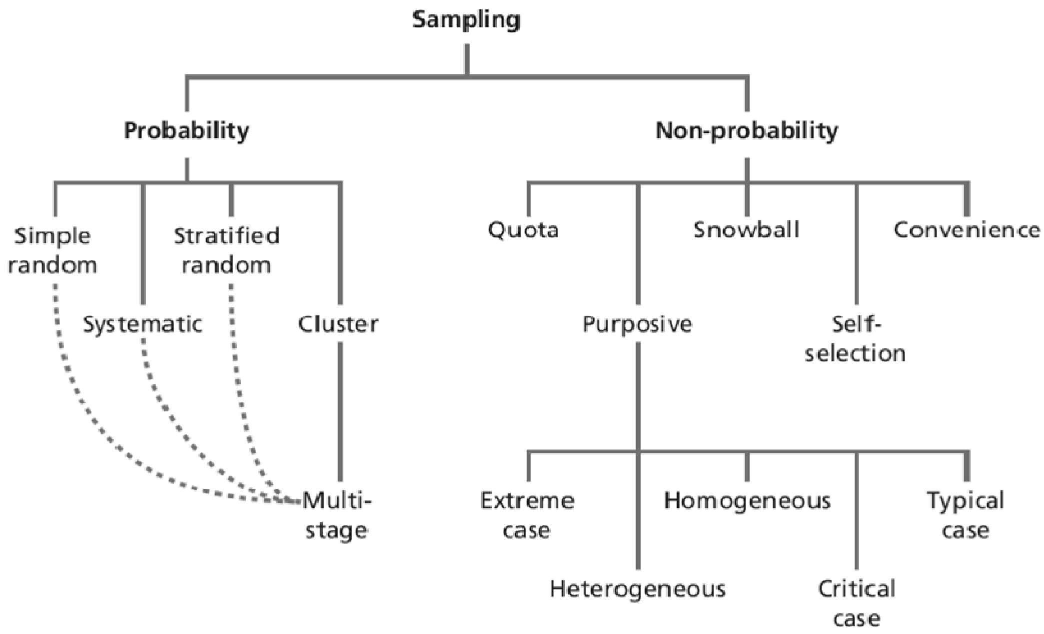


Figure 3.5: Sampling Techniques

(Source: Adapted from Saunders et al., 2009)

A decision support map for selecting a proper sampling technique is presented in Figure 3.6, which was followed by the researcher in selecting the stratified systematic sampling technique, for selection of samples from the construction industry. The steps of selecting the ultimate sampling technique are marked with @, guided by directional arrows. The selected technique itself provides a better comparison among the strata, together with a high order of representation.

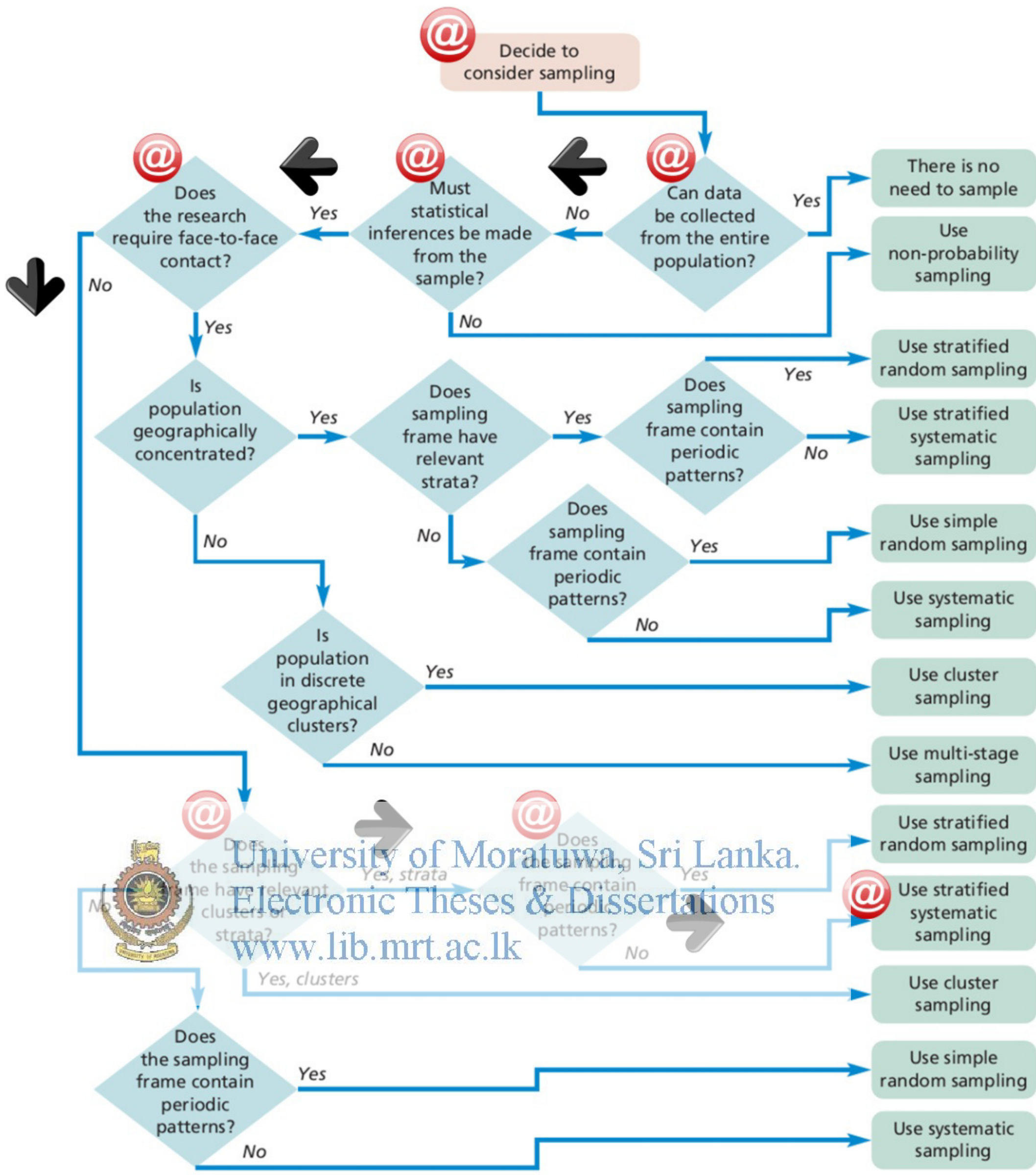


Figure 3.6: Probability Sampling Method Selection for Industry Survey

(Source: Adapted from Saunders et al., 2009)

Hence, stratified systematic sampling was used in the data collection Phase I in this particular study for deriving industry samples. Moreover, Denscombe (2014) suggests the importance of considering response rates in deciding the initial sample size. In general, for most academic studies involving top management or organisation representatives, a response rate of approximately 35% is reasonable (Baruch, 1999). Considering the arguments, initial sample was designed with 120 units of organisations for the organisational survey. Table 3.5 presents the cross-sectional statistics of the survey group in focus, accordance with CIDA grading.

Table 3.5: Cross-sectional statistics of the Organisational Survey Focus Group

CIDA Grade Cluster	**C1**	**C2**	**C3**	**Total**
Population	51	35	62	148
Sample	48	32	40	120
Response Rate	39.58%	21.88%	12.50%	24.65%
Responsive Sample	19	7	5	31

Further, the industry practitioner survey sample comprised of 135 units of architects, 130 units of engineers and 125 units of quantity surveyors. Even though, the populations of architects and engineers were high in number compared to the quantity surveying population, closely equal number of units were included in the sample to avoid the deviation from construction management focus. The cross-sectional details of the practitioner survey, focus group are presented in Table 3.6.

Table 3.6: Cross-sectional statistics of the Industry Practitioners Survey Focus Group

Field of Specialisation	**Architecture**	**Engineering**	**Quantity Surveying**	**Total**
Population	1071	2352	240	3663
Sample	135	130	125	390
Response Rate	22.22%	23.08%	24.00%	23.10%
Responsive Sample	30	30	30	90

Finally, 31 duly filled questionnaires from organisations and 90 duly filled questionnaires from individual practitioners were collected back with an overall response rate of 23.72%. Therefore, 31 organisations, and 30 practitioners from each category of architects, engineers, and quantity surveyors (who is being the leading professionals in construction management) were included in the industry survey responsive sample.

Further, the research design comprises a second phase of data collection, which was conducted aftermath of the first data collection phase. The data collected in Phase I, were screened and forwarded for further explorations in Phase II of qualitative data collection. Hence, it was required to derive samples for Phase II of the study. For inductive approached data collection, non-probability sampling provides a range of techniques, to select samples based on researcher's subjective judgement (Saunders et al., 2009).

For all non-probability sampling techniques, as presented in Figure 3.5 (purposive, self-selective, snow-ball, convenience), other than for quota sampling, the issue of sample size is ambiguous. Rather, the logical relationship between sample selection technique, the purpose, and focus of the research is important. Hence, the sampling technique selection for the data collection Phase II is rationalised in Figure 3.7 based on the work of Saunders et al. (2009).

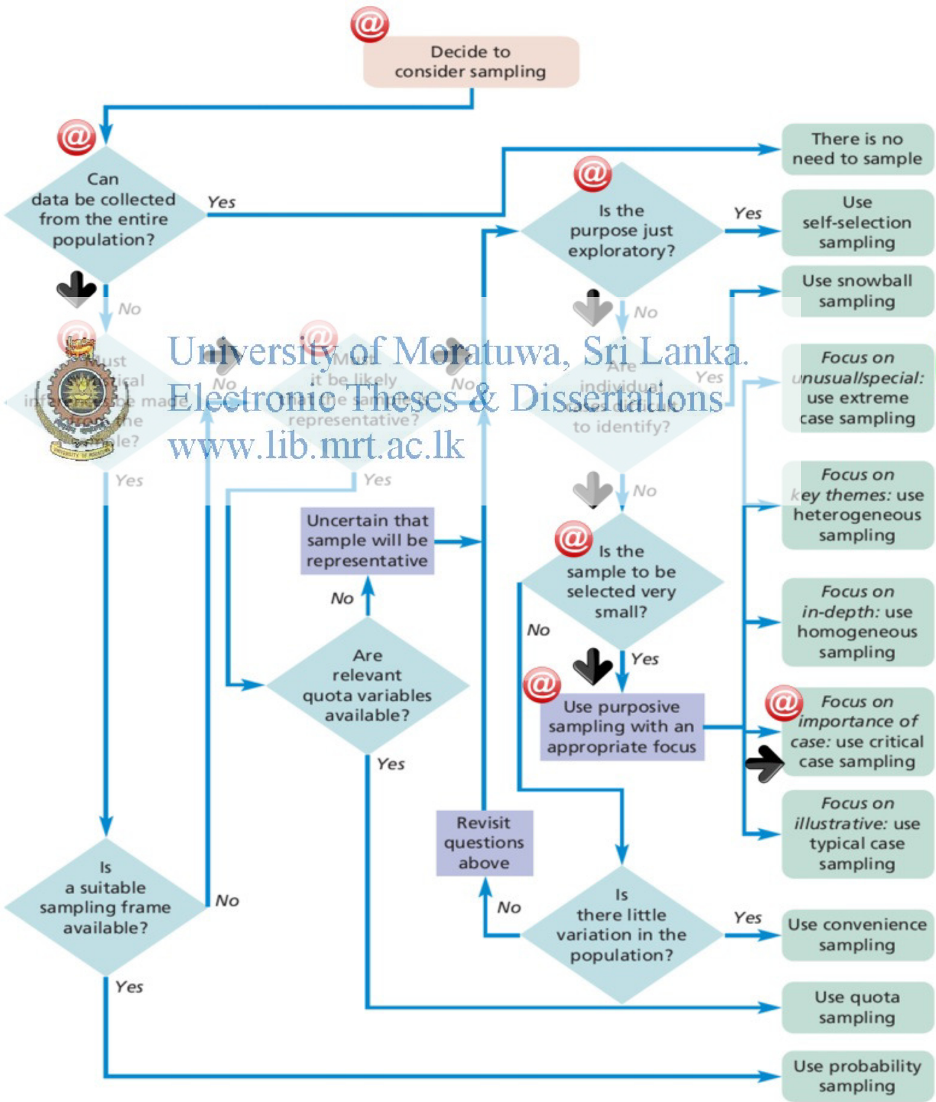


Figure 3.7: Non- Probability Sampling Method Selection Criteria

(Source: Adapted from Saunders et al., 2009)

Critical case sampling, which comes under purposive (judgmental) sampling, was selected as the most suitable sampling technique with special emphasis upon importance of cases. Purposive or judgmental sampling enables to judge cases, which best enables answering research question(s), and to meet objectives. According to Saunders et al. (2015), this form of sample is often used, when working with very small samples, such as in case study research, and, when the researcher wishes to select cases, which are particularly informative. Under purposive sampling, critical case sampling selects critical cases on the basis, that they can make a point dramatically, or because they are important. The focus of data collection is to understand, what is happening in each critical case, so that logical generalisations can be made (Stoecker, 1991), correspondingly to the requirement of this study. However, it is possible to generalise from non-probability samples about the population, but not on statistical grounds. Yet, the validity, understanding, and insights gained from the data will be more to do with the data collection and analysis skills, than with the size of the sample (Denscombe, 2014).

Hence, three (03) cases were studied from the industry, by selecting innovative construction organisations, based on the recent interest shown towards innovative construction management. Individual construction companies were considered as the unit of analysis. Three (03) professionals were interviewed from each case, including; an architect, an engineer, and a quantity surveyor positioned as; general managers/deputy general managers, or section heads. Interviews were conducted individually, yet, at case 01, single interview was conducted with a pair, as per the preference of the interviewees.

Further, expert opinions were taken from the related academia via three (03) qualitative interviews with academic research experts. Cases were identified based on the performance of academic's research disseminations achievements, while the unit of analysis being the individual academic.

3.5.2 Data collection techniques

Selecting proper data collection techniques according to the requirements of RQs is a key in abstracting the relevant data from the field. Therefore, this section reviews the capacities of available techniques, against the requirements of the research study. The discussion is presented in two (02) directions as; collecting primary data using questionnaires and collecting primary data using interviews.

a. Collecting Primary Data using Questionnaires

'Questionnaire' is a technique in which each person responds to the same set of questions in a predetermined order and provides an efficient way of collecting responses from a large sample prior to quantitative analysis (Williams, 2015). Saunders et al. (2012) suggest 'questionnaires', as a suitable technique for descriptive or explanatory research.

Within this particular research, the use of questionnaires is made within the survey strategy based data collection in Phase I. Hence, two (02) questionnaires were developed separately, for the academics, and for the industry in the form of self-administered questionnaires, based on the facts presented in Chapter 02. All three (03) means internet, postage, and delivery and collection were followed in data collection. Individual questions were designed with clear and pleasing layouts, lucid explanation of the purpose, and pilot testing. Therefore, it was required to review the literature carefully, discuss ideas widely, and conceptualise the research clearly prior to designing the questionnaire, as suggested by Williams (2015), which has been achieved through the synthesised comprehensive literature survey, presented in Chapter 02.

Further, Williams (2015) discusses validity and reliability of the questions and answers, making sense, therefore, Saunders et al. (2009) recommend using a word processor or survey design software to increase the robustness. Accordingly, 'Google Forms' was used to create the questionnaires in this particular research. The snapshot views of the web based questionnaires are presented in Figure 3.8.

Figure 3.8: Snapshots of Web based Questionnaire Forms

The first questionnaire (refer Appendix - C1) was developed to collect data from the university academics, who conduct research in construction management. The questionnaire comprised two (02) major divisions as; 'General Questions', and 'Core Questions'. At general division, some questions were kept as optional; to create room for privacy needs of the respondents. The core division comprised of questions, which are coming from three (03) major areas as; research knowledge utilisations levels, barriers for dissemination, and success factors of research based innovative construction management. A second questionnaire (refer Appendix - C2) was developed to collect data from the industry organisations. The same questionnaire with slight changes in the demographic data section (refer Appendix - C3) was used to collect data from industry practitioners. The core data sections of the questionnaires for industry survey were developed with the same structure, as the questionnaire developed for the academia, yet, with different factors.

The questionnaires were designed to obtain data via the three (03) types of questions, (opinion, behaviour and attribute) as categorised by Dillman (2007). Based on the definitions of Fink (2003), the demographic questions were kept as open questions, while core questions were closed questions. However, the respondents were given the freedom to come up with additional ideas. Out of the six (06) types of closed questions (list, category, ranking, rating, quantity, and matrix), rating questions were used in this particular research, in line with the argument of Corbetta, (2003). Hence, the respondents were asked to rate the factors using a 1-5 Likert scale.

Although, questionnaires may be used as the only data collection method, it is better to link them with other methods in a multiple-methods research design (Jankowicz, 2005). Accordingly, this particular research used interviews in Phase II of data collection, additionally to the questionnaires used in Phase I.

b. Collecting Primary Data using Interviews

An interview is a purposeful discussion between two (02) or more people (Kahn & Cannell, 1957). According to Saunders et al. (2009) interviews can be used to gather valid and reliable data relevant to RQ(s) and objectives. Interviews are in many forms and one commonly used typology is related to the level of formality and structure as; structured interviews, semi-structured interviews, and unstructured or in-depth interviews. Another typology differentiates between standardised interviews and non-standardised interviews (Shepherd, 2015). Robson (2002), based on the work of Powney and Watts (1987), refers to a different typology as; respondent interviews, and informant interviews.

When undertaking an exploratory study, it is likely to include non-standardised research interviews in the research design (Cooper & Schindler, 2008). As per Saunders et al. (2015), an explanatory study is also likely to include interviews to infer causal relationships between variables. The authors further emphasis, how semi-structured or in-depth interviews may also be used as part of mixed methods research, as a mean to validate findings from questionnaires (Bryman, 2006). Semi-structured and in-depth interviews provide the opportunity to 'probe' answers, where it is possible to make interviewees to explain, or build on their responses. This is important, when adopting an interpretivist epistemology, where it concerned to understand the meanings, which participants ascribe to various phenomena.

Hence, in this research, semi-structured interviews were used to collect data from academics, and industry practitioners in construction organisations with the use of two (02) interview guidelines (refer Appendix - S), developed based on the screened data from the survey (Phase I). The interview guidelines also followed the same structure of the questionnaires, developed based on the findings of Chapter 02. Yet, the questions were kept open-ended, differently to the questionnaire.

However, a number of data quality issues can be identified in relation to the use of semi-structured and in-depth interviews, related to reliability forms of bias and validity. Yet, these issues were eliminated by maintaining rigour, careful preparation, being knowledgeable, promoting credibility, finding appropriate locations for interviews, maintaining appropriate researcher's appearance, good opening comments, proper approach to questioning, attentive listening skills, and recording data, as suggested by Keaveney (1995).

In summary of the sampling and data collection, the research used many different techniques. A census was used for the academic survey, whereas for the industry survey, it was systematic stratified sampling under probability sampling. Non-probability purposive sampling technique, called as 'critical case sampling' was utilised for Phase II sampling. In terms of data collection techniques, the research used both, questionnaires and semi-structured interviews. Hence, questionnaire based surveys, interviews based case studies, and expert opinions were used to collect data. Table 3.7 presents the sampling and data collection techniques used in relation to the RQs, in summary.

Table 3.7: Sampling and Data Collection Techniques against the RQs

RQs	**Sampling Technique**			**Data Collection Techniques**	
	Phase I		**Phase II**	**Phase I**	**Phase II**
	Academia	**Industry**			
RQ1, RQ3 and RQ4	Census	Probability Stratified Systematic	Non-probability purposive critical case	Questionnaires	Semi-structured interviews

RQ2 is not included in Table 3.7, as it is not tested in the field, as per the research design.

3.6 Data Analysis Process

The discussions upon analysis of data are presented in sub-sections 3.6.1 and 3.6.2. Sub-section 3.6.1 outlines and illustrates the main issues considered, when preparing data for quantitative analysis, and, when analysing such data by computer aided software. The most appropriate diagrams to display data, and the most appropriate statistics to describe data, to explore relationships, and to examine trends were selected according to the needs of the study. Sub-section 3.6.2 outlines and discusses the main approaches available to analyse data qualitatively. An overview of the analysis process, the use of deductively based and inductively based analysis procedures are discussed, which were considered in selecting appropriate methods for qualitative data analysis.

3.6.1 Analysing quantitative data

Numerical data or contain data could usefully be quantified to help answer RQ(s) and to meet objectives. Hence, quantitative data were processed into useful information via analysis techniques to explore, present, describe and examine relationships, and trends within the data. There are a variety of software applications to assist the process, ranging from spreadsheets such as, MS Excel to more advanced data management and statistical analysis software packages such as, Minitab, SAS, SPSS, Statvie, SNAP, and SphinxSurve (Saunders et al., 2009). Accordingly, MS Excel and SPSS were extensively used in this study.

Before selecting analysis techniques, it was required to understand the nature of quantitative data, which can be divided into two (02) distinct groups as; categorical and numerical data. Categorical data can be further sub-divided as; descriptive-dichotomous data, descriptive-nominal data, and ranked-ordinal data (Morris, 2003). Rating or scale questions, collect ranked (ordinal) data. Similarly, numerical data are sub-divided as; interval data and ratio data, where there are again sub-categorised as; continuous data and discrete data (Dancey & Reidy, 2008). Moreover, each data category is having unique characteristics, which lead to different possibilities of data processing. Hence, data type identification protocol, suggested by Saunders et al. (2009) was followed in identifying the data category, developing Figure 3.9. Therefore, Figure 3.9 concludes the demographic data collected for this research are as 'descriptive: nominal' in nature and the core data as 'ranked: ordinal' data. The decision process related to demographic data is given in red, while for the core data is given in black.

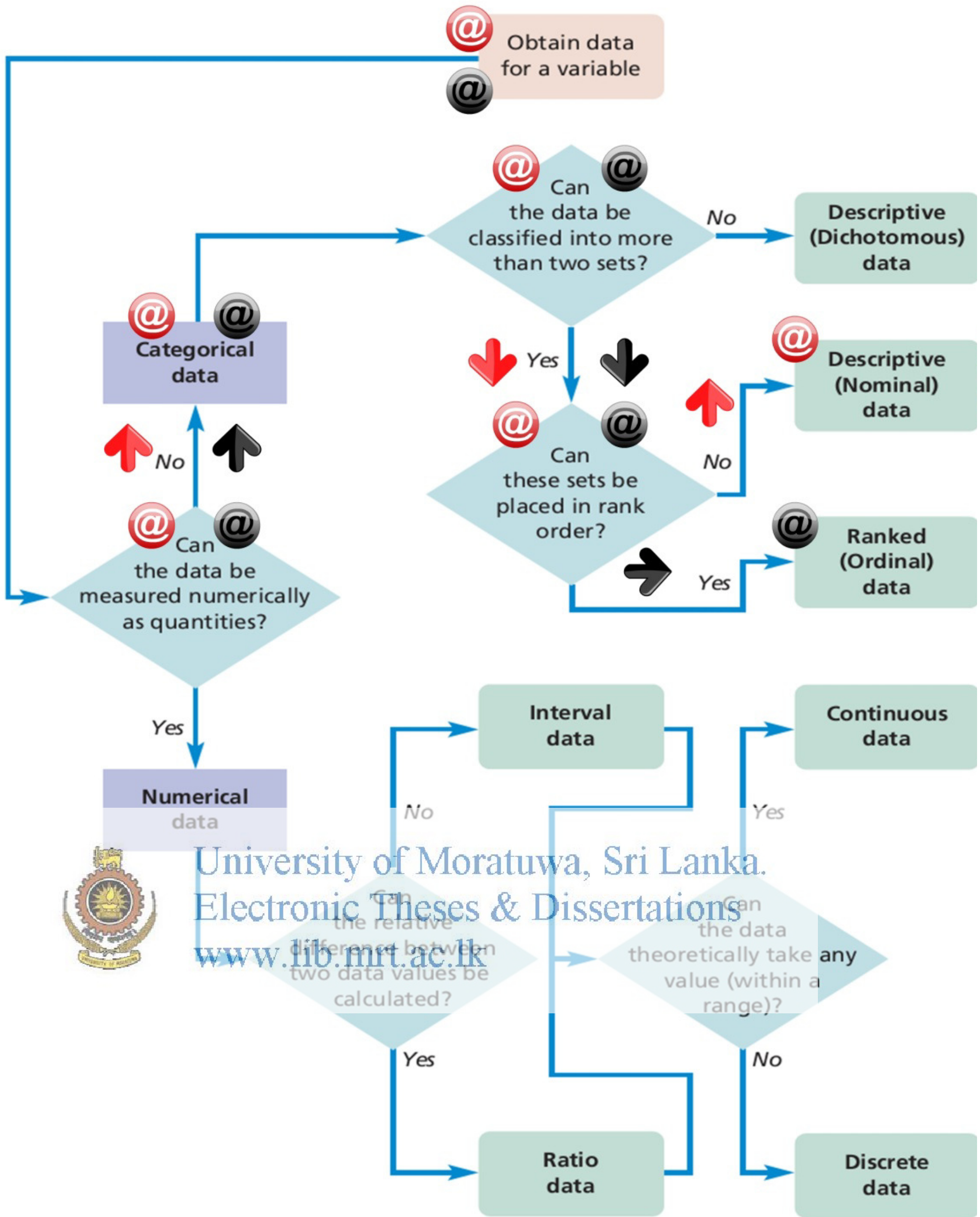


Figure 3.9: Data Type Identification

(Source: Adapted from Saunders et al., 2009)

Since the data categories were identified, it was required to recognise the possible tools for data analysis for each category of data. Data analysis tools are in three-way fold as data presentation tools, descriptive statistics (to describe and compare variables numerically), and statistical experiments (to examine relationships, differences and trends). Table 3.8 presents the techniques against data category, which were useful for this particular research, where irrelevant techniques italicized.

Table 3.8: Analysis Techniques against the Data Category

	Categorical		**Numerical**	
	Descriptive	**Ranked**	***Continuous***	**Discrete**
Data presentation				
To show one variable so that any specific value can be read easily	Table/Frequency distribution (Data often grouped)			
To show the proportion of occurrences of categories or values for one variable	Pie chart or bar chart (Data may need grouping)		*Histogram or pie chart (Data must be grouped)*	*Pie chart or bar chart (Data may need grouping)*
To compare the distribution of values for two or more variables			Multiple Box plot	
Descriptive statistics				
Central tendency represents the middle value			Median	
Dispersion that states the difference within another fraction of the values			Deciles or Percentiles (Data need not be normally distributed but must be placed in rank order)	
Statistical experiments				
To predict the value of a dependent variable from one or more independent variables			Regression equation (Regression analysis)	

(Source: Adapted from Saunders et al., 2009)

Therefore, Tables, Pie charts and Box plots were used to present the analysed Descriptive Nominal data. Further, in analysing Ordinal Ranked data, Median, and Percentile analysis were used as descriptive statistics, for ranking factors according to the relevance and significance. Moreover, Ordinal Regression was performed to detect the relationships between respondents' research activeness, and suggested barriers and success factors to further screen the recognised relevant/significant factors via descriptive statistics.

In justification of use of statistical techniques in analysing Ordinal Ranked data, Blumberg, Cooper and Schindler (2008) stated, despite being in the categorical data category, where data are likely to have similar size gaps between data values, they can be analysed as if they were numerical interval data. Hence, rating or scale questions, where a respondent is asked to rate, how strongly she or he agrees with a statement, which collect ranked (ordinal) data can be analysed using numerical data analysis techniques, as per guidance given for using SPSS software, by Laerd statistics (2013).

Since, the use of a 1-5 Likert scale of the core data collection in this study, created space for undertaking numerical data analysis approaches, where necessary. Further, the scale was expanded, in analysing data of academic research dissemination efforts and industry research utilisation efforts, considering the order of stages, and the five (05) ratings (refer Appendix - H1) together. Therefore, the sum of the scores of all seven stages, obtained by each respondent was considered as the dependent variable input, in running the ordinal regression model.

In identifying the most influential factors, parameters were considered in the order of significance as; Median, Positivity/Negativity of Regression Coefficient, 25th Percentile, 75th Percentile, and Regression Coefficient value. Further, the variables checked for Standard Error (within +/-2 for the 95% confidence interval).

Supplementary, to process a proper data analysis with quantitative data, it has ensured a proper data layout, coding, entering, checking for errors, and weighting of cases as suggested by Saunders et al. (2015).

3.6.2 Analysing qualitative data

Qualitative data are associated with concepts, and characterised with the richness and fullness based on the opportunity to explore a subject in a realistic manner as possible (Robson, 2002). Yet, due to the non-standardised and complex nature, the data were required to be condensed, grouped, and restructured as a narrative to support meaningful analysis. Further, Miles and Huberman (1994), explain the process of analysis in three (03) concurrent sub-processes as; data reduction, data display, and drawing and verifying conclusions.

However, there is no standardised procedure for analysing qualitative data (Tesch, 2013). Yet, Yin (2013) prefers devising theoretical propositions prior to data collection, as a technique to analyse data and emphasises a number of specific analytical procedures with a deductive perspective. Hence, qualitative data were collected following the conceptual framework, developed based on Phase I data analysis. However, as Saunders et al. (2012) noted, a number of analytical procedures combined with inductive and deductive approaches to analyse qualitative data. Moreover, the support of the NVivo software was taken, out of the suggested software such as; Computer Assisted Qualitative Data AnalysiS (CAQDAS), NVivo, ATLAS.ti, N6, and HyperRESEARCH (Saunders et al., 2009) for data analysis.

Therefore, the data were comprehended and categorised, integrating related data drawn from different transcripts and notes. Once a transcript was produced of an interview or observation session, it was also possible to produce a summary of the key points that emerged. The interactive nature of the qualitative data collection process allowed recognising important themes, patterns, and relationships. Hence, pattern matching was involved in predicting patterns of outcomes, based on theoretical propositions to explain; what is expected to find (Saunders et al., 2015). Further, evidence for a correct explanation was flown from finding the same pattern of outcomes in other similar cases as suggested by Yin (2011).

Categories derived from the data were labelled with codes to group data. Altogether, the categories were devised as a coherent set, which provided a well-structured, analytical framework to pursue the analysis, as suggested by Saunders et al. (2012), with the use of template analysis. A template is essentially a list of codes or categories, which represent the themes revealed from the data. Template analysis combines deductive and inductive approaches to qualitative analysis, in the sense that codes can be predetermined and then amended or added to, as data are collected and analysed (King, 2004). Hence, categorising was used to recognise apparent relationships among themes. Figure 3.10 illustrates an example coding structure developed in the main theme of 'Implementing success factors as industry organisations/individuals', where the nodes were identified in four (04) sub levels. The first level was created considering the structure of the interview guidelines, while the next three (03) levels emerged through categories arising of transcript data.

- a. Success factors to be implemented as individual organisations, practitioners
  - a. Serving opportunities for employees to be exposed to innovations
    - a. Training and development
      - a. Participation for seminars, courses etc.
        - a. Funds
        - b. Leave
      - b. Exposure to innovative adoptions
        - a. Overall work experience
    - b. R&D unit
    - c. Promote and support innovative moves
  - b. Mechanism to identify important innovative management practices
    - a. Meetings
      - a. Brainstorming between the directors
      - b. Project managers meeting
      - c. Informal discussions
    - b. Company reviews
      - a. Issues in the practice
        - a. Assigned teams
      - b. Remedial measures taken by the other units.
      - c. Reviewing industry developments and new trends
      - d. QA practices
      - e. Audits
    - c. Training and development division input
  - c. Senior management assistance for innovations
    - a. Reviews industry development
    - b. Pro-active thinking
    - c. Active relationships with the academia
    - d. Experienced on innovations
    - e. Setting goals for innovations
      - a. Takes calculated risks
      - b. Flexibility for changes
      - c. Allocate necessary funds

Figure 3.10: Sample Coding Structure

The next stage was to 'unitise data', to attach relevant bits of data to the appropriate category or categories. However, regenerating the categories and re-organising data had to be done in designing a suitable matrix and placing the data within its cells, as predicted by Yin (2015), with the efforts for displaying data. In this study, the data were presented with a holistic approach to the discussions, following the interview guideline. Hence, individual case reports are not presented in raw format inside the thesis to keep the flow of the explorations upon research questions within a fine clarity and brevity as informed by the arguments of Yin (2014).

In addition to the discussions, data display involves organising and assembling data into summary diagrammatic or visual displays. Miles and Huberman (1994) describe a number of ways of displaying data, and refer to two (02) main families of data display as; matrices, and networks, where the latter was followed in this particular study. Recognising relationships and patterns, drawing conclusions and verifying conclusions, are helped by data displays. Finally, by rigorously testing the propositions against the data, looking for alternative explanations, and seeking to explain why negative cases occur, it was able to move towards the development of valid and well-grounded conclusions, which were displayed in summary, in developing the final model.

In summary, quantitative and qualitative data analysis techniques were utilised in this study to generate the necessary information out of the collected data. The specific background of the data analysis techniques, against the RQs is presented in Table 3.9.

Table 3.9: Data Analysis Techniques against the RQs

	Data type	Software used	Quantitative data Analysis			Qualitative data Analysis
			Presented as:	Descriptive statistics	Statistical experiments	
RQ1	Descriptive nominal data Ranked ordinal data	MS Word MS Excel SPSS Nvivo Edraw Max Edraw Mindmap	Table Pie chart Multiple Box plot	Median Percentiles	Ordinal Regression	Summarising Pattern matching Template analysis Categorising Unitising Mind-maps
RQ2	Descriptive nominal data	MS Word MS Excel Edraw Max Edraw Mindmap	Table			Summarising
RQ3 and RQ4	Descriptive nominal data Ranked ordinal data	MS Word MS Excel SPSS Nvivo Edraw Max Edraw Mindmap	Table Pie chart	Median Percentiles	Ordinal Regression	Summarising Pattern matching Template analysis Categorising Unitising Mind-maps

3.7 Ethics and Credibility in Research

Ethics have important implications in negotiation of access to people, organisations, and collection of data. Hence, the research design of this study did not subject the research population to embarrassment, harm or any other material disadvantage.

Further, the research design was aimed for achieving credibility via paying attention on reliability and validity. 'Reliability' refers to the extent, which the data collection techniques or analysis procedures will yield consistent findings (Easterby-Smith et al., 2008). Robson (2002) asserts four (04) possible threats to reliability as; subject or participant error, subject or participant bias, observer error, and observer bias. Hence, the reliability of data were checked with the use of 'Cronbach's Alpha' test in order to assure the reliability of findings (refer Appendices - G to R). Moreover, 'validity' is, whether the findings are really about what they appear to be about (Saunders et al., 2009). Robson (2002) has also identified the possible threats to validity as; history, testing, instrumentation, mortality, maturation, ambiguity about causal direction, and generalisability, which is also referred to as external validity. Therefore, to keep the credibility, as suggested by Saunders et al. (2015), attention was paid on logic leaps, and false assumptions in identification of the research population, proper data collection, and correct data interpretation, with high scrutiny.

In addition, the final model was tested for the external validity by presenting to three (03) high profile experts, who are extensively, engaged in academic, industry, and industry regulatory bodies. The qualifications of the experts are given in Table 3.10.

Table 3.10: Background Information of Experts participated for External Validation of Research Findings

	Highest Level Academic Involvements	Highest Level Industry Involvements	Highest Level Involvements in Regulation
Expert 1	• Dean of a construction management and design faculty of a reputed university • Professor/senior lecturer in construction management	• Principal architect/proprietor of a reputed consultancy organisation • Member of Royal Institute of British Architects (RIBA) • Fellow member of the Sri Lanka Institute of Architects (SLIA) • Fellow member of the Institute of Quantity Surveyors Sri Lanka (IQSSL)	• Vice-president of Organization of Professional Associations (OPA) • Former president of Sri Lanka Institute of Architects (SLIA) • Member of the board of management - Central Environment Authority (CEA) of Sri Lanka • Former member of board of management of Urban Development Authority (UDA) • Former chairman of Architects Registration Board (ARB)
Expert 2	• External examiner to a construction management department of a reputed university • Faculty board member of a reputed university • Chairman – Board of management of the college of quantity surveying of the IQSSL • Visiting lecturer in construction management	• Chairman of a reputed consultancy organisation • Fellow member of IQSSL • Fellow of the Royal Institution of Chartered Surveyors (RICS) • Fellow of Australian Institute of Quantity Surveyors (AIQS)	• Immediate past president of IQSSL • Member of the board of governors of the Sri Lanka National Arbitration Centre (SLNAC) • Resource person of the Centre for Housing Planning and Building (CHPB), Sri Lanka • Adviser to the civil engineering committee of the Sri Lanka Standards Institution (SLSI) • Representative for Sri Lanka of the AIQS • Executive committee member and finance committee member of Chamber of Construction Industry Sri Lanka (CCI) • Member construction cluster, of the National Economic Development Council (NEDC) • Member of the consultative committee and steering committee of ICTAD
Expert 3	• Visiting lecture and a guest speaker in construction management	• Chartered quantity surveyor • Member of IQSSL	• Present director of development division of CIDA, Sri Lanka

3.8 Summary

Chapter 03 presented the philosophical stance of the research, together with the methodological decisions made by the researcher, in terms of the RQs. The chapter, therefore, justified the scientific nature of the research, in terms of philosophical foundation, research approaches, research design, sampling, data collection, and data analysis. Further, chapter revealed the ethics and credibility concerns of the research.

CHAPTER 4 – RESEARCH FINDINGS AND ANALYSIS: PHASE I

4.1 Introduction

The data collection was conducted in two (02) phases and the results of the data analysis of Phase I are presented in this chapter. Chapter 05 presents the results of the data analysis of Phase II. The data were collected and processed in response to the research problem posed in Chapter 01 of the thesis. Two (02) fundamental goals necessitated the collection of the data and the subsequent data analysis of Phase I. The goals were to identify barriers and success factors of research interactions, as necessitated via the conceptual framework presented in Chapter 02. Hence, the context specific academic research knowledge dissemination and utilisation efforts, and most influential barriers for knowledge dissemination and utilisation, and success factors for research based management innovations in the construction industry were identified.

4.2 Demographic Data Analysis

The demographic data shows the strengths of the sample in terms of the capability of contributing to the knowledge ultimately created via research. Hence, demographic data were collected from the respondents of the academia survey and the industry survey with organisational representatives and individual practitioners. The data analysed using statistical means are presented in the following section.

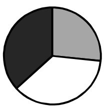
4.2.1 Academic respondents' demographic data analysis

As the first step of the data analysis, the demographic data of the academic survey respondents were analysed to understand the strengths of the respondents' ability to contribute to the study.

Since the research required higher order of academic experience, the sample was selected from senior academics in the field of construction management. Hence, the respondents consisted of professors and senior lecturers and majority (96.66%) of them belonged to the latter category, parallel to the research population cross-section.

Subsequently, in terms of the field of specialisation, respondents belong to three (03) basic backgrounds in the construction field; design, economics and engineering. However, only the academics, who conduct research into construction management were considered as the population for the study. As per Table 4.1, the number of academics with an academic background in design is comparatively less within the sample. However, this disproportion is reflected in the population itself as well. Engineering and economics fields have equal representation in the sample.

Table 4.1: Analysis of Field of Study of the Academics

	Field of Study	Number of Units inside the Sample	Response Rate	Percentage in Responsive Sample
	Construction design	12	66.67%	26.67%
	Construction engineering	22	50.00%	36.67%
	Construction economics	15	73.33%	36.67%
	Total	49		**100%**

Further, the publication efforts of the academics were examined 'number of publications' being the general measurement for efforts of research knowledge dissemination. It showed that the majority of the respondents have around 40 publications and that 35% of the sample has more than 40 publications. Further, there were one (01) respondent with the rights of a patent.

Therefore, the data (refer Appendix - D) indicated that the respondents possess the necessary capacity to provide a reasonable view on the researched issue. Hence, the core data collected via the questionnaire survey were analysed to screen the factors presented under the identified themes relevant to the RQs. The analysis is presented in detail hereon.

4.2.2 Demographic data analysis of respondents from construction industry

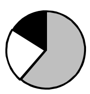
The industry survey was conducted in two (02) subdivisions to capture the organisational and industry practitioner views separately. However, final industry view was developed merging the total data collected from the industry. Yet, the demographic data were analysed separately, for organisation representatives and individual industry practitioners to prove the capacity of each category in contributing to the research.

a. Organisational Representatives' Demographic Data Analysis

The respondents hold positions as; general managers, deputy general managers, and other executive professionals, and all respondents belonged to the senior management of the concerned organisations. The majority of the respondents were deputy general managers. When considering the general managers and deputy general managers together, the total represents more than 70% of the sample. Further, the amount of work experience of the organisational representatives was analysed. The results show that the more than 50% of the respondents have over ten (10) years of experience. Since the organisation representative respondents are experienced executives, the quantitative data collected could justly be considered as rich in quality.

The organisational CIDA grades were also taken into consideration in selecting a cohesive sample to obtain the view of industry organisations. The sample was originally limited to the construction organisations, which are with C1, C2 and C3, CIDA grades in order to obtain a cohesive set of data representing the top strata of the industry. Table 4.2 presents the percentage of organisations, which contributed to the data collection belonging to each CIDA grading.

Table 4.2: Industry Organisational CIDA Grading Analysis

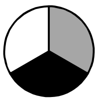
	CIDA Grading	**Number of Units inside the Sample**	**Response Rate**	**Percentage in Responsive sample**
	C1	48	39.58%	61.29%
	C2	32	21.88%	22.58%
	C3	40	12.50%	16.13%
	Total	**120**		**100.00%**

The majority of the organisations belong to the highest grade of CIDA grading. Since C1grade is obtained only by the best established companies in the industry, it suggests that the sample selected for the research survey, possess enough capability to add value to the research (refer Appendix - E).

b. Industry Practitioners' Demographic Data Analysis

The industry practitioners' responsive sample comprised 30 units of architects, engineers, and quantity surveyors from each category (refer Table 3.6). The results of the analysis show that each professional category has made equal contributions towards developing the industry practitioner view. Table 4.3 presents the percentages of each professional category.

Table 4.3: Field of Specialisation of Individual Practitioners

	Professional category	Number of Units inside the Sample	Response Rate	Percentage in Responsive sample
	Architects	135	22.22%	33.33%
	Engineers	130	23.08%	33.33%
	Quantity Surveyors	125	24.00%	33.33%
	Total	**390**		**100.00%**

Further, the analysis was extended to examine the stakeholder groups that the individual practitioners belong to. The individual practitioners belong to all three (03) major parties to a construction project (refer Appendix - F). The results illustrate that the majority of the individuals belong to contracting organisations. Apart from that, almost equal contribution was made by the stakeholder groups of consultants and clients in the sample. Since the sample comprises practitioners belonging to all three (03) major stakeholder groups, a strong base to capture the overall view of the individual practitioners is made available.

Further, the industry experience of the practitioners was also inquired. The findings (refer Appendix - F) indicate that 40% of the respondents have more than ten (10) years of work experience, while 60% of the respondents have less than ten (10) years of work experience. Yet, all the respondents were charter qualified since the professional capacity is not in question. Moreover, it is an advantage to have diversity in terms of age within the sample to bring new insights and historical perspectives to the study.

Hence, demographic data analysis confirms the use of a cohesive sample to represent the industry view, as per the strong demographic backgrounds of organisational and individual practitioner survey samples.

Since the capacity of the samples to contribute to the study was proven via the demographic data analysis, the thesis here on proceeds to the presentation of key findings.

4.3 Key Findings

The core data of the study were analysed and presented in this section under three (03) major headings as (a) current knowledge utilisation/dissemination efforts, (b) barriers for interactions, and (c) success factors for research collaborations. Under each section, academic and industry perspectives are discussed separately and integrated view is generated upon the completion of the analysis.

4.3.1 Knowledge utilisation/dissemination efforts

Alker (2008) has developed a model called Chain of Knowledge Utilisation (MCKU) (refer Figure 2.9), which explains the stages of research utilisation. Therefore, the stages suggested in MCKU were used to identify the construction management academics' success in disseminating research knowledge. Similarly, Pipeline Model of Knowledge Dissemination (PMKD) of Alker (2008), (refer Figure 2.10) is used, as a guide in understanding the industry use of research outcomes. The seven (07) stages of each model, as presented in Table 4.4 were weighed by the respondents using a 1-5 Likert scale.

Table 4.4: Stages of Model - Chain of Knowledge Utilisation and Pipeline Model of Knowledge Dissemination

	Stages of Model - Chain of Knowledge Utilisation	Stages of Pipeline Model of Knowledge Dissemination
1	Reception	Aware
2	Cognition	Accept
3	Reference	Locally Applicable
4	Effort	Doable
5	Adoption	Act
6	Implementation	Adopt
7	Impact	Adhere

Further, the scale is expanded from -14 to +14 in value order based on the stage and the ranking, considering the seven (07) stages together (refer Appendix - G1 and H1).

Since the ratings 1 and 2 given in the Likert scale are on the negative side, the weightages given to them comprise minus values. Rate 3 was the neutral point; therefore, the 3rd rating of all stages was assigned a zero (0) score. The scale was expanded to run Ordinal Regressions to identify practical barriers to research dissemination and the success factors. Since rating was based on the respondents' experience, the reached stages of dissemination by the respondents were defined as the dependent variable. The barriers and the success factors were defined as the two (02) independent variable categories (refer Appendices - G and H).

a. Dissemination Efforts by the Academia: Reaching Stages of Model - Chain of Knowledge Utilisation

The respondents have rated the stages of MCKU, based on the experience of dissemination efforts of each individual. The data were analysed using SPSS to calculate the Median and Percentiles for reaching each stage (refer Appendix - G). Further, Box Plots were drawn in order to generate a complete picture of the practical reach of utilisation stages. Figure 4.1 presents the stages of the model against the field survey results.

Figure 4.1 shows that the dissemination efforts closely results knowledge utilisations following MCKU of Alker (2008). However, the higher stages are poorly reached. The stages, 'Reception' and 'Cognition' are well within the reach of the research sample, as the Box Plots show that the Lower Quartile at the value of three (03) and Upper Quartile at the value of (04). The results indicate a Median falling at the value of four (04) meaning that a majority (75%) of the sample is successfully reaching the stages 'Reception' and 'Cognition'. Hence, the academics are currently being able to reach the desks of the recipients and people understood the research, as per the interpretations of the stages by Alker (2008).

Since the Median falls in the value of three (03), only 50% of the sample reaches the stages ‘Reference’ and ‘Effort’. Hence, half of the researchers only, have been able to change the way people think and to shape action.

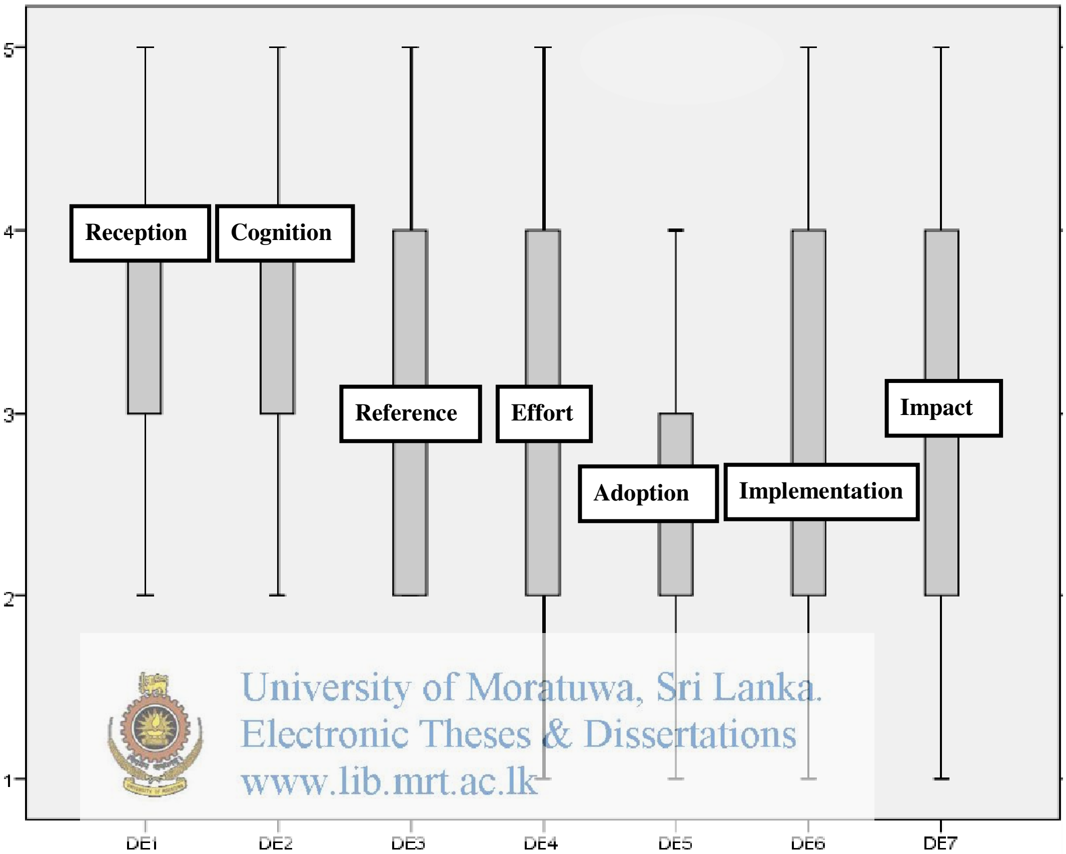


Figure 4.1: Reaching Stages of Model - Chain of Knowledge Utilisation by Academic Researchers

Further, in line with the MCKU, only 25% of the sample is reaching the stage of ‘Adoption’, as the Upper Quartile is at the value of three (03). Therefore, it concludes only 25% of the academics can reach the final two stages, ‘Implementation’ and ‘Impact’ according the theory.

Therefore, the results indicate that researchers have least experience in directly influencing actual policy/practice, developing policy/practice and bringing tangible benefits to the citizens. This leads to further confirmation of the research hypothesis that the previous research has not contributed much to the development of the industry management practice up to now. Yet, results show that more than 25% of the sample reaching the stages ‘Implementation’ and 50%, reaching the final stage, which signals of deviations from MCKU. The deviation may be reasoned by the nature of construction industry's innovation adoption being commonly incremental or modular as explained by Koskela and Vrijhoef (2001). Considering the variations, it can be concluded that only 25% academic researchers are benefiting the industry through creating proper policy/practice impacts.

However, it was necessary to study the industry knowledge utilisation level in order to develop a complete picture of the scenario. Hence, the next section presents the analysis of the knowledge utilisation efforts by the industry. The section starts with the analysis of utilisation efforts of the organisations. Thereafter, the individual practitioners’ utilisation efforts analyses are presented.

b. Utilisation efforts by the industry organisations: Reaching stages of Pipeline Model of Knowledge Dissemination

The representatives of the industry organisations were requested to rate the levels of research utilisation that the organisations practice using the stages of PMKD of Alker (2008). The results were analysed using the Median and Percentile analysis (refer Appendices - H1 and H2) and presented with the use of Box Plots (refer Figure 4.2) to identify the stage of dissemination, which the industry organisations generally reach.

The results of the analysis indicate poor performance in reaching dissemination stages, yet, in line with the low dissemination efforts by the academia. Median value for all the stages stays at the value of three (03) or less meaning that only less than 50% of industry organisations are aware of research in general. The stages ‘Aware’ and ‘Accept’ has reached by 50 % of the sample, yet, only a small quota of the sample (less than 50%) have seen research as ‘Locally Applicable’. However, the 75^{th} Percentile has reached the rate of four (04) by all the stages, which means 25% of the sample are reaching through the final stage of the model. The findings complement the results of the academic survey on dissemination efforts.

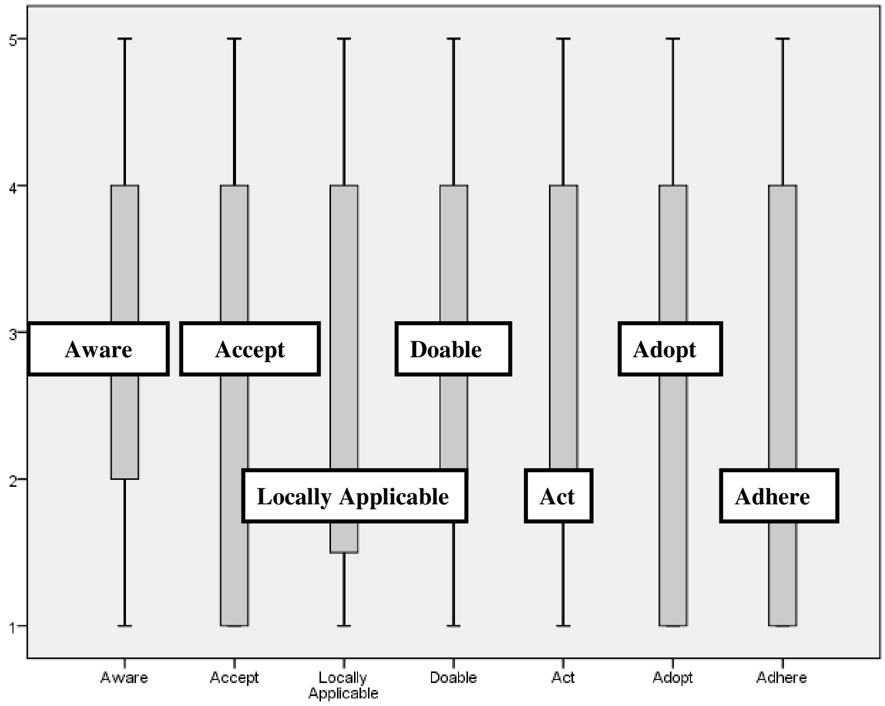


Figure 4.2: Reaching Stages of Pipeline Model of Knowledge Dissemination – Industry Organisational Effort Analysis

Additionally, it was important to investigate the individual practitioners' performance in terms of reaching dissemination stages of PMKD of Alker (2008). The next section, therefore, presents the results of individual performance analysis.

c. Utilisation Efforts by the Industry Practitioners: Reaching Stages of Pipeline Model of Knowledge Dissemination

The individual practitioners' experiences were examined in order to determine the individuals' reach of dissemination stages in general (refer Appendices - H1 and H3). The analyses of the data are presented in Box Plot, Figure 4.3.

Similarly, individual practitioners' experiences further indicate poor performance in reaching dissemination stages. The stages, 'Aware' and 'Accept' have reached by the 50% of the sample, while only 25% have reached the stage ''Locally Applicable'. Complimenting the organisational survey findings, only 25% reaches through the dissemination pipeline to the ultimate stage of adhering into research findings.

Hence, the results of both the organisational survey and individual practitioner survey suggest poor use of research knowledge in the industry. Therefore, the results signal the active Red Ocean Strategy (ROS) symptoms in the construction industry, disturbing the operation of Triple Helix Model (THM). The situation hinder the implementation of innovations emanating from academic research in the construction management practice.

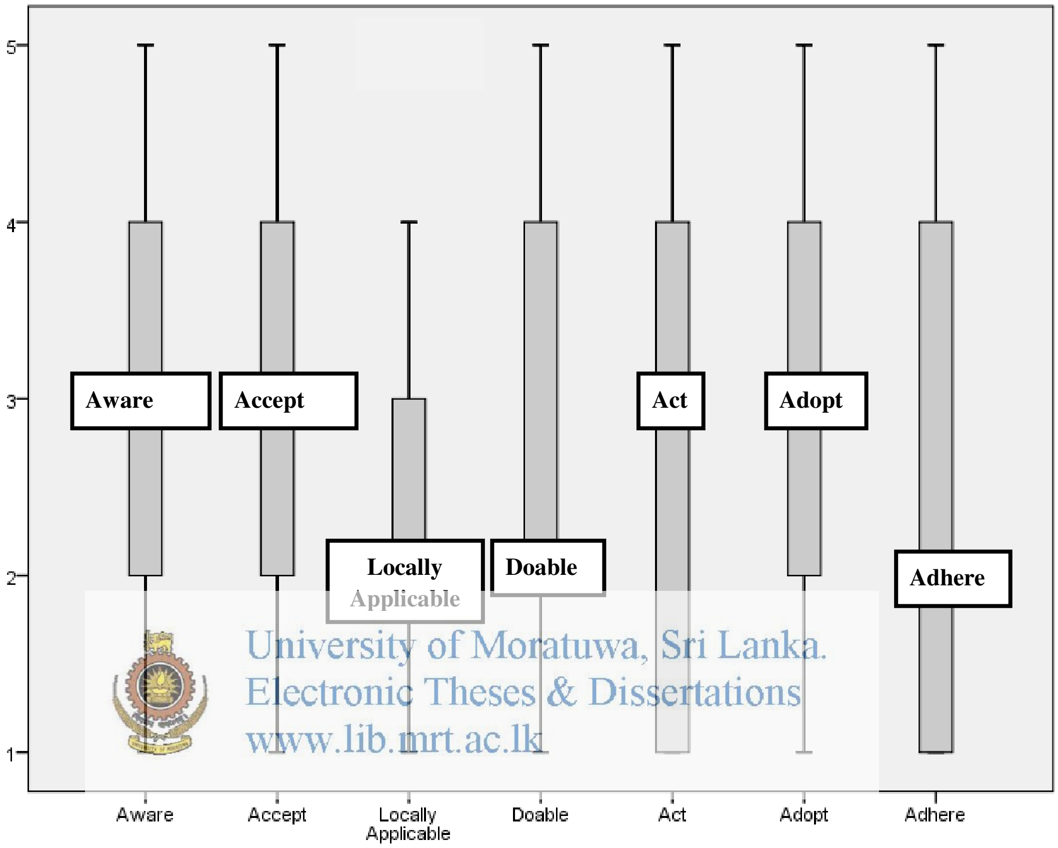


Figure 4.3: Reaching Stages of Pipeline Model of Knowledge Dissemination – Individual Practitioner Effort Analysis

Complementarily, Kim et al. (2008) stated that the construction market is characterised by a typical 'red ocean' environment, where the companies compete on their overhead rather than on their ability to reduce production cost and create value. Hence, the companies have a reactive practice towards development and follow the development in the market rather than shaping their own market. The approach towards development is characterised by being unstructured, undocumented and non-reflexive. The situation leads to a slower development in the construction sector. This is interpreted as a sign of unprofessional management practices in the businesses, which reproduces the existing barriers for research based innovations.

Therefore, it is necessary to inquire into the barriers, which disturb research flowing into the construction industry. Therefore, the research tried to identify the true barriers behind the hindered innovation in management practice. The next section presents the identified barriers for academics collaborating with the industry.

4.3.2 Barriers for research interactions

Barriers for the research interactions were identified and tested in the field separately, for the academia and industry. This subsection presents the discussions of the most influential barriers for the academia and for the industry respectively. In each section, internal and external barriers for each sector are discussed separately.

a. **Barriers for the Academia**

Barriers for academics in creating research based innovations in construction management practice were identified via the literature review and presented in Chapter 02 (refer Table 2.4). Since the literature findings are the common factors representing world face of the issue, it was necessary to select the factors, which influence the academia interacting with the local industry. The results are presented in two (02) categories, as internal barriers and external barriers, considering the academic affiliation, to be the boundary. The Median, Percentile and Ordinal Regression analyses led to showcase the average view on the highest influencing barriers. The Regression Coefficient values were used to further screen the similarly ranked factors, according to Median and Percentile analysis. In ranking factors, considered parameters in the order of significance is as; Median, Nature of the relationship with the dependent variable, 25th Percentile, 75th Percentile, Standard Error (within +/-2 for the 95% confidence interval) and Regression Coefficient value.

Internal Barriers

The internal barriers in the order of most influential to least influential for academics are presented in Table 4.5 (refer Appendix - I). The critical statistics in deciding the exact placement of the factors are highlighted.

Based on the Median analyses (refer Appendix - I2) the factors IB3-IB5 and IB8 have a Median value of four (04) with indication of a comparable high influence.

Further, according to the Regression Coefficients (refer Appendix - I3), out of the four (04) factors, IB5 shows a negative relationship with the dependent variable.

Table 4.5: Internal Barriers in Influential order for Academics

ID	Internal Barriers	Median Value	25th Percentile	75th Percentile	Regression Coefficient
IB8	Time pressure	**4.00**	4.00	5.00	**+0.848**
IB3	Increased work load due to raised number of universities, colleges and students	**4.00**	4.00	5.00	**+0.795**
IB4	Increasing pressure from stakeholder groups upon quality assurance and OBE	**4.00**	4.00	**4.25**	+0.086
IB5	Tension due to funding mechanisms	**4.00**	4.00	5.00	**-1.094**
IB10	Low success in getting research funds	3.00	3.00	**4.25**	**+0.188**
IB9	Poor planning and absence of a proper outcome dissemination strategy	3.00	3.00	4.00	**+1.424**
IB1	Research culture of the affiliation demanding to involve in either pure or applied research	3.00	3.00	4.00	**+0.243**
IB2	Maintaining traditional research culture while partnering with a commercial industry	3.00	3.00	4.00	**-0.242**
IB6	Iniquity of rewards for research and teaching	3.00	3.00	4.00	**-0.385**
IB7	“Think global, act local” challenge	3.00	3.00	4.00	**-1.751**

Therefore, the below mentioned factors were identified as the highest influencing internal barriers for academics in collaborating with the local industry to promote innovative management practices.

- Time pressure (IB8)
- Increased work load due to raised number of universities, colleges and students (IB3)
- Increasing pressure from stakeholder groups upon quality assurance and OBE (IB4)

The findings confirm the presence of time pressure for academic researchers, making it difficult to allocate time for involved in development projects, as suggested by Havnes and Stensaker (2006). Further, raised number of universities and students is acting as a barrier for research activities of the academics align with the view of Brezis and Crouzet (2004). Moreover, Payne (1996)'s explanation on effects of pressure created by quality assurance and OBE upon academic research are visible in the local context. However, all three (03) factors are basically related to time management. Therefore, it was required to be further explored to find out, how academic research experts manage this barrier.

Further to the factors listed in the questionnaire, academics were requested to suggest any other factors, which affect the respondents. Hence, 'attitude of the academic' was suggested by a single respondent, as a barrier for collaborations with the industry. This factor has shown some validity according to the expert opinions at data collection Phase II, as it was suggested that attitude of the academic matters, when an individual decide on the level of dissemination expect to achieve.

As per the literature, in addition to the internal barriers, there are other barriers, which are out of the individual researcher's control. Such barriers were also presented to the respondents to identify the highest influencing external barriers.

External Barriers

The external barriers in the order of most influential to least influential for academics are presented in Table 4.6 (refer Appendix - J). Statistical values, which were critical in ordering the factors, are highlighted.

Table 4.6: External Barriers in Influential order for Academics

ID	External Barriers	Median Value	25th Percentile	75th Percentile	Regression Coefficient
EB12	Goals and paradigms of trans-national research driven by the perspectives of economically advanced countries	**4.00**	3.00	5.00	**+2.260**
EB7	Effects of research take a long time appear even if adopted	**4.00**	3.00	5.00	**+0.084**
EB4	Inadequate allocation of resources for research	**4.00**	3.00	5.00	**+0.044**
EB2	Passive and low opportunity for actual research outcome dissemination	**4.00**	3.00	**4.00**	+0.316

ID	External Barriers Cont.	Median Value	25th Percentile	75th Percentile	Regression Coefficient
EB3	Inadequate quality assurance mechanisms for research	**4.00**	3.00	**5.00**	**-1.414**
EB1	Diminishing financial support from public sources for research	**4.00**	3.00	**4.00**	**-0.265**
EB9	Increased global competition in higher education and research	**3.50**	2.00	4.25	**+1.835**
EB10	Ignorance of fashionable management concepts by practitioners	**3.50**	2.00	4.00	-2.495
EB6	Lack of autonomy in higher education	3.00	**2.00**	4.25	**+0.115**
EB5	Indicators of 'world-class universities' and 'cutting-edge' research reduces the chances for less privileged universities	3.00	1.00	4.00	**+0.570**
EB8	Low and middle-income countries inability in reviewing and preventing low quality of research programmes	3.00	2.00	**4.25**	-1.751
EB11	Commercialisation of university research	3.00	2.00	4.00	-0.750

In Median analysis (refer Appendix - J2), the factors; EB1, EB2, EB3, EB4, EB7, and EB12 gained a value of four (04) showing a comparatively high influence level. The Regression Coefficient values (refer Appendix - J3) of the factors were further investigated. Out of the factors with a Median value of four (04), the factors EB1 and EB3 have negative Regression Coefficient values. Hence, the two (02) factors indicate non-applicability in the local context. Further, remaining all four (04) factors has a similar value at 25th Percentile. Yet, when considering the 75th Percentile (refer Appendix - J2), EB2 is at the value of four (04), while the rest of the factors are with a comparatively higher value of five (05). Therefore, it was confirmed that the below mentioned factors as the highest influential barriers, which affect academic researchers externally.

- Goals and paradigms of trans-national research driven by the perspectives of economically advanced countries (EB12)
- Effects of research take a long time to appear even if adopted (EB7)
- Inadequate allocation of resources for research (EB4)

Therefore, the findings confirm that academic research conducted in the local context is deviated from the needs of the local industry, which hinders the dissemination of outcome, as suggested by Meek et al. (2009). As a result, the appearance of effects of the research is slow in the local context, as Marsh (2010) explained. The situation has decreased the interest of industry in investing in research, multiplying the adverse effects, as OECD (2010) and Abbott et al. (2008) has described.

Further to the forwarded factors via the questionnaire, one (01) respondent has suggested government policies mandating approval for conducting research projects and other formal proceedings disturb the academic research collaborations with the industry. In relation to this suggestion by the respondent, proper support from the stakeholders in leading innovations was identified as a success factor for the industry, which is further discussed in Chapter 05.

Apart from the barriers for the academia discussed above, there are barriers for the industry in collaborating with academia. The analyses of such barriers are presented in the next section.

b. Barriers for the Construction Industry

Barriers for the construction industry in moving towards research based management innovations were identified under two (02) major categories, as internal barriers and external barriers. The literature review revealed 38 factors comprising 23 external barriers and 15 internal barriers. The identified factors were presented to the industry organisations and practitioners survey samples to gather data in application to the local construction industry context. The analyses of collected data on barriers for the construction industry are presented hereon.

Internal barriers for construction industry organisations/individual practitioners

Auxiliary, the internal barriers for industry organisations/individuals were also tested in the field to identify the most influential internal barriers. Data were collected on internal barriers from both the organisational representatives and individual practitioners. The results were analysed using Median, Percentile and Ordinal Regression analysis techniques (refer Appendix - K). The internal barriers in the order of most influential to least influential for industry are presented in Table 4.7.

Table 4.7: Internal Barriers for Industry Organisations/Individual Practitioners in the order of Influence

ID	Internal Barriers	Organisational Survey				Practitioner Survey			
		Median Value	25th Percentile	75th Percentile	Regression Coefficient	Median Value	25th Percentile	75th Percentile	Regression Coefficient
BW11	Academic research is more focused on subjects, which are not crucial for the construction industry	4.00	2.00	**5.00**	**+1.622**	4.00	2.00	**5.00**	**+0.109**
BW10	Constantly changing team compositions disturbs information flow and methods of innovation diffusion	4.00	2.00	**5.00**	**+0.430**	4.00	2.00	**4.00**	**+0.624**
BW14	No proper structure to accumulate financial capital to invest in research	4.00	2.00	**4.00**	**+1.076**	4.00	2.00	**4.25**	**+0.121**
BW2	Research outcome capturing is difficult, as it is tacit knowledge intensive	4.00	2.00	4.00	**+0.352**	4.00	2.00	4.00	**+0.341**
BW3	Link between R&D and profit levels is not visible	4.00	2.00	4.00	**+0.341**	4.00	2.00	4.00	**+0.012**
BW7	Less incentives for interest on research and development activities	4.00	**3.00**	4.00	+1.684	4.00	**3.00**	5.00	-0.181
BW8	Out-dated skills of professionals failing to match with requirements of innovations	4.00	2.00	5.00	-0.599	4.00	**3.00**	4.00	+0.189
BW13	Challenging requirement of adapting to a number of personal and professional changes at a rapid pace	4.00	3.00	5.00	**-1.655**	4.00	2.00	4.00	**+0.173**
BW4	Unawareness due to research outcome not reaching the industry	4.00	3.00	5.00	**+1.227**	4.00	2.00	5.00	**-0.214**
BW12	Poor organisational learning orientation	4.00	2.00	**4.00**	+0.532	4.00	3.00	4.00	-0.294
BW1	Lack of skilled people to promote innovations	4.00	2.00	**5.00**	**-0.179**	4.00	2.75	**5.00**	**-0.100**
BW6	Competition among construction companies being highly price based	4.00	2.00	**4.00**	**-1.658**	4.00	3.00	**5.00**	**-0.042**
BW9	High cost of training employees to match with requirements of innovations	4.00	2.00	**4.00**	**-0.486**	4.00	2.00	**4.00**	**-0.309**
BW15	Research reported in an academic style making difficult to interpret	**4.00**	2.00	5.00	**+0.490**	**3.00**	2.00	4.00	**+0.050**
BW5	Less knowledge about capacity of research	**3.00**	2.00	4.00	-1.857	**4.00**	3.00	5.00	-0.097

According to the results of the Median analysis, all the factors except BW5 and BW15 gained a Median value of four (04) or above from both the surveys. Therefore, they were considered as high influential internal barriers (refer Appendices - K2 and K3). However, only the factors BW2, BW3, BW10, BW11 and BW14 indicated positive relationships with the dependent variable in the Ordinal Regression analysis (refer Appendices - K4 and K5). Therefore, the five (05) factors were further analysed with the Percentile values. Hence, it was revealed that all five (05) factors are with a similar 25th Percentile value, yet the factors BW10, BW11 and BW14 have 75th Percentile values above the value of four (04) indicating comparatively high influences (refer Appendices- K2 and K3).

Therefore, the below mentioned three (03) factors were identified as the most influential internal barriers for the industry.

- Academic research more focused on subjects, which are not crucial for the construction industry (BW11)
- Constantly changing team compositions disturbs information flow and methods of innovation diffusion (BW10)
- No proper structure to accumulate financial capital to invest in research (BW14)

Hence, the findings are complying with the suggestions of Bigelow et al. (2016), as the practitioners claim that the academic research results are inapplicable and impractical for use in real- life construction projects. Further, information flow and methods of innovation diffusion are hindered by constantly changing team compositions creating a lack of teammate to teammate familiarity is presence within the local construction industry disturbing the innovations in line with the argument of Sabol (2007). Moreover, local construction organisations are not properly structured to accumulate sufficient financial capital to invest in research, nor do they have R&D infrastructure make research driven innovations more difficult to be implemented, as suggested by Perkmann (2015). Therefore, the three (03) above mentioned factors were taken forward for the further analysis at the second phase of data collection.

External barriers for construction organisations/individual practitioners

The external barriers in the influential order are presented in Table 4.8.

Table 4.8: External Barriers for Industry Organisations/Individuals in the order of Influence

ID	External Barriers	Organisational Survey				Practitioner Survey			
		Median Value	**25^{th} Percentile**	**75^{th} Percentile**	**Regression Coefficient**	**Median Value**	**25^{th} Percentile**	**75^{th} Percentile**	**Regression Coefficient**
BB18	Industry is timid in adapting management innovations	**4.00**	4.00	5.00	**+13.375**	**4.00**	2.00	4.00	**+0.319**
BB17	Industry lacks leadership to direct towards R&D	**4.00**	**2.00**	4.00	**+5.103**	**4.00**	**2.00**	4.00	**+0.023**
BB15	Lack of investment on R&D by the industry	**4.00**	**2.00**	5.00	-1.807	**4.00**	4.00	5.00	+0.370
BB3	Ignorance of good quality academic research	**4.00**	2.00	5.00	**+3.326**	**4.00**	**3.00**	4.00	**-0.509**
BB20	Industry's short-term focus on achieving project goals	**4.00**	2.00	4.00	**+2.103**	**4.00**	**3.00**	5.00	**-0.014**
BB14	Low responsiveness to change	**4.00**	2.00	5.00	**+0.055**	**4.00**	**3.00**	4.00	**-0.646**
BB2	Reluctance to invest on research	**4.00**	2.00	**5.00**	+2.649	**4.00**	2.00	**5.00**	-0.125
BB13	Slow pace of development in construction sector	**4.00**	2.00	4.00	**-3.384**	**4.00**	2.00	4.00	**+0.513**
BB23	Industry mind-set that academic research is not directly usable and valid	**4.00**	2.00	4.00	**-0.603**	**4.00**	2.00	4.00	**-0.018**
BB21	Limited resources and opportunities for supply chain driven innovation	**4.00**	**3.00**	4.00	**Invalid***	**4.00**	2.00	4.00	+0.179
BB22	Risk averse nature of the construction industry	**4.00**	2.00	4.00	**Invalid***	**4.00**	2.00	4.00	+0.042
BB8	Ignorance of the knowledge worker and importance of skills agenda	4.00	2.00	4.00	**+2.306**	3.00	2.00	4.00	**+0.119**
BB4	Educational research does not often lead directly to practical advances	3.00	2.00	5.00	**+5.501**	4.00	2.00	4.00	**-0.014**

ID	External Barriers Cont.	Organisational Survey				Practitioner Survey			
		Median Value	25th Percentile	75th Percentile	Regression Coefficient	Median Value	25th Percentile	75th Percentile	Regression Coefficient
BB7	Very unique nature of construction industry	3.00	2.00	4.00	**-2.763**	4.00	2.00	4.00	**-0.190**
BB11	"One off" nature of many construction projects	4.00	2.00	4.00	**-4.850**	3.00	2.00	4.00	**-0.039**
BB9	Highly fragmented nature of construction industry	3.00	2.00	4.00	**Invalid***	4.00	2.00	4.00	**+0.438**
BB1	Difficulties in going ahead with current construction industry development trends	4.00	2.00	4.00	**Invalid***	3.00	2.00	4.00	**+0.288**
BB19	Industry is driven by the technology push over the demand pull	4.00	2.00	4.00	**Invalid***	3.00	2.00	4.00	**+0.243**
BB16	Research outcomes are impractical for use in real- life construction projects	4.00	2.00	**5.00**	**Invalid***	3.00	2.00	4.00	-0.203
BB12	Clients interest of 'lowest-price criteria' to award contracts	3.00	2.00	4.00	**Invalid***	4.00	2.00	4.00	-0.014
BB10	Complexity of construction industry production process	**3.00**	2.00	4.00	Invalid*	**3.00**	2.00	4.00	+0.056
BB5	Low attention given to construction product quality	2.00	2.00	5.00	+0.781	3.00	2.00	4.00	+0.058
BB6	Less funded/consulted research being low influential/useful	2.00	2.00	3.00	**Invalid***	3.00	2.00	4.00	-0.222
*	**Standard Error not within +/-2**								

The results were analysed using Median, Percentile and Ordinal Regression analysis techniques (refer Appendix - L). According to the Median analysis (refer Appendices - L2 and L3), eleven (11) factors (BB2, BB3, BB13-BB15, BB17, BB18, BB20, BB21, and BB22) gained a Median value above three (03) from both the organisational and individual survey. Yet, only three (03) factors (BB15, BB18 and BB17) resulted in positive Coefficient values (refer Appendices - L4 and L5) at the Ordinal Regression analyses showing higher applicability in the local context. All three (03) factors have similar values at the 25th Percentile in both the surveys. Yet, factor BB18 has a higher value as the 75th Percentile in the analysis of the industry practitioner compared to the factor BB17 (refer Appendices - L2 and L3).

Following the ranking criteria, therefore, the below factors identified as the highest influencing external barriers for the construction industry organisations/individual practitioners.

- Industry is timid in adapting management innovations (BB18)
- Industry lacks leadership to direct towards R&D (BB17)

The results have confirmed the non-presence of appropriate leadership in the local construction industry and timidity in leading the adaptation of new technologies within the construction sector is critically restricting the innovative management practices, as mentioned by Jones and Saad (2003 cited Maqsood et al., 2007).

Hence, most influential barriers for merging academia and industry in terms of research were identified via Phase I of the data collection and analysis. The results of the analysis have identified the barriers for industry and for the academia separately. Under each category there are internal and external barriers. The Figure 4.4 presents an overview of the most influential barriers.

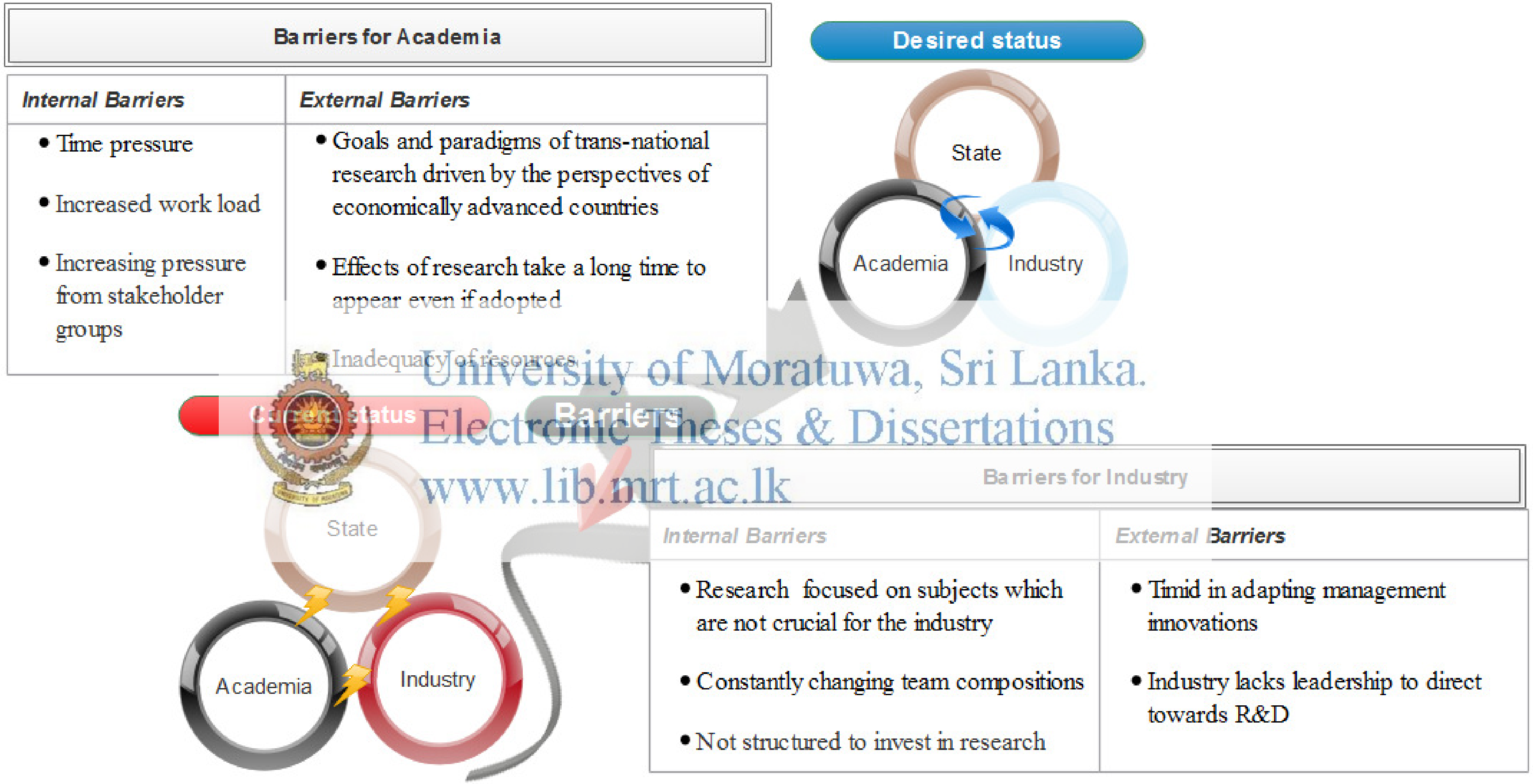


Figure 4.4: Barriers for Academic-Industry Research Interactions

The identified local barriers hinder research based innovations in the construction management context. Since the university-industry collaborations are absent, THM operation is disabled challenging the industry development. Consequently, the ROS of Kim and Mauborgne, (2005) operation in the construction remains unchanged from becoming a Blue Ocean Strategy (BOS). ROS further disturbs the development of a professional construction industry. Hence, it is necessary to investigate the success factors of the required behaviour for a merge between the academia and the industry. Therefore, the next section presents the analysis of the suggested success factors for the academia and the construction industry.

4.3.3 Success factors for academic-industry research interactions

In addition to studying existing barriers, it was necessary to develop CSFs for guiding the merge of academia and industry. Therefore, the success factors were developed based on the arguments from the current knowledge base concentrating the academia and industry separately, and together, as well. This section presents the field study results separately for each of the three (03) categories.

a. Success Factors for the Academia

The initial literature review has revealed 27 success factors; yet, it was required to be tested further in the field to find out the most influencing and locally applicable factors. Therefore, the factors were subjected to a survey, to identify the most significant success factors for academia. Further, the factors were categorised into three (03) groups as; success factors of research initiation, success factors of research execution, and success factors of research dissemination. The results of the analysis under each stage are presented herein.

Success factors of research initiation

The success factors of research initiation in the order of most influential to least influential are presented in Table 4.9 (refer Appendix - M).

Table 4.9: Success Factors of Research Initiation for academia in Influential Capacity Order

ID	Success Factors of Research initiation	Median Value	25th Percentile	75th Percentile	Regression Coefficient
WI7	Play a more active role in relationship with industry	**4.50**	4.00	5.00	**-1.331**
WI9	Establish networks of expertise on research	4.00	**4.00**	5.00	**+3.742**
WI11	Add a dissemination plan into initial academic research proposals	4.00	**3.75**	5.00	**+1.585**
WI2	Select research more biased towards applied sciences	4.00	**3.75**	5.00	**+0.237**
WI1	Create new knowledge linked to development goals	4.00	**3.00**	5.00	**+0.274**
WI6	Align research culture with the changing industry behaviour	4.00	**4.00**	5.00	-0.850
WI10	Consider end-user perspective in planning knowledge dissemination	4.00	3.00	5.00	**-0.246**
WI3	Undertake conceptual research with the ability to gradually penetrate to the industry	4.00	3.00	5.00	**-0.312**
WI8	Focus not only on global challenges, but also on individual industries	4.00	3.00	5.00	**-0.572**
WI4	Give the correct priority to the research	4.00	3.00	5.00	**-0.856**
WI5	Select research more related to the teaching discipline of the academic	4.00	3.00	**4.25**	-0.827

According to the Median analysis (refer Appendix - M2), all the factors have gained a Median value of four (04), while WI7 gained the highest Median value (4.5). However, Regression analysis (refer Appendix - M3) revealed that only four (04) factors, i.e. WI1, WI2, WI9 and WI11 are having positive relationships with the dependent variable. Hence, it explains that even though all the success factors are significant, there are factors that are context sensitive.

When further investigating the four (04) factors with positive Regression Coefficient values, apart from WI1, other three (03) factors have 25th Percentile values above three (03) (refer Appendix - M2).

Hence, the below mentioned factors were identified as the highest influential success factors for the research initiation stage.

- Establish networks of expertise on research (WI9)
- Add a dissemination plan into initial academic research proposals (W11)
- Select research more biased towards applied sciences (WI2)

Abbot et al. (2008) state establishing networks of expertise as a challenge, yet, has become as a major requirement of successful research dissemination. Moreover, dissemination plans designed at the initiation of a research is found to be second most important, which confirms the view of Ordoñez and Serrat (2009). Moreover, having a dissemination plan will lead researchers to think more about the use of the research and especially about the nature of the end product required. Further, the findings are aligned with the argument of Brown, and Smith (2013), which state that the research conducted in higher education should be more biased towards applied sciences over pure sciences. Applied research can easily penetrate into the industry.

The three (03) success factors will support academics to initiate collaborations with the industry smoothly. Further, practising of identified factors will lay industry trust upon the research calibre of research academics in adding value to the industry practice. In addition to the factors listed in the questionnaire, a respondent has added the comment 'identify the need of industry and aware the academic' as a new factor. This addition was confirmed at Phase II during data analysis and further discussions are presented in Chapter 05 of the thesis.

However, proper initiation needs to be backed up with a healthier execution to reach a successful end. Therefore, the next section discusses the success factors to be integrated into the execution of a research.

Success factors of research execution

Nine (09) factors were identified in the literature review as success factors of research execution. The factors are presented in Table 4.10 in the order of most influential to least influential (refer Appendix - N).

Table 4.10: Success Factors of Research Execution for Academia in Influential Capacity order

ID	Success Factors of Research Initiation	Median Value	25^{th} Percentile	75^{th} Percentile	Regression Coefficient
WP7	Treat research as a value creation process by being ethical	**5.00**	4.00	5.00	**+0.316**
WP9	Establish academic research development centres	**5.00**	4.00	5.00	**-0.107**
WP8	Reduce complications and administrative burdens of research funding	**5.00**	4.00	5.00	**-0.780**
WP3	Follow a clear method based on research methodology	4.00	**4.00**	5.00	**+0.585**
WP2	Balance teach-ability, complexity and specificity of research	4.00	**4.00**	5.00	**+0.088**
WP1	Maintain required quality of research	4.00	**4.00**	5.00	**+0.057**
WP5	Send affiliation authorised thanking letters to study participants	4.00	**3.75**	5.00	+0.182
WP4	Include summary documents	4.00	3.00	5.00	**+0.238**
WP6	Send newsletters to study participants	4.00	3.00	5.00	**-0.114**

The Median analysis results (refer Appendix - N2) confirm that all the factors are significantly influential in general, where three (03) factors, i.e. WP7, WP8 and WP9 with a Median value of five (05). However, when examining the Regression Coefficient values (refer Appendix - N3), three (03) factors, i.e. WP6, WP8 and WP9 with negative values indicating their inapplicability for the local context. Further, when analysing the factors with Median value of four (04), it was revealed that WP3, WP2 and WP1are with a value above four (04) at 25^{th} Percentile (refer Appendix - N2).

Hence, the below mentioned factors were identified as the most influential success factors of research execution.

- Treat research as a value creation process by being ethical (WP7)
- Follow a clear method based on research methodology (WP3)
- Balance teach-ability, complexity and specificity of research (WP2)
- Maintain required quality of research (WP1)

The results of the survey, therefore, confirm the view of Saunders et al. (2009) on research ethics and of Le and Bronn (2007)'s, as the importance of research's methodological accuracy in contributing to value creation. Hence, by scientifically applying experience and avoiding the same mistakes, design and construction companies can realise cost efficiency improvements and increased design and performance quality. Findings further confirm the views of Bogers, (2011) and OECD (2010). Therefore, research with balanced teachability, complexity, specificity and quality will have increased user-friendliness.

Success factors of research dissemination

Moreover, the success factors of research dissemination were identified in the literature review and screened via the survey with academics. The success factors of research dissemination are presented in Table 4.11 in the order of most influential to least influential (Appendix - O).

Table 4.11: Success Factors of Research Dissemination fro Academia in Influential Capacity order

ID	**Success Factors of Research Dissemination**	**Median Value**	**25th Percentile**	**75th Percentile**	**Regression Coefficient**
WD4	Ensure availability of the product to the target audience	5.00	4.00	5.00	+0.527
WD6	In dissemination, tailor research findings to a target audience to increase use of research in policy making	4.00	**4.00**	5.00	**+1.108**
WD3	Make stronger efforts to communicate outcomes of higher level research to the broader community	4.00	**4.00**	5.00	**+0.706**
WD2	Recruit specialist staff with business potential to manage knowledge resources	4.00	**3.00**	5.00	**+0.134**
WD7	Present research outcome as a benefit or a solution to a problem	4.00	**3.00**	5.00	**+0.131**
WD5	Allow for feedback from audiences	4.00	**4.00**	5.00	**-1.312**
WD1	Use multiple dissemination techniques	4.00	**3.75**	5.00	**-0.159**

Median analysis results (refer Appendix - O2) confirmed that all the suggested factors are with the capacity to improve the effectiveness of research knowledge dissemination. Moreover, the factor WD4 is having a Median value of five (05), making it to the highest influential factor. Further, Regression analysis (refer Appendix - O3) has rejected the two (02) factors (WD5 and WD1)'s applicability to the local context. Additionally, when examining the 25th Percentile values (refer Appendix - O2), WD6 and WD3 were having values above four (04), indicating the comparatively high influence in relation to the other factors, which are applicable to the local context.

Hence, the below mentioned factors were identified as the most influential success factors of research dissemination stage.

- Ensure availability of the product to the target audience (WD4)
- In dissemination, tailor research findings to a target audience to increase the use of research in policy making (WD6)
- Make stronger efforts to communicate outcomes of higher level research to the broader community (WD3)

The findings confirm the need of ensuring availability of the research outcome to the target audience, as suggested by Ordoñez and Serrat (2009). Shared vision and common understanding of what one wants to disseminate together with a way of describing that to those who stand to benefit from it, therefore, is critically important. The need for the active dissemination by tailoring research findings to a target audience with a dynamic flow of information from the source to increase the uptake of research in policy making, as suggested by RD Direct (2009) is further confirmed by the study. Moreover, the findings are also in line with Hays (2007), therefore, bigger the project and the higher the level of the degree, research outcomes are worth communicating beyond the basic requirements to the broader research community.

Further to the above success factors of dissemination, one (01) respondent suggested that mass media and social media to be used for research knowledge dissemination. The use of such media may be helpful in reaching the target audience and provoking the thoughts of the possible research users.

b. Success Factors for the Construction Industry

The literature review revealed 23 success factors, as necessities of merging academic research and industry practice. The 23 suggested factors were categorised under two

(02) major themes, as success factors to be implemented as an organisations/individuals and success factors to be implemented as an industry. The factors were forwarded to the research sample comprising industry organisation representatives and individual industry practitioners. The results are analysed and presented separately under the major two (02) themes in the next section.

Success factors to be implemented as individual organisations/practitioners

The literature review identified twelve (12) success factors that can be practised by individual organisations/practitioners in order to merge academic research and industry development requirements. The factors were forwarded to the organisational representatives and individual practitioners via the industry survey. The collected data were analysed using SPSS and, Median, Percentile, and Ordinal Regression Coefficient values were obtained. The success factors are presented in Table 4.12 in the order of most influential to least influential (refer Appendix - P).

According to Median values (refer Appendices - P2 and P3), all the factors except WW2 have gained a Median value of four (04) confirming the comparative significance. However, the results of the Regression analysis (refer Appendices - P4 and P5), suggested only three (03) factors as locally applicable.

Therefore, the below mentioned three (03) factors were identified as the most influential success factors for individual organisations/practitioners.

- Offer chances to attend conferences as a reward for deserved employees (WW10)
- Develop a mechanism to identify important innovative management practices from research (WW9)
- Increase senior management's awareness on benefits of external knowledge can bring to organisation budgets (WW6)

Table 4.12: Success Factors for Industry Organisations/Practitioners in the order of Influential Capacity

ID	Success Factors to be implemented as an Industry	Organisational Survey				Practitioner Survey			
		Median Value	**25th Percentile**	**75th Percentile**	**Regression Coefficient**	**Median Value**	**25th Percentile**	**75th Percentile**	**Regression Coefficient**
WW10	Offer chances to attend conferences as a reward for deserved employees	4.00	3.00	**5.00**	**+0.107**	4.00	3.00	4.00	**+0.018**
WW9	Develop a mechanism to identify important innovative management practices from research	4.00	3.00	4.00	**+0.435**	4.00	3.00	4.25	**+0.058**
WW6	Increase senior management's awareness on benefits of external knowledge can bring to organisation budgets	4.00	3.00	5.00	**+0.713**	4.00	**2.00**	5.00	**+0.063**
WW7	Reward research-informed decision-making	4.00	**4.00**	5.00	**-0.321**	4.00	3.00	4.00	**+0.261**
WW5	Ask project managers to identify and report on innovation opportunities	4.00	**4.00**	5.00	**-0.286**	4.00	3.00	4.00	**+0.019**
WW1	Change internal dynamics of construction organisations to be able to respond to change	4.00	**3.00**	5.00	-0.760	4.00	**3.00**	4.00	+0.354
WW4	Aim to maximise economic value through intellectual property	4.00	2.00	5.00	**+0.658**	4.00	3.00	4.00	**-0.193**
WW11	Share how new knowledge has contributed to improved performance to create an explicit cause-and-effect link within the organisation	4.00	2.00	5.00	**-0.048**	4.00	3.00	4.00	**+0.079**
WW3	Combine in-house and external resources	4.00	**2.00**	4.00	+0.659	4.00	**2.75**	4.00	-0.329
WW12	Promote the concept of 'knowledge worker'	4.00	**4.00**	5.00	**-0.548**	4.00	**3.00**	5.00	**-0.087**
WW8	Organise events with employees returning from a conference to share knowledge to other employees	4.00	**2.00**	5.00	**-0.574**	4.00	**2.00**	5.00	**-0.504**
WW2	Use research literacy as a criterion for staff appraisal	**3.00**	2.00	4.00	+0.187	**3.00**	2.00	4.00	+0.095

The results confirm the views expressed by Ward (2003) upon advantages of conference participation. Moreover, industry highlights the need for developing mechanisms for identifying research capacities. Auxiliary, the role of the senior management in aligning industry practices with novelties developed by research is considered to be highly important. Therefore, the three (03) factors were selected for further analysis in Phase II of data collection.

Success factors to be undertaken as an industry

Success factors to be implemented as an industry were analysed for Median, Percentile, and Ordinal Regression values. The success factors in the order of most influential to least influential are presented in Table 4.13 (refer Appendix - Q).

Median analysis results (refer Appendices - Q2 and Q3) confirm the validity of all the suggested success factors [with a Median value of four (04)] in developing better collaborations with the academia. However, three (03) factors were further selected, as the most applicable success factors in the local context according the Ordinal Regression Coefficient values (refer Appendices - Q4 and Q5).

Hence the below mentioned factors were identified as the most influential success factors, which are to be implemented as an industry.

- Create networks with other/foreign industries to collaborate in developing construction management skills (WB9)
- Develop approaches to promote R&D (WB1)
- Include research soundness into job-descriptions (WB7)

The survey findings confirm the view of Ofori (2015), on the requirement of movement for networking, where members could collaborate with each other in developing construction techniques and skills, and exchanging ideas for increasing efficiency and quality. Further, Alker (2008)'s suggestion to promote R&D becomes a critical need of the expected collaborations. Egan (1998)'s suggestion of inclosing research soundness into job descriptions is also a necessity of the present day. Therefore, the three (03) factors were taken forward for further analysis in the Phase II of data collection.

Table 4.13: Success Factors to be implemented as an Industry in the order of Influential Capacity

ID	Success Factors to be implemented as an Industry	Organisational Survey				Practitioner Survey			
		Median Value	25^{th} Percentile	75^{th} Percentile	Regression Coefficient	Median Value	25^{th} Percentile	75^{th} Percentile	Regression Coefficient
WB9	Create networks with other/foreign industries to collaborate in developing construction management skills	4.00	**4.00**	5.00	**+0.240**	4.00	**3.00**	5.00	**+0.127**
WB1	Develop approaches to promote R&D	4.00	**3.00**	5.00	**+0.186**	4.00	**3.00**	4.25	**+0. 195**
WB7	Include research soundness into job descriptions	4.00	**2.00**	4.00	**+0.210**	4.00	**2.00**	4.00	**+0.399**
WB5	Develop more innovative management friendly procurement methods	4.00	**3.00**	4.00	**+0.564**	4.00	**3.00**	5.00	**-0.331**
WB11	Develop strategic and professional leadership for R&D through industry professional bodies	4.00	**3.00**	5.00	**-0.399**	4.00	**3.00**	4.00	**+0.111**
WB10	Update knowledge of the workers in line with the new knowledge generation	4.00	**2.00**	**5.00**	+0.022	4.00	**3.00**	4.00	-0.113
WB2	Encourage industry to use research as a strategic resource	4.00	**2.00**	4.00	+0.780	4.00	**3.00**	4.00	-0.283
WB8	Increase the ability to attract, retain and develop skilled people	4.00	**2.00**	5.00	-0.465	4.00	**2.00**	5.00	+0.474
WB3	Direct industry in capacity building to access research	4.00	**3.00**	4.00	**-0.027**	4.00	**3.00**	5.00	**-0.101**
WB4	Encourage industry investments on research	4.00	**3.00**	4.00	**-0.257**	4.00	**3.00**	5.00	**-0.128**
WB6	Move beyond the traditional practices to adopt new practices	4.00	**2.00**	4.00	**-0.370**	4.00	**3.00**	4.00	**-0.303**

Hence, the most influential success factors to be implemented individually for academia and industry were identified via Phase I of the data collection and analysis. Success factors for academia are identified and presented in three categories considering the stages of a research. In terms of the industry success factors, there are factors, which are to be implemented by the organisation/individual and implemented as an industry as presented above in this section.

Apart from the success factors, which are to be implemented separately, by the academia and the industry, there were success factors, which need to be collaboratively practised. The next section presents the analysis of such factors.

c. Success Factors to be practised Collaboratively by the Academia and the Construction Industry

Since, the research aims for a merge of research direction and industry development requirements, it was necessary to identify the success factors to be practised collaboratively. The twelve (12) factors identified by the literature survey were forwarded to the academic and industry samples to test the relativity with the local context. The discussions upon the analyses of the identified factors are presented in this section.

Success factors to be practised collaboratively – Academics' view

The twelve (12) factors were presented to the academic researchers in the sample via the questionnaire in order to get rated. The collected data were analysed using Median, Percentile and Ordinal Regression techniques using SPSS software. The success factors are presented in Table 4.14 in the order of most influential to least influential (refer Appendix - R).

Table 4.14: Success Factors to be practised Collaboratively in the order of Influential Capacity according to the Academics' View

ID	Success Factors to be practised Collaboratively	Median Value	25th Percentile	75th Percentile	Regression Coefficient
WT11	Promote collaborations amongst governments, economic sector and research universities to link knowledge to development goals	**5.00**	4.00	5.00	**+0.775**
WT2	Introduce incentives to motivates staff and institutional leaders to participate in, or initiate, research collaborations	**5.00**	4.00	5.00	**-0.289**
WT12	Enhance researcher-practitioner collaboration to conduct research on vital problems to find adoptable solutions	**5.00**	4.00	5.00	**-0.550**
WT4	Increase communication between researchers, research funders and research users	**5.00**	4.00	5.00	**-0.559**
WT10	Create strategic partnerships - formal alliance to help each other in achieving aims which cannot be achieved alone	**5.00**	4.00	5.00	**-1.371**
WT6	Judge research programmes by industry impact and tangible benefit	4.00	3.00	5.00	**+1.341**
WT8	Practice the concept of knowledge brokering	4.00	3.00	5.00	**+1.333**
WT7	Promote joint publications between university researchers and practitioners in industry and governing bodies	4.00	3.00	5.00	**+0.592**
WT1	Resolve conflict of interest issues before legal and business arrangements	4.00	3.00	5.00	**+0.085**
WT3	Direct student research more into actual issues in the industry	4.00	**4.00**	5.00	**-0.219**
WT5	Review, how research can be more effectively connected to real-world activity and policy setting	4.00	**3.00**	5.00	**-1.657**
WT9	Embed researchers within companies, as part of existing research activity	**3.00**	3.00	4.00	-0.218

The Median values (refer Appendix - R2), suggest that five (05) factors strongly leading to a merge between the academia and the industry. Yet, only one (01) factor (WT11) was identified as locally applicable, as per the results of the Regression Analysis (refer Appendix - R5). Further, out of the factors which gained a Median value of four (04), i.e. WT1, WT6, WT7 and WT8, were identified as locally applicable according to the Regression analysis. Moreover, the factors are having equal 25th and 75th Percentile values, yet the two (02) factors; WT6 and WT8 are with a Regression Coefficient greater than one (01), which is comparatively high.

Therefore, the below mentioned factors were identified as the highest influential success factors that need to be practised collaboratively, as per the academia's view.

- Promote collaborations amongst governments, economic sector and research universities to link knowledge to development goals (WT11)
- Judge research programmes by industry impact and tangible benefit (WT6)
- Practice the concept of knowledge brokering (WT8)

The findings were in line with the arguments of Meek et al. (2009), who urge the need of collaborations, which have been reduced due to privatisation of companies. Kassel (2009) suggested that research programmes should be judged not just by the quality and quantity of science produced, but by the industry impact and tangible benefits resulting from the research, which was accepted as a valid argument by the field survey sample. Further, knowledge brokering was identified as another key factor in academic-industry collaborations to ensure and disseminate information and knowledge and to prepare usable, targeted synthesis for the clients, as suggested by Alker (2008).

Since the suggested success factors are to be practised collaboratively, it was important to obtain the view of the industry. Hence, the next section presents the industry's view on the Success Factors to be implemented collaboratively.

Success factors to be practised collaboratively – Industry's view

The same twelve (12) factors, which were subjected to the rating by the academics, were presented to the industry sample in order to obtain the view of the organisational representatives and the individual practitioners. The data obtained were analysed using Median, Percentile and Ordinal Regression analysis via SPSS software. Success factors are presented in Table 4.15 in the order of most influential to least influential (refer Appendix - R).

Table 4.15: Success Factors to be practised Collaboratively in the order of Influential Capacity according to the Industry's View

ID	Success Factors to be practised Collaboratively	Organisational Survey				Practitioner Survey			
		Median Value	**25^{th} Percentile**	**75^{th} Percentile**	**Regression Coefficient**	**Median Value**	**25^{th} Percentile**	**75^{th} Percentile**	**Regression Coefficient**
WT11	Promote collaborations amongst governments, economic sector and research universities to link knowledge production to development goals	4.00	3.00	5.00	**+1.904**	4.00	3.00	5.00	**+0.450**
WT4	Increase communication between researchers, research funders and research users	4.00	3.00	5.00	**+1.634**	4.00	3.00	4.00	**+0.018**
WT10	Create strategic partnerships - formal alliance to help each other in achieving aims which cannot be achieved alone	4.00	**2.00**	5.00	**+1.231**	4.00	3.00	4.00	**+0.267**
WT7	Promote joint publications between university researchers and practitioners in industry and governing bodies	4.00	3.00	5.00	+1.294	4.00	3.00	5.00	-0.397
WT1	Resolve conflict of interest issues before legal and business arrangements	4.00	3.00	5.00	+2.027	4.00	3.00	**4.00**	-0.234
WT3	Direct student research more into actual issues in the industry	4.00	2.00	5.00	**-0.987**	4.00	3.00	**5.00**	**-0.194**
WT6	Judge research programmes by industry impact and tangible benefit	4.00	2.00	5.00	**-1.392**	4.00	3.00	**5.00**	**-0.077**
WT9	Embed researchers within companies, as part of existing research activity	4.00	2.00	5.00	**-2.541**	4.00	3.00	4.00	**-0.400**
WT2	Introduce incentives to motivate staff and institutional leaders to participate in, or initiate, research collaborations	4.00	2.00	5.00	**-1.207**	4.00	3.00	4.00	**-0.294**
WT12	Enhance researcher-practitioner collaboration to conduct research on vital problems to find adoptable solutions	4.00	2.00	5.00	**-0.202**	4.00	3.00	4.00	**-0.283**
WT5	Review how research can be more effectively connected to real-world activity and policy setting	4.00	3.00	5.00	-1.630	**3.50**	3.00	5.00	+0.182
WT8	Practice the concept of knowledge brokering	4.00	2.00	5.00	+0.502	**3.00**	2.00	4.00	+0.228

According to Median values (refer Appendices - R3 and R4), all the suggested success factors except, WT5 and WT8 have gained a Median value of four (04) confirming the significance of the factors. Yet, as per the results of the Regression analysis (refer Appendices - R6 and R7), only three (03) factors were positive in terms of the applicability of the local context.

Hence, the below mentioned three (03) factors were identified as the most influential success factors for practice collaboratively, as per the industry view.

- Promote collaborations amongst governments, economic sector and research universities to link knowledge production to development goals (WT11)
- Increase communication between researchers, research funders and research users (WT4)
- Create strategic partnerships - formal alliance to help each other in achieving aims which cannot be achieved alone (WT10)

The findings of the industry survey confirmed the suggestions of Meek et al. (2009) and Kassel (2009), which was confirmed by the academic survey results, as well. Further, the Alker's (2008) view on communication between academia and industry was also seconded by the results. The three (03) factors suggested under this section were also taken forward for further explorations at the data collection Phase II.

Hence, the most influential success factors to be implemented individually and collaboratively by academia and industry were identified via Phase I of the data collection and analysis. Figure 4.5 presents the overview of identified success factors.

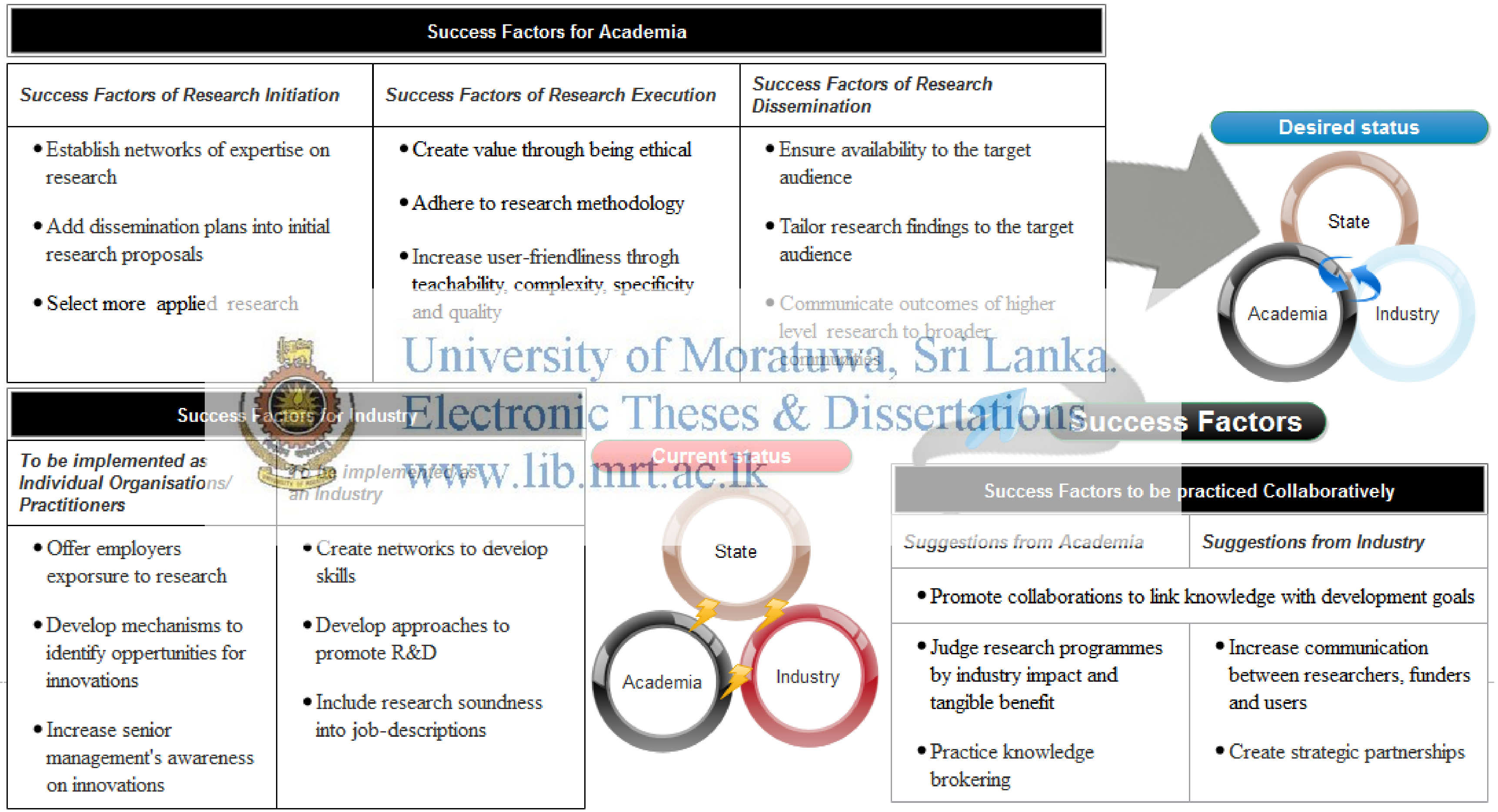


Figure 4.5: Success Factors of Research Interactions for the Academia and Industry

Screening the literature suggestions via a field test was important to identify the most influential barriers and success factors in the process of development of CSF in achieving the research aim. As per the design of the research, a funnel approach of deduction to induction was suggested to develop the final answers for the RQs. Hence, the research was taken forward to Phase II of the data collection and analysis, which takes an inductive approach.

4.4 Summary

In this chapter, study results and a discussion of the findings of data collected in Phase I have been presented. The importance of demographic background of the samples was also discussed prior presenting key findings. The findings of Phase I of the study found to be consistent with the findings of several previous related studies on the research knowledge dissemination to industries. The findings were described as correlations to the study variables and presented as tabulations. Phase I of data analysis created a vantage point to screen the theories leading to the identification of the most relevant literature suggestions. Hence, the screened theories will be explored further, at Phase II of data collection via case studies and expert opinions. The discussion on the findings of Phase II is presented in Chapter 05.

CHAPTER 5 – RESEARCH FINDINGS AND ANALYSIS: PHASE II

5.1 Introduction

Data collection proceeded in two (02) phases and the results of the data analysis of Phase II are presented in Chapter 05. The fundamental goal of the data collection and the subsequent data analysis of Phase II was to explore the screened data in Phase I further. Hence, within the contexts of academic research knowledge dissemination and utilisation efforts, barriers for knowledge dissemination and utilisation, and success factors for research based management innovations in the construction industry, were scrutinised in Phase II of the field study. The discussions are presented in Chapter 05.

5.2 Demographic Data Analysis

Since the most influential barriers and success factors for academic-industry research interactions were identified, it is necessary to explore the methods to overcome the identified barriers and the methods to integrate the Success Factors into the system in order to propose CSFs. Hence, Phase II of data collection was conducted with an inductive approach, starting with studying three (03) cases of successful, innovative construction firms in the industry followed by extorting expert opinions from successful academic research disseminators. Table 5.1 presents the coding used to represent the interviewees to maintain the clarity and brevity of the discussion.

Table 5.1: Interviewees Coding

Interviewee Coding: Case Studies – Industry Organisations			
	Case 01	**Case 02**	**Case 03**
1st Interviewee	CS1-1	CS2-1	CS3-1
2nd Interviewee	CS1-2	CS2-2	CS3-2
3rd Interviewee	CS1-3	CS2-3	
4th Interviewee	CS1-4		

Interviewee Coding (Cont.): Expert Opinions – Academic Researchers			
	Academic Expert 01	**Academic Expert 02**	**Academic Expert 03**
Construction management field	AE1-CM		
Construction engineering field		AE2-CE	
Construction design field			AE3-CD

The analysis of data was conducted in two (02) stages, as demographic data analysis and core data analysis. The demographic data revealed the strengths of the selected data sources to prove the cohesiveness of data. The core data revealed, how the cases have overcome the barriers identified and the comments were provided upon the practicality of integrating identified success factors into the system.

5.2.1 Industry cases demographic data analysis

The demographic data of three (03) cases are presented separately, in terms of background of the organisation, recent innovative moves, and the received awards of excellence, as evidence for the capacity in contributing this research study.

a. Case Study 01

The organisation concerned in the case 01 was incorporated as a public limited liability company in 2001 and the initial organisation was founded in 1994. The company received accreditation from the national construction association of Sri Lanka, as a major specialist contractor. CIDA has assigned the organisation into the highest classification – C1 grade, for many specialty areas. The company successfully obtained the International Organisation for Standardisation (ISO) 9001:2004 certification for quality management system and ISO 9001:2008 certification. The organisation has received recognition from the Sri Lanka Institution of Engineers (SLIE) with accreditation, as an institute for training engineers for charter. Further, the company has obtained ISO 14001:2004 accreditations for environmental management system. The organisation received global recognition, as the first Sri Lankan construction company to be admitted to the United Nations (UN) global compact policy initiative.

The organisation has won numerous awards in a variety of categories, including 6th Asia best employer brand award, global commerce excellence award, chartered accountants annual report gold award, people development award, business today top twenty five 2013-2014, best corporate citizen sustainability award, national award for innovative techniques in construction, Techno Sri Lanka awards, national occupational safety and health awards, national business excellence awards, national engineering and technology awards, engineering excellence awards, corporate accountability rating, national award for construction performance, and the golden award for quality and business prestige.

In terms of recent innovative moves, the organisation has successfully implemented Systems Applications and Products (SAP) in data processing – Enterprise Resource Planning (ERP) software into the company system, and concluded a one day workshop on 'better business integration through process improvement', where a group of over 150 individuals of the company was invited to learn and discuss various topics on SAP in data processing - ERP software solutions. This is a part of the change management programme conducted in view of the implementation of SAP in data processing, as a company ERP tool from mid December 2013. The organisation's SAP in data processing software implementation team includes two (02) outside companies. Hence, with the interest expressed and capacity to bring in management innovation, this organisation was chosen as a case to explore research data points further.

b. Case Study 02

Organisation concerned under the second case study was established in 1984 and since then, has been an active participant in the construction industry of Sri Lanka. Over the past 30 years, the organisation has defined them by continually re-investing in knowledge and capital. The organisation possesses an experienced group of construction project managers, consisting of over 70 senior project managers, and over 300 graduate engineers in the fields of civil, mechanical, electrical, materials, and mining and earth resources engineering, together with designers, planners, quantity surveyors , technicians, and over 8000 craftsmen.

The organisation received many awards for its outstanding performance: International Federation of Asian and Western Pacific Contractors' Associations (IFAWPCA) gold medal, national construction excellence awards, ICTAD awards, IESL excellence awards, National Chamber of Commerce Sri Lanka (NCCSL) business excellence awards, corporate accountability platinum rating by Sting consultants, 2008 - business superbrands certification, 2011 - national gold award for environmental protection for private & public sector, national green award, best construction company in Sri Lanka's water supply and drainage sector, grade C1: performance in major water supply projects from 2010-2012 awarded by National Water Supply and Drainage Board (NWS & DB) and the Ceylon National Chamber of Industries (CNCI) achiever award. This confirms the company stability in the local construction sector.

Recently, the organisation implemented a fully-fledged ERP system together with US and India based resource developer, to improve its management control to achieve service excellence. After a comprehensive requirement analysis and vendor evaluation with the help of an advisory body, the organisation has selected a suited ERP software implementation partner. The selected service provider is a global giant in providing enterprise software, ranging from financial systems and resource planning, to supply chain and customer relationship management. The organisation is implementing a latest version, Infor LN 10.4, covering the scope of project management, estimation and tendering, procurement and inventory management, sub-contracting, production and sales, plant fleet management, and financial accounting.

The modules to be further supported with document management, workflows and reminders, business intelligence tools, and the dashboard and mobile apps. Moreover, the integrated resources management system will focus on bringing technology, business processes, and people together, to achieve optimal business results. By analysing these three (03) factors with respect to performance, complexity, and cost and utilisation, the organisation is confident in its ability to implement control strategies to drive system optimisation, eliminate inefficiencies, reduce costs, and optimise value generation across the board. The project team from the organisation and the service provider is working towards successful implementation under the guidance of top management of both companies. The ERP project implementation project ran for a period of twelve (12) months, covering all departments, projects, and activity centres across the country.

Hence, the above described organisation was selected as a data source for the study, considering the company's open and positive approach towards management related innovations, implementation of ERP software being healthy evidence.

c. Case Study 03

The organization concerned in case three (03) was developed based on a Japanese company, which commenced its operations in Sri Lanka in 1977. At present, the organisation is a team committed to provide quality products and services at an affordable price and on time, in the execution of construction projects, and in the manufacturing of related products, in total harmony with the society and the environment as per the company view. The organisation is further, committed to satisfy the customers, whilst improving the life quality of people and, thereby, improving the viability of the organisation. The organisation value teamwork, efficiency, responsibility, and responsiveness to achieve these goals, through optimisation of resources and continual improvements of systems at all levels of operation to further enhance products and service quality.

Moreover, the organisation has obtained many awards, including (British Standards) BS – Occupation Health and Safety Advisory Service (OHSAS) 18001:2007, National Construction Association of Sri Lanka (NCASL) construction excellence award, national construction performance award, national business excellence award, global commerce excellence award, corporate social responsibility award, National Chamber of Exporters (NCE) award, national productivity award, and ICTAD award for construction excellence. Further, the organisation is an ICTAD C1 grade company, with ISO 9001:2008 Quality Management System (QMS) Certification.

The organisation is certified further with OHSAS 18001:2007 certification process to obtain ISO 14001:2004 - Environmental Management System (EMS) certification. Hence, with the interest shown in innovative management practices, the described organisation was selected, as the third case for further explorations upon the research issues.

With the three (03) cases exhibiting the qualities of established innovative construction organisations, nine (09) professionals with more than ten (10) years of company experience were interviewed and the analysed output is presented under core data analysis section.

5.2.2 Demographic data analysis of academic experts'

In addition to the industry case studies, Phase II comprises another qualitative data collection section, where the source of data being academic experts. The researcher was interested in analysing the academic experience in developing research collaborations with the industry to explore, how the academic researchers overcome identified barriers and implement selected success factors within the practical scenario. Therefore, three (03) academic research experts from the concerned three (03) construction research disciplines (design, engineering, and economics), who are actively involved with research dissemination were interviewed. Demographic data of the selected three (03) experts are presented here on.

a. **Expert Opinion 01**

AE1-CM serves as a senior lecturer attached to an academic department related to construction economics at a reputed government university. The academic was employed in the education sector over ten (10) years, and have performed in all three (03) fields of teaching, researching, and community engagement. The research profile of **AE1-CM** exhibits active involvement in research. **AE1-CM** is currently supervising Doctor of Philosophy (PhD) Degrees, Master of Philosophy (MPhil) Degrees, Master of Science (MSc) Degrees, and undergraduate dissertations. **AE1-CM** is actively engaged in the dissemination research outcome via publications and develops further research projects based on her PhD thesis. Further, the research areas of **AE1-CM** encompass construction management, sustainability, waste management, and Information Technology (IT) for construction management. **AE1-CM** is qualified with a PhD degree, as the highest educational achievement. Moreover, **AE1-CM** obtained many awards for research excellence including; presidential awards, university research excellence award continuously for five (05) years, and several best paper awards. Therefore, **AE1-CM** process strong research strengths to create a valuable contribution to this particular research.

b. Expert Opinion 02

AE2-CE serves as a senior lecturer attached to an academic department related to construction engineering, in a reputed government university. The academic is working in the education sector for more than ten (10) years, and involved in all three (03) fields; teaching, researching, and community engagement. Research profile of **AE2-CE**, reveals a strong research involvement in academic exhibits. **AE2-CE** currently supervise three (03) PhDs, two (02) MPhils, and three (03) MScs in full time basis, and many part time postgraduate research. Further, research areas of **AE2-CE** embrace construction management, sustainability, structural engineering, and building materials. AE2-CE obtained many awards for research excellence: university research excellence award, Taiper Award, Hat annual research university award, Hiran Tillekerathe research award, university grant commission award for the research performed during the period 2007 to 2009, Sri Lanka Associate for the Advancement of Science (SLAAS) - postgraduate research merit award- 2009, university of Moratuwa award for the best civil engineering graduate in construction engineering and management, university of Moratuwa award for the best civil engineering graduate in building and structural engineering, and University of Moratuwa award for the best civil engineering graduate in transportation and geotechnical engineering. **AE2-CE** has qualified with a degree of PhD, as the highest education qualification. Hence, the background of the concerned academic researcher provides strong evidences for the ability of **AE2-CE** to make an important contribution to this particular research.

c. Expert Opinion 03

AE3-CD serves as a senior lecturer attached to a construction design related academic department in a reputed government university. The academic worked in the education sector over ten (10) years and performs in all three (03) fields of teaching, researching, and community engagement. Further, **AE3-CD** exhibits strong research involvement. Currently, **AE3-CD** is into supervising PhDs, MPhils, MScs, and undergraduate dissertations and actively engaged in further research projects based on his PhD thesis. The main research areas of **AE3-CD** are, into sustainable construction and design and he is qualified with a degree of PhD as the highest education qualification. Moreover, **AE3-CD** obtained many awards for research excellence, including a president's award. Therefore, **AE3-CD** poses a strong research background to add value to this particular research.

Hence, it is confirmed that the selected data sources are capable of contributing to this particular research. Hereon, the thesis presents the analysed core data via cross case analysis.

5.3 Core Data Analysis

The core data collected under Phase II of the study were analysed and presented in this section under three (03) major headings, as knowledge utilisation/dissemination efforts, barriers for research interactions, and CSFs for research collaborations. Under each section, academic and industry perspectives were discussed separately, and an integrated view was generated aftermath of the analysis.

Results of Phase II data analysis have evidenced for a low academic-industry success in research knowledge dissemination and utilisation. Hence, in Phase II, industry cases were studied upon the level of academic research collaborations they maintain, while moving ahead with the innovative management practices. Further, the academic expert opinions obtained on the significance of knowledge dissemination to industry and the ways and means for such disseminations. Hence, the two (02) discussions are presented here in order.

5.3.1 Research knowledge utilisation efforts by the industry

The selected industry cases were inquired upon the level of research informed decision-making practised in the organisations and the nature of industry organisations interactions with the academia, to study the industry interest in academic research. The collected data were analysed using the NVivo and the discussions are presented in this section.

a. Is Organisational Decision-making 'Research Informed'?

As an opening approach to the interview, the interviewees were inquired on the organisation's decision-making practices to find out the extent of research informed decision-making practised in the industry. The discussions presented here on following the node structure given in Figure 5.1.

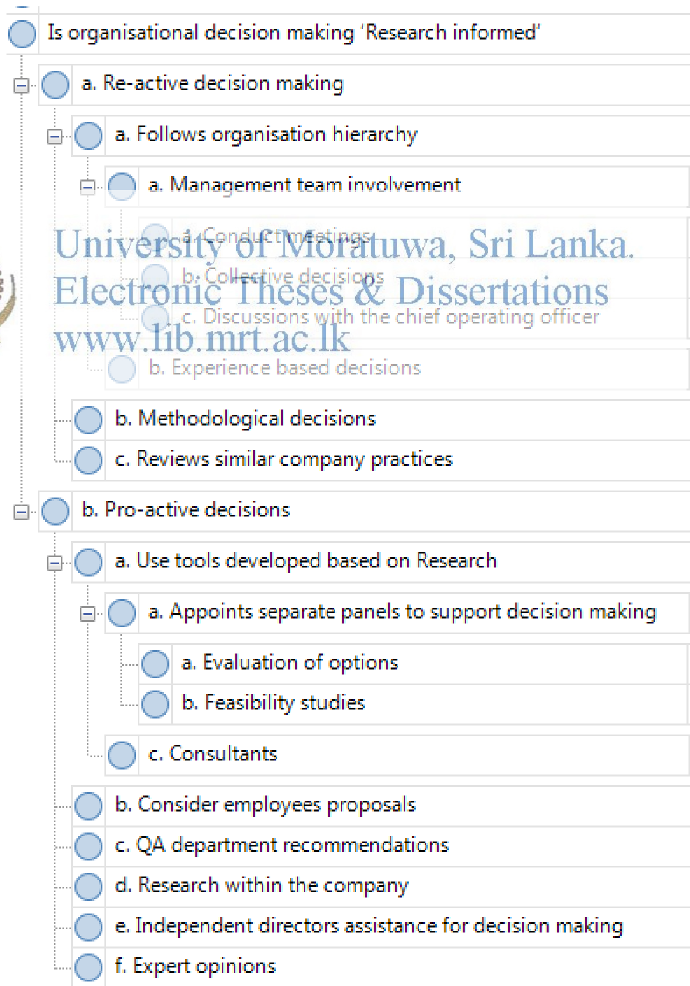


Figure 5.1: Node Structure of the Theme, 'Is Organisational Decision-making Research Informed?' as per Industry View

'Proactive' decisions, with the assistance of research or novelty, as well as traditionally bound '**Reactive**' decisions are made in all three (03) cases. The organisations are mostly into reactive decision-making following the organisation hierarchy, company methodologies and imitating similar company practices.

It was further claimed that **case 01**'s decision-making is to be 'reactive' most of the time. According to the results, decision-making of entire three (03) cases, mostly conducted along the **organisation hierarchy,** depending upon the scale of the issue. All three (03) cases experience ***management team involvement*** in decision-making. In **case 02,** the proposals on innovations are presented to the management team for their consideration and approval. In addition, the project managers come up with decisions, which are seconded by the chairman, while the management has adequate autonomy to make decisions. Yet, each individual is responsible of his/her decisions.

Additionally, in **case 02**, employees are requested to bring up any issues to the monthly *meetings,* which are being further investigated thereon. As the entire staff is present at monthly meetings, everyone can bring up their ideas to help solving existing issues. Further, development proposals for the organisation also can be presented at monthly meetings. Brainstorming within the meetings will decide upon a solution and action plan for implementation. Moreover, if the issue is very critical, shareholders will be involved, once the issue is presented at the Annual General Meeting (AGM) in **case 02.** Besides, in **case 01**, progress review meetings provide a platform for identifying issues. Additionally, in **case 01** and **case 03***, decisions are made collectively* as a company according to **CS1-4 and CS3-1**. In addition, sometimes the management team studies current solutions individually and go for brainstorming sessions. *Discussions with the chief operating officer* happen after identifying a problem in **case 01,** as a decision-making practice. Further, shared decisions with the consent of Chief Executive Officer (CEO) may take place, if the issue affects more than one unit of the company. However, in **case 03**, some ideas get into actions, without following the proper line of authority.

The three (03) cases further confirmed that the organisations are also into ***experience-based decision-making*** since each firm retains a specific culture. **Case 03** interviewees added that, when developing a particular company, the experience with the same company highly matters. Accordingly, optional solutions to a problem are identified through experience in **case 03**. However, the professionals should possess a good background in such case and pre-planning is always present with the company practice. Besides, **case 02** is a mix of business persons and professionals, and thus, mostly the decisions are made based on experience via discussions. Similarly, collaborative decision-making is promoted in **case 03**.

Supplementary, **case 03** has been into **methodological decision-making** from the time of the beginning of the company with Japanese influence. Furthermore, **case 02** and **case 03 review similar company practices** in making decisions, as precedence.

Hence, no R&D division available to make decisions for the companies, but the company management hierarchy decides, what is good for the company. Still, **CS1-4** explained that, **case 01** identifies the importance of R&D, and hence, innovativeness is promoted within the company set-up. Therefore, proactive decisions are made following; the use of tools developed based on research, employee proposals, Quality Assurance (QA) department recommendations, research within the company, assistance of independent directors, and based on expert opinions.

Case 03 is claimed to be proactive in decisions making. In addition, all three (03) cases stated the organisations' use of **tools developed based on research**. In **case 02,** currently the company implements ERP tool. Further, **case 03** is implementing ISO to ensure quality of the work, OSHA standards for health and safety, and ISO 14000 for environmental compliances, and refers to standards, whenever solutions for company issues required. In addition, **case 01** has provided the example of SAP in data processing project implementation. Based on SAP in data processing project implementation experience, **CS1-1**claimed that, the local academic solutions were very primitive compared to what the international context offered, at that instance. Moreover, the initially identified local solution was not much successful and, therefore, the company has opted for the well-established SAP in data processing software after investing a considerable amount of money. Hence, it proves that, the company has taken research assistance, even from the international context. Yet, the **CS1-3** noted that, **case 01** is not probing into the research level in finding answers to the issues frequently, but accepted that, **case 01** explore into research solutions.

Auxiliary, **case 01** and **case 02** used to appoint ***separate panels*** to decide upon innovation adoptions. Such committees review, and examine the existing knowledge base for solutions. Out of the committee outcomes, one option will be selected as the solution by the director board. However, the practice is rare. Yet, **case 01** has formed a temporary unit with project managers etc. to identify possible solutions at SAP in data processing project implementation.

Case 01 and **case 02** used to do *evaluations of options,* when searching optional solutions from the existing service suppliers. As an example, **case 02** has evaluated vendors, when ERP software was selected as the matching solution for the resource management issue. Similarly, in **case 01,** the management has searched for possible solutions where initially, SAP in data processing software has been one of the options. Further, in selecting the software company, for SAP in data processing project implementation, **case 01** has gained the support of an independent consultant's opinion to avoid biases in vendor evaluation. However, *feasibility studies* are conducted prior to taking actions.

Besides, **case 02** uses the service of *consultants* in decision-making, where necessary. As an example, at the initiation of ERP software implementation, a consultant was appointed to find a proper vendor to deliver a centralised system for resource management.

In **case 02** and **case 03**, **employees' proposals** are considered in decision-making. Such reporting has not necessarily been official and even can be friendly and casual discussions. Further, employees can report on issues, they see in the process, maybe with a possible solution. Moreover, **CS1-1** mentioned**, "***even though there is a hierarchy, the company operates as a single unit with a friendly environment. So anybody can come up with new ideas***"** highlighting the freedom for collaborative decision promoted by the company.

It was emphasised that, employees are encouraged to report upon innovation opportunities to **QA department**s. In **case 01** and **case 03** promote **research within the company**. **Case 01** facilitates the research conducted by employees within the company. Since employees perform technical research, it gives cost advantages to the company at present. The **case 03,** as well used to perform own research, when required. Moreover, **case 01** integrates **independent directors** into the director board, and thus, contributions of independent views are a concern. Further, the companies search **expert opinions,** where necessary.

Hence, proactive and reactive decision-making happens at the industry organisations, depending on the situation. Yet, research informed decision-making is rare to be seen in construction organisation practice, in general. Therefore, the interviewees were questioned about the nature of interactions between the industry organisations and academia, maintained at present. The next section presents the findings, which reveals the current practices of academic- industry interactions.

b. Interactions between Industry Organisations and Academia

Discussions with the interviewees disclosed the occasions of current academic-industry interactions, which created the node structure given in Figure 5.2.

Figure 5.2: Node Structure of the Theme, ‘Interactions between Industry Organisations and Academia’ as per Industry View

All three (03) cases stated that the organisations obtain the academics' service as **consultants**. **CS2-1** further explained that academics been appointed as project consultants, as of the requirements generated by the project conditions. Moreover, when the company is in search for new business generations, they connect with the universities for necessary consultation. Additionally, **CS1-3** stated, *"the organisation seeks consultancy for the company from academics because we believe academics, as the right people to go for, when we need advanced advices"* revealing the industry belief upon the academic consultations' inherited value deriving from the profession itself.

However, **CS1-3** and **CS2-1** mentioned that the organisations appoint academics as consultants mostly for technical report preparations. Moreover, **case 03** obtain ***technical reports*** from the universities. Further, in all three (03) cases, ***academic recommendations*** are considered valuable. In **case 01,** marketing issues, human resource related issues, highly technical issues, issues at the project initiation, and disputes are sometimes being referred to universities for a third party opinion. In addition, **case 03** engineers maintain close relationships with university professors, and the technical issues are referred to university for recommendations and reviews. Further, **case 01** has reviewed recently the ***academic research solutions*** for resource management related issues. Yet, the local academic solutions have been inferior; therefore, they have selected a well-established research solution called SAP in data processing from the international context.

Further, all three (03) cases mentioned that the companies cooperate with academia in providing **industrial training** for undergraduates. The undergrads involved in site works and head office work allows transferring the issues related to the industry practices and company specific methods of construction management to the academic researchers, via undergraduate research. Moreover, all three (03) cases promote employees to acquire **higher educational qualifications** such as, MSc and Master of Business Administration (MBA). Employees at the organisations of first two (02) cases are provided with leave and other company resources for educational purpose. In addition, employees in **case 03** are allowed to participate in short courses conducted by the universities.

Further, employees are encouraged to participate for **CPDs** and **guest lectures** by the company. In addition, **case 02** employees **conduct lectures at universities,** when invited for guest lectures and industrial training workshops, and has **assisted in curriculum developments** for undergraduate courses at the universities. Besides, **case 01** employees **support research students** in data collection. Yet, the time spent on such activity does not give a considerable return for the companies since students never deliver the research results back to the organisations. Further, **case 01** being a public ordered company, has high profile **academics appointed to the director board** to assist corporate management.

Hence, the cases suggest, though the industry has many diverse interactions with the universities, still the research-related relationships are weak.

However, the findings reveal that the current practices of decision-making are weakly research informed. Moreover, the academic-industry research interactions have not revealed much positive signs. The findings complement the findings of reaching research dissemination stages of Pipeline Model of Knowledge Dissemination (PMKD) of Alker (2008) by the industry practitioners in Phase I. Therefore, the findings suggest no considerable research relations between the industry and the academia exist at present.

Further, it was important to investigate the academic experts' opinion to understand, whether there is any significance of research in developing an innovative construction management culture, and if so, the successful mechanisms to reach the target audience. The next section presents the academic experts' views upon the mentioned inquiries.

5.3.2 Research knowledge dissemination efforts by the academia

In the effort of obtaining academic research experts' opinions, many different arguments to support the significance of disseminating research outcome and, how it can be performed effectively were disclosed. This section presents the discussions on the two themes following the respective node structures produced through the use of NVivo.

a. Significance of Research Dissemination

Initially, the experts were inquired about the significance of research dissemination to the academia and further into the industry. The discussion hereon brings up the contents of node structure (refer Figure 5.3) in detail upon the topic, 'significance of research dissemination'.

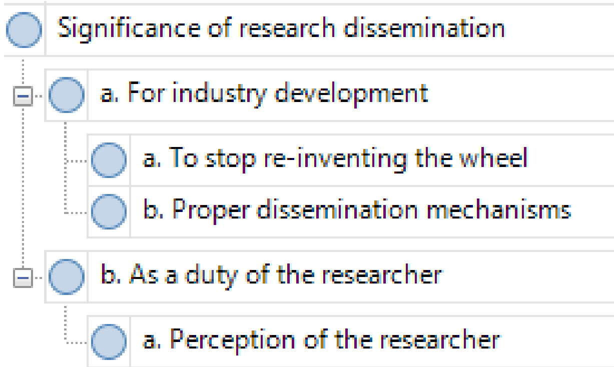


Figure 5.3: Node Structure of the Theme, ‘Significance of Research Dissemination’ as per Academic Researchers’ View

Moreover, the experts suggested that the dissemination of academic research is important in leading the industry developments. This argument aligns with the research hypothesis developed, based on the Triple Helix Model (THM) of Etzkowitz and Leydesdorff (2000). In parallel, **AE2-CE** commented, that the knowledge with the capacity to bring positive changes to the industry must be disseminated to the industry, or else it may be a waste of resources by the researchers and the act would further lead the industry to ***re-invent the wheel***. Hence, **AE1-CM** and **AE3-CD** stated that, the interviewees personally believe in the significance of using ***proper dissemination mechanisms*** to influence industry development in a positive manner. Moreover, **AE1-CM** stated that dissemination at least should reach the academia via publications. Yet, **AE3-CD** contradictorily mentioned that the risk of limiting the dissemination to publications would totally close the access of industry practitioners to the newly created knowledge, leading to lesser innovations in the industry. In addition, **AE1-CM** and **AE3-CD** indicated the responsibility of dissemination of research outcome, as a **duty of the researcher**. However, **AE2-CE** did not agree upon this argument. **AE1-CM** and **AE3-CD** suggested that dissemination efforts depend upon the ***perception*** of the researcher. **AE3-CD** explained the situation further by stating, *"if the researcher only wants to do the publications to create his/her research background; such researcher's will not go beyond publications, as a practice"*. However, as per the view of **AE1-CM** and **AE3-CD,** a researcher with a broader vision and interest in serving the society over self-benefit, will not stop at publishing. Further, **AE2-CE** mentioned that, there is no hard and fast rule indicating all academic research should to be returned to the industry. However, it is the attitude of the researcher that matters in delivering created knowledge for the betterment of the society, if such knowledge is with the capacity to bring in changes to the industry. Therefore, all three (03) experts believed in the significance of disseminating research outcome beyond academia.

Therefore, the arguments conclude the significance of disseminating research outcome. Hence, it was important to understand the nature of dissemination that the industry would be willing and able to capture.

b. Mechanisms for Knowledge Dissemination

The discussions revealed a number of commonly practised mechanisms in dissemination of research knowledge, which are presented in Figure 5.4.

Figure 5.4: Node Structure of the Theme, 'Mechanisms for Knowledge Dissemination' as per Academic Researchers' View

Out of the mechanisms currently in practice, **academic-industry research collaborations** claimed to be the most successful. **AE1-CM** and **AE3-CD** further explained that, research conducted as projects will automatically disseminate. **AE1-**

CM further mentioned about the practical difficulties in implementing such projects, since research initiations by the industry are rare in current situations. Therefore, the suggested solution was to initiate research projects, after considering the need of the industry. Still, **AE1-CM** and **AE3-CD** highlighted that, research conducted in collaboration with industry may sometimes not allow further dissemination beyond the sponsoring organisation, as the organisation may own the product right. This urges the need of having proper agreements in linking research to a particular organisation. **AE1-CM** further mentioned that, if the sponsoring company is not against, the academics could publish the knowledge created without an issue. Yet, the opportunity may depend upon the particulars of the organisation. Further, ***attaching research student into companies,*** as a researcher or a product developer, or to the R&D division, was also practised by **AE2-CE** and **AE3-CD**.

The second most popular dissemination mechanism according to the experts was to deliver the outcome to a company at the end of a research. Therefore, the experts suggested that research outcomes should be processed into **directly applicable tools**. Obtaining **patents,** as suggested by **AE2-CE,** may create a strong opportunity for disseminating research outcome to the industry. Yet, it was claimed that, patents might not be easy to acquire for construction management type of social research. Thus, **AE2-CE** stated, *"research output need to be developed into a level, strong enough for applying for a patent by taking the research outcome beyond raw stage"*.

The experts were further inquired upon the mechanisms used in disseminating research knowledge to the academia. All three (03) cases declared '**publications**', as the foremost successful mechanism in disseminating research outcome to the academia.

Therefore, different researchers use different mechanisms to disseminate research outcome to the industry. Even though the efforts to disseminate are earnest, **AE1-CM** and **AE3-CD** highlighted the necessity of marketing research outcome to increase industry awareness. Therefore, the views of the industry cases and research experts revealed the current status of poor research collaborations in the field of construction management. The findings of the section in summary, is displayed by the mind-map in Figure 5.5.

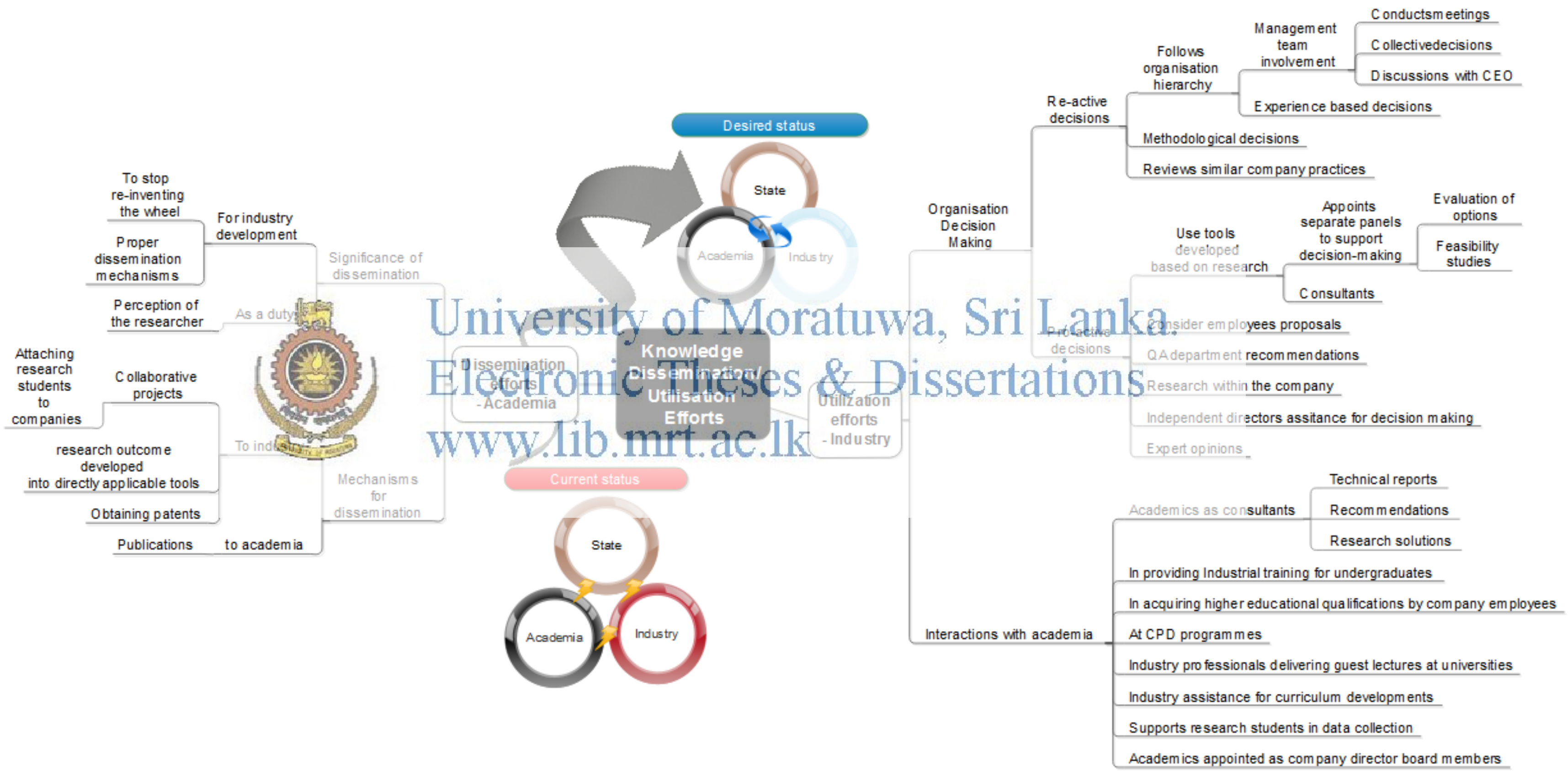


Figure 5.5: Research Significance and Dissemination Requirements

The findings confirm the significance of research outcome dissemination, and the use of proper dissemination mechanisms. Irrespective of the significance of research, practical barriers exist for both the industry and the academia in developing research interactions. The next section presents the discussions upon overcoming such barriers by the industry.

5.3.3 Overcoming barriers for research knowledge utilisation by the industry

With the proven significance of the research in leading industry management towards innovation and industry lacking research utilisations, it was required to explore further, how successful industry innovators overcome barriers identified in Phase I. Hence, this section presents the discussions upon such experiences developed under Phase II of the data collection and analysis of the study. The discussion is presented in two (02) subsections as; 'overcoming internal barriers', and 'overcoming external barriers'.

a. Overcoming Internal Barriers for the Industry Organisations/ Practitioners

The results of Phase I (refer Table 4.7) confirm that, non-alignment of research areas and industry needs, as the most critical internal issue. While changing team compositions was identified as a major challenge for research based innovations, it was also necessary to explore the possibility of allocating funds for research by the industry. Hence, Phase II of the study was aimed to investigate these issues in detail. Figure 5.6 presents the node structure developed based on the subsequent case data analysis.

Figure 5.6: Node Structure of the Theme ‘Overcoming Internal Barriers for the Industry’

Aligning academic research focus with industry research interest: Crucial research areas

Since the industry has claimed that the academic research are not in the crucial subject areas of industry interest, the cases were inquired upon the areas of industry interest. The suggested areas are discussed below.

As per **CS2-1** and **CS1-2**, the interests are **different from company to company**. Hence, **CS2-3** suggested studying companies, separately. Further, **CS1-4** stated that, it would be better if academics study the industry needs before starting research projects, as it would be easier to disseminate such knowledge. It would also benefit the academic, as it will provide opportunity to learn the theories' behaviour in practical settings. However, there is no fixed one-off kind of research area, which raises interest of all companies, since the industry is highly competitive. **CS1-2** further mentioned that, *"the industry is in high competition. We would be interested in solving our specific issues. As construction management is very subjective at a company, it is difficult to adopt commonly generalised findings"*.

The **CS2-1** and **CS2-2** further claimed that the research interests of the companies **differ over time**. Therefore, company specific research need to be conducted in the mode of action research or case studies. **CS1-4** and **CS3-1** suggested '**best practices for saving costs**', as the most important area needs to be researched. **CS3-2** further mentioned research on cost effective new materials, and cost management for cost saving, would be of industry interest. According to **CS1-3**, feasibility and cost benefit analysis for technical solutions at different circumstances and such research for management innovation implementations would be also important. Apart from the above argument, **CS2-3** and **CS3-1** interviewees suggested **resource management,** as an important area of research. **CS2-2** stated that central resource management systems for construction companies are essential. Moreover, according to **CS2-2** and **CS3-1**, **quality management** and **site management** related research, are necessary for the construction industry.

According to **CS2-2**, there are **specific issues to local industry, which** need to be resolved via research. Re-thinking of unique practices of local industry is in need and technology screening to avoid the lead of 'technology push over demand pull' is essential. Moreover, **CS1-3** and **CS3-1** mentioned that the **time saving mechanisms** need to be developed via research. Faster and efficient methods for construction practices would influence positively, in industry development. **Waste recycling** was also identified as an important research area, as waste is becoming a serious issue. Hence, **case 03** employees are involved in converting machinery waste to spare parts, where, it creates assets out of the waste. Therefore, waste management for waste reductions is an important action towards sector development.

Further, **CS2-3** pointed out that **information management,** as a requirement of the industry. Parental control tools for the head offices to manage site information are essential for growing companies. Hence, with the industry development, these kinds of research are of utmost importance. Besides, in order to develop, companies should expand. Hence, **CS2-1** and **CS1-2** further stated that research could assist industry in **managing company expansions**. Reviews upon return on investment due to expansions will be vital for the industry. In addition, **Health and safety** was suggested as a significant area of research by **CS3-2**.

Therefore, the cases have suggested many areas of research that are critical to the construction industry. Hence, it is necessary to align the academic research with identified research needs. Apart from this issue, constantly changing team compositions at construction organisations have been identified as a hindrance for innovative moves. Therefore, the cases were inquired upon the measures taken by the organisations to avoid innovations affected by the cause.

Avoiding disturbs for innovations due to constantly changing team compositions

All the cases suggested **continuous training** as the practical solution. **CS2-3** mentioned, "*it is true that a company cannot keep employees for very long times. Anyhow, we give necessary trainings irrespective of the fact and the loss, we do not see it as a loss; yet we see that as a service to the industry*".

Continuous recruitment is another good solution practised by the **case 01** and **case 03.** For an example, **CS1-1** explained the experience of SAP in data processing project implementation, where most of the top positioned employees have left after the implementation, yet the company progresses with new recruitments; thus, the issue was managed. Besides, **CS2-1** and **CS1-2** stated changing teams allow companies to intake new blood, as new recruitments for aged employees. Since the aged employees may not be able to go ahead with the new approaches/technologies/tools, it is an advantage to have some space created for fresh recruitments. Moreover, **CS2-3** stated, new incoming may bring new ideas, that may even lead to innovative changes. In addition, **CS1-4** highlighted another positive factor about such changes; that the new members bring new knowledge, which may help the companies to perform better.

However, the **employees with company experience** are always positioned at the top of units in **case 03,** to avoid disturbances created by the team changes. Continuous recruitment may help a company to have employees with company specific experience all the time. However, **case 01** promotes employees to stay long at the company, but the company does not bond the employees. Moreover, **case 01** accepted it as a challenge. Since the companies irregularly expand with time, new employees will join the companies frequently. Hence, maintaining the integration within the company is a big problem. The **resource management software** (ERP) implementation was a solution for this issue at **case 01**. **Knowledge is kept as a shared resource** at **case 02**. If the leaver plays an active role within the company, this may have some impact. However, since work is team based most of time, the knowledge is managed as a shared resource. Hence, the changes in teams do not severely affect innovation adoptions.

Therefore, the mechanisms of overcoming disturbances for innovations due to team changes are discussed above. The next section presents the views of cases on company willingness and availability of support for research with industry resources.

Possibilities of investing in research irrespective of structural inferiority

Due to resource constraints in conducting such research, it was important to explore the possibility of obtaining funding support from the industry. All three (03) companies were positive about providing funds for **company specific research**. Therefore, **CS2-3** stated that, *"if the researchers can give answers to our company specific problems, we would be interested in collaborating"*. Similarly, at present,

case 02 has invested in ERP tool implementation project a considerable amount of money. This is a good example showing company’s willingness to spend upon necessary innovations. Initially, **case 01** has invested around 100 Million Sri Lankan Rupees, for SAP in data processing project and the considerable annual maintenance cost they bear with the implementation. The evidence suggests that, if the problem is critical and the solution is sound, a business company is willing to spend the necessary money. In parallel, **CS3-1** mentioned that, if a particular research addresses a company issue, the company would be interested in sponsoring the research fully or partly. Moreover, **case 01** is interested in funding research, which can give the company a comparative advantage, over common knowledge generation.

At present, construction companies establish **R&D units,** as a bragger, or for the recognition of having a R&D unit. Yet, **CS1-3** stated that companies could fund research with arrangements such as strategic partnerships**,** in case of considerable return is guaranteed for the company. According to **CS2-1**, currently the funds are allocated for **employee education**, including higher studies and participation of seminars, CPDs, etc. **CS2-2** emphasised further that companies would easily agree to support **student research** attached to a specific company.

Hence, the discussion revealed strong suggestions to diminish the internal barriers for research interactions between academia and industry. The next section presents the views of the three (03) cases in overcoming external barriers, identified in Phase I.

b. Overcoming External Barriers for Industry Organisations/Practitioners

In response to the major external barriers identified in Phase II (refer Table 4.8), it was necessary to explore, how to overcome construction industry timidity in research based innovations and to identify the expected role of the external stakeholders in leading construction management innovations. The overview of the discussion based on N-Vivo analysis is presented in Figure 5.7.

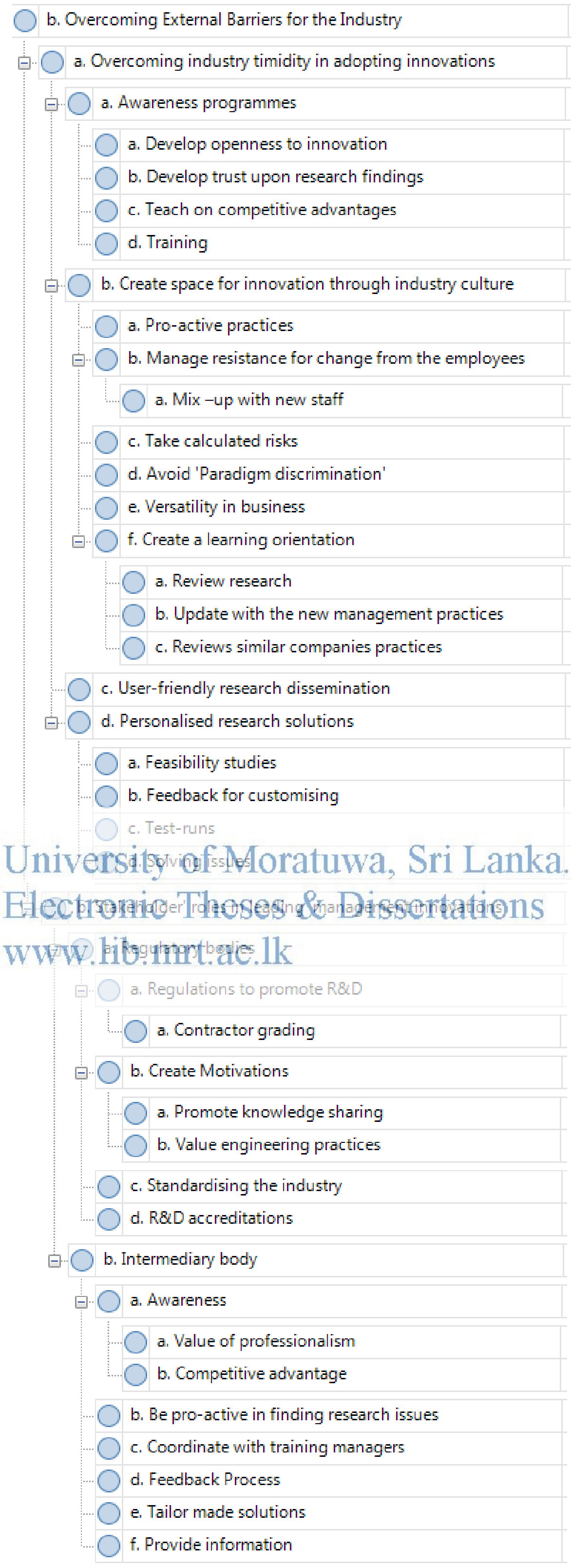


Figure 5.7: Node Structure for the Theme ‘Overcoming External Barriers for the Industry’

Overcoming industry timidity in adopting management innovations

Possible actions undertaken to overcome timidity towards adopting research outcome were inquired. In response, all three (03) cases highlighted the importance of the **awareness programmes**. Hence, **case 02** facilitates conducting lectures for employees to get familiar with the new implementations, as in the example of ERP tool implementation experience. However, **case 01** respondents declared that, currently the awareness upon the academically created research knowledge is low. Moreover, the industry is poor at identifying the need for research.

Hence, ***openness to innovation*** was identified by **case 01** and **case 03** interviewees, as a plus factor. Moreover, ***trust upon research*** findings is also in question; both **case 01** and **case 03** interviewees agreed on the fact. **CS1-3** described management as a mix of science and art; hence, the companies still have doubts about the practicality of scientific solutions for management issues. Therefore, the trust on research findings needs to be generated. Further, **CS2-1** mentioned ***competitive advantages*** of research removes timidity. Therefore, researchers should make the industry known upon the benefits of research informed practices. Further, **case 01** mentioned the importance of ***training*** company employees to make them familiarise with new systems.

Besides, **case 01** and **case 02,** interviewees stated that **industry culture** needs to be changed to overcome timidity. Further, **case 02** and **case 03** emphasised, a strong structure within the industry is essential to overcome timidity and to proceed with necessary innovations. Further, the company type matters. Public Limited Company (PLC)s are more into innovative developments, as the short-term profit is not the only focus.

The current construction management innovation efforts are reactive, whereas proactive practices are almost nil. Hence, all three (03) cases agreed that ***proactive practices*** should aim to overcome timidity in being innovative.

Further, **case 01** and **case 03** interviewees highlighted the importance of ***managing resistance to change from the employees***. Moreover, *mixing–up with new staff* helps to manage the change resistance built up by aged employees.

In addition, **case 01** and **case 02** interviewees noted that the importance of top management's willingness to ***take calculated risks*** to move ahead with the innovations. **Case 03** interviewees claimed that philosophical ***paradigm discrimination*** must be avoided to create an innovative culture in construction management. **CS3-1** stated**,** *"industry is mostly led by engineers, who are coming from a week management background. Management research is based on a different line of thinking, which does not match with the trusted thinking line of engineers".*

Since the engineering thinking belonging to a different philosophical paradigm, the industry is reluctant to adopt management related innovations. This perception needs to be changed. Therefore, the engineers at management level should be equipped with management knowledge, social science basics, and thinking patterns. In addition, according to **CS1-4**, ***versatility in business*** allows the company to be innovative.

Further, construction industry should develop ***learning orientations*** to a common practice. Therefore, organisations need to be more open minded to *review research* outcome. *Updating with the new management practices* is also important. Hence, **CS1-2** mentioned, organisations need to get themselves updated with the new management practices and ERP system is currently being installed in the organisation in this manner. **Case 01** interviewees further stated that self-review upon the company leads to innovations. Hence, organisations must possess strong self-review mechanisms to identify the grey areas that need development. The habit of re-thinking upon industry practices lead to **'**learn and change**'** for better practice next time. Further, **CS2-3** suggested *reviewing practices of similar companies* leading to innovations.

In addition, **user-friendly dissemination mechanisms** such as research tools that make work easy inspire industries in innovations. In parallel, **CS1-2** stated that SAP in data processing project is now installed in the organisation to monitor the site resource use at one point, which is accessible for the whole organisation management at different requirement levels, due to the ease provided by such tools.

Additionally, **personalised research solutions** would attract industry interest. **Case 01** and **case 02** interviewees stated that it was important to conduct ***feasibility studies*** prior to adopting innovations. The SAP in data processing project and ERP project consultants conducted feasibility studies and have prepared a customised version of the standard software, considering the specific character of the company, after a few months of studies. Moreover, **case 02** interviewees explained the ERP system implementation experience and mentioned that the software owners acquired the ***company feedback*** for customising ERP tool for the organisation. The feedback process helped to create trust upon the novelty, since the construction companies are timid in nature for changes. In addition, **case 01-1** mentioned that ***test-runs*** are important in adopting innovations. ERP system is currently installed in the organisation in this manner. Ultimately, ***solving issues*** also leads to innovative actions, as it has happened with the ERP system implementation.

Therefore, the discussions have revealed many ways for overcoming industry's natural timidity towards innovations. Apart from that, case studies continued to identify, how stakeholders can assist construction management innovations.

Stakeholders' role in leading management innovations

It was suggested that the non-presence of leadership to promote management innovations, as a hindrance for industry research knowledge utilisations. Hence, the cases were inquired about the role of able stakeholders (Regulatory body/Mediatory body) in providing such leadership. Answers of cases are discussed herein.

Findings confirmed the necessity of **regulatory bodies'** active involvement. **CS1-2** and **CS3-1** emphasised the need of establishing ***regulations*** to promote R&D. **CS1-2** highlighted the necessity by stating, *"regulatory bodies can make it to a mandatory for the companies to achieve benchmarks in the field of R&D to reach higher construction grading"*. Moreover, **CS3-1** highlighted the need of innovativeness, as a requirement for *contractor grading system ratings*. **CS1-2** suggested integrating some marks for being innovative into the evaluation schemes for construction companies.

Further, **CS2-1** and **CS1-2** highlighted that, **creating motivations** for the companies to be innovative is achievable through regulatory bodies. Hence, **CS2-3** highlighted the need of such mechanisms by stating that, some employees are less motivated in proceeding with innovations. Further, **case 02** promotes *knowledge sharing*. Once the employees returning from knowledge dissemination occasions, if the findings are important, the content will be shared with other employees at the monthly project managers' meetings. In addition, promoting practices like *value engineering* with motivations would lead companies for innovations.

Moreover, **CS2-3** and **CS1-4** explained the need for **standardising the industry**. Hence, **CS2-1** stated that regulatory bodies must put efforts on standardising the industry. Moreover, unique features of the local construction industry hinder standardising, and such features need to be identified and eliminated. Hence, an awarding system for construction management innovations would be necessary and such encouragements are important. For an example, **case 01** follows such schemes and award requirements, which have positively promoted integrating innovations into the company. Further, **CS1-2** mentioned that, presence of quality assurance mechanisms reinforces the company development, leading to better innovative practices. In addition, **CS3-2** suggested, **R&D accreditations** need to be offered by regulatory bodies since such accreditations would be important in convincing clients.

Auxiliary**, CS1-2** and **CS3-1** appreciate a new role of an **intermediary body** between the academia and industry. **CS2-2** stated that, if the intermediary body ***promote awareness*** of new knowledge, the company can support employees in terms of monitory and leave for participation. In addition, **CS1-3** noted that, possible institutions should play a more active role in presenting academic research to the industry. They can be the mediatory body to develop a research link between industry and the academia. Further, the institution should bring the industry problems to the academia to research and should carry back the available knowledge to the industry organisations.

Further, the values of professionalism, as highlighted by **CS1-2**, need to be learned by the industry. During the course, intermediary body can play an active role by increasing the awareness on the power of research in assisting construction development. Hence, professional bodies should materialise the industry to be more professional. It will lead organisations to learn the value addition gained through being professional. Further, **CS1-4** highlighted the importance of *competitive advantage* gained via being innovative. Hence, intermediary body can help organisations to gain competitive advantages via coordinating academic research with separate companies.

Also, **CS2-1** declared the importance of **coordinating with training managers** in promoting innovations by the external stakeholders. Training managers are appointed by the companies to find opportunities offered by the stakeholders for the employees to develop knowledge. **CS1-3** suggested intermediary body to **be proactive in finding research issues**. Since the industry is reactive in terms of management innovations, if the academic research can be proactive in finding research issues, would be a great support for the industry.

Moreover, the intermediary body can capture and promote good practices for construction companies. As an example, **CS2-2** use **feedback process** in adopting innovations. MD will take the feedback upon the knowledge gained in seminars, CPD, and if necessary, the company adopts such innovations. However, according to **CS2-3**, innovations are rare since the **promotions are not tailored for a specific company's need**. Moreover, **CS2-1** highlights the importance of intermediary body, providing **course materials** of selected courses that the employees participate, to the other employees.

Therefore, the case studies uncovered many actions taken by the successful innovative companies to overcome the internal and external barriers for research-based management innovations. Figure 5.8 presents a summary displayed as a mind-map. .

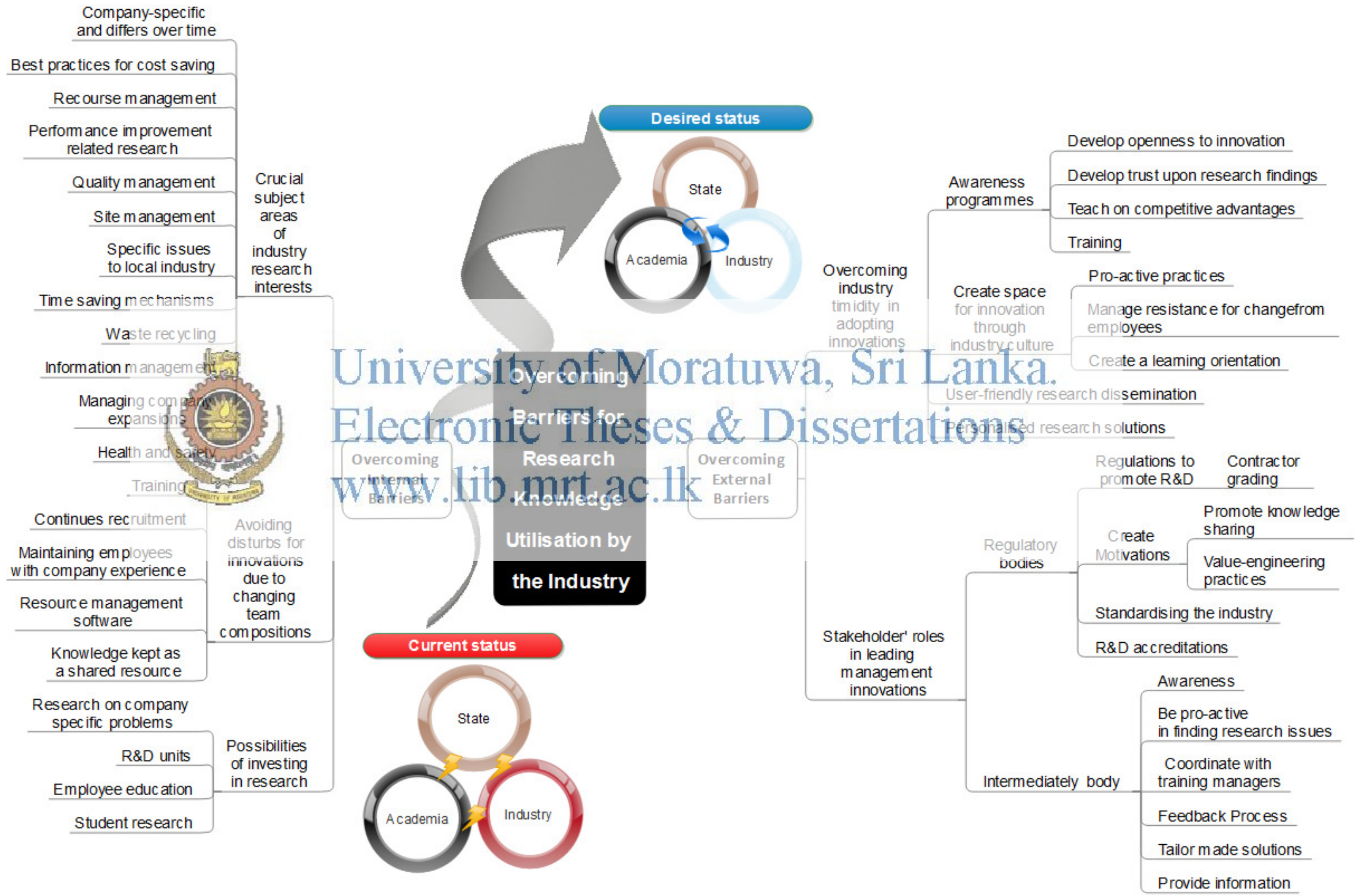


Figure 5.8: Overcoming Barriers for Construction Industry

Apart from the barriers for the industry, there were barriers for the academia as per the study. Hence, the next section presents discussions with academic research experts in overcoming such barriers.

5.3.4 Overcoming barriers for research knowledge dissemination by the academia

With the identification of ways and means of overcoming industry barriers, it necessitated the exploration of how successful academics overcome the barriers, identified in Phase I. Hence, this section presents the discussions of academic research expert opinions developed in Phase II of data collection and analysis of the study. The discussion is presented in two (02) sub-sections; overcoming internal barriers and overcoming external barriers. The overview of the analysis is presented in the node structure developed by the N-vivo analysis presented in Figure 5.9.

- Overcoming Barriers for Research Outcome Dissemination by Academia
  - a. Internal Barriers
    - a. Handling time pressure through proper use of deadlines
      - a. Timely finishing
      - b. Regulate the research process
      - c. Practicality issues
        - a. Depends on the researcher
        - b. Depends on the supervisor
        - c. Nature of the research
      - d. Audience requirements
    - b. Managing increased workloads
      - a. Personal descipline
        - a. Dissemination as a habit with short term and long term goals
      - b. Create time for continuous research focus
      - c. Priorotising duties
      - d. Intermediary body for research interactions
    - c. Balancing research and pressures of applying OBE for teaching QA
      - a. Concept itself compliments research
      - b. Planning skills
  - b. External Barriers
    - a. Re-shaping global research focus for local industry requirements
      - a. Avoids testing high end theories using a local sample
      - b. Consider the scale of industry
      - c. Creates marketable research output
      - d. Localised new developments of the global context
      - e. Avoid academics from deviating from their subject expertise
    - b. Developing research with visible industry impacts
      - a. Collaborative research
        - a. Industry links
        - b. Research profile
        - c. Publicity upon the research capacity of the university
        - d. University support
        - e. Agreements
      - b. Real world problem
      - c. Pro-active researching
    - c. Obtaining resources for research
      - a. University resources and grants
      - b. Industry sponsorships
        - a. Profile of the academic
        - b. Marketable research output
        - c. Agreements
      - c. Grants from research institutions

Figure 5.9: Node Structure of the Theme ‘Barriers for Academia’

a. Overcoming Internal Barriers for Academia

The main three (03) internal barriers for the academics were identified as; time pressure, increased workload, and pressure from stakeholder groups upon quality assurance and OBE (refer Table 4.5), which are basically related to time management. The discussions upon strategies of overcoming each barrier, as per the academic research experts' view, are presented herein.

Handling time pressure through proper use of deadlines

The experts were questioned about the effect of deadlines on managing time pressure. All the experts agree that deadlines lead to a **timely finishing**. Therefore, successful researchers always consider the deadlines, as a positive push to achieve expected outcomes on time. However, flexibility up to a certain extent would avoid quick finishing of research without acquiring the expected quality level in response to such pressures. Further, all the experts have agreed that deadlines **regulate the research process**. In addition, **AE1-CM** has highlighted more of positive and negative effects of having deadlines as, *"having PRs in between pushes the student towards progressing. However, the deadlines should not put unnecessary pressures upon the researcher. Flexibility to have extensions should be there, in case if necessary to control the pressure"*.

Therefore**, AE1-CM** has shown empathy towards researchers through the above statement highlighting the **practical issues** in meeting deadlines. However, **AE2-CE** has expressed rigidity and stated that, students on full time basis are exempted since the students receive internationally accepted time periods to complete their research work.

Moreover, **AE1-CM** and **AE3-CD** have suggested that the pressure created by tight deadlines is a negative impact upon research, depending on the ***nature of research***, since long-term research, such as PhDs would most probably be influenced by researcher's personal life events.

The impacts of the deadlines were suggested to ***depend on the researcher*****,** as per the views of **AE1-CM** and **AE3-CD**. If the researcher is not capable of meeting deadlines, he/she may even leave the research halfway, creating losses for all parties involved. The experts suggest such pressures could be positively used, if the researcher is smart enough to do so. **AE2-CE** and **AE3-CD** have mentioned that, dedication is necessary as long term researching needs patience and courage to have a good, timely finishing.

Further, it was suggested that the impact of the deadlines is to ***depend upon the supervisor***. Therefore, supervisors should be smart in directing the students towards achieving the research aims within the correct period, while also being flexible, where necessary.

AE1-CM and **AE3-CD** have stated that the impact of the deadlines further depends upon the **audience requirement**. Research, which requires quick outcomes, needs tight time bars. Occasionally, short-term research would not be able to give a considerable output. Still, when it comes to industry-linked research, quick outcome is preferred; hence, deadlines play an important role in balancing the input time and output quality of a research.

Managing increased workloads due to raised university/programmes/students numbers

The field survey with academic researchers confirmed the literature suggestion of heavy workloads disturbing research involvement. Hence, the experts were questioned on personal time management mechanisms. The three (03) experts produced different mechanisms of personal time management, which lead the experts towards their research success.

Personal discipline is the most important mechanism, suggested by **AE1-CM** and **AE3-CD**. However, **AE1-CM** further explained that mechanism is highly subjective and depends upon the person by stating that, *"self-enthusiastic researchers can do research, even within tight time schedules. But, people are different. A very few active researchers are present at the moment"*. Contradictorily, it was argued that the issue is not about time management, but more of an issue of the mentality of the researcher. The researcher's less focus on the research leads to create time issues was the reasoning given by all three (03) experts. Further, **AE2-CE** personally does not consider time management as an issue, yet picking up a good research student is most difficult. Moreover, **AE1-CM** declared that supervising cannot be a burden and if it so, it is the fault of the person as she/he may have accepted students beyond his/her limit. Nevertheless, academics do not have any choice to accept the preferred student numbers due to staff limitation.

AE1-CM and **AE3-CD** suggested practicing **dissemination as a habit** with pre-planned short-term and long-term goals. Moreover, **AE1-CM** mentioned that, *"when it is about publications, index journal paper writing needs more time and focusing is quite difficult. If the paper was rejected, it can aim for a non-index journal with the same paper. Since the time available for research work is limited, academics are used to do more of conference publications, which are not much effective in terms of thought provoking".*

Hence, utilising vacation leave for **continuous focus** was suggested as a possible time management option by **AE1-CM** and **AE3-CD**. Further, the cases suggested personal and professional agendas disturb research work, as it needs continuous focus for some time to complete a good quality research. Since the latter fact is not available, utilising a mandatory vacation leave for research work would create positive results. Further, it was highlighted the difficulty of conducting research without necessary reserved time for researching. Now there is time, yet the slots that can be allocated for research is too small to invest upon a good research work.

Hence, if it is possible to make compulsory for the senior staff to take vacation leave for one (01) or (02) months and utilize this time for research work, it will lead most academics to be more research active. However, outcome evaluation procedures are necessary. As the vacation leave is an entitlement, regulatory bodies can use it to guide academics to gain more research success by making use of it as a mandatory. Overall efforts will increase the university capacity in research. **AE1-CM** further emphasised, developing publications need at least full ten (10) days to prepare an index journal paper. Yet the inability to keep research mode longer as the teaching burden is high, lead to generation of poor quality research output.

All three (03) cases highlighted the importance of **prioritising the duties of academics**. Further, all three (03) cases have stated that the academics interested in research may better keep sufficient time reserved for researching, similar to other countries. Moreover, **AE2-CE** and **AE1-CM** have referred to the international practice in suggesting solutions by stating ‘at international arena, senior academics' workload comprises more of researching and less of lecturing.

It is somewhat similar to local set-up, yet, the administrative work cuts off much time from academics, which they could have used for researching. As a solution, the two (02) cases suggested to endow the administrative work management to academics, who have less interest in conducting research. **AE1-CM** has strongly emphasised that, it is not the lectures, but the administrative work, which generate the burden. The expert has further explained that maintaining quality of the academic programmes via accreditations, etc. takes the entire time of academic, once the visitations are on the board. At such times, chances for the academics to focus upon research continuously are nil.

Establishment of an **intermediary body** to manage academic-industry research interactions was suggested as a solution by **AE1-CM** and **AE3-CD**. As the time matters, such body would assist to create research links with the industry. Hence, it would help save time for academics to conduct research. The two (02) cases further suggested attaching staff to such a research unit, following a roster that will provide an opportunity for everybody. This ensures the continuous presence of some academics in the intermediary body involved with research, and a roster will prevent teaching severely affected.

The experts have suggested many best practices for proper time management to handle workload related issues. The next section discusses the effect of increasing pressure from stakeholder groups upon the quality of teaching.

Balancing pressure from stakeholder groups upon OBE for teaching QA

The experts were interviewed to find whether the trend towards moving into OBE for teaching QA is supportive for research engagement of academics, and to identify the positive and negative impacts of OBE on academic research. The answers provided by the experts are discussed below.

All the experts expressed that, OBE **concept itself complements research**. Further, **AE1-CM** and **AE3-CD** denied calling the trend as a negative factor in academic research. The experts further agreed, considering OBE as experiments for academics, and suggested the possibility of using the experience as action research input for pedagogic research. The trend promotes academics to be more research oriented, even at teaching. Similarly, **AE1-CM** further stated, *"I do not consider it as a hindrance. It is a positive factor, since even without OBE, time need to be allocated for teaching"*. However, it is suggested that an enthusiastic academic can create activities for OBE, which could provide data for some research in the subject area.

AE1-CM further suggested that academics need good **planning skills** to be successful researchers, when moving into OBE. The three (03) experts agree the fact that OBE consumes time. Yet, **AE3-CD** stated that, an absence of severe disturbance to the industry-linked research from OBE. All the experts suggested that creating a personalised balance between teaching and researching, as a solution for the issues created by moving into OBE. If OBE disturbs a particular academic research agenda, he or she can reduce the teaching hours and balance the time with researching credit hours. **AE2-CE** and **AE3-CD** indicated the absence of any institutional issue in doing so. Yet, there may be practical instances, where the academics do not enjoy the freedom to use their privileges due to lack of staff.

Therefore, the successful researchers do not consider moving into OBE as a negative factor for researching, but have balanced the two (02) duties positively through proper personnel planning.

The discussions upon internal barriers for academics were mostly related to time management. Many best practices were revealed through the discussions, as presented. Hence, it was also required to look into mitigating the external barriers for the academia. The discussions upon such external barriers are presented in the next section.

b. Overcoming External Barriers for Academia

Apart from the internal barriers, there are external barriers, which need to remove in order to create a smooth research link between the academia and the industry.

Therefore, barriers identified via Phase I (refer Table 4.6) were forwarded to the experts to find, how successful researchers manage such issues.

Re-shaping global research focus for local industry requirements

Survey with academic researchers identified aligning global research focus with the local industry requirements, as a challenge for researchers in general. Hence, the research experts were interviewed to comprehend the ideal practices.

The experts stated **testing high-end theories using a local sample** are questionable in terms of the quality of the generated research output. When testing high-end theories using a local sample, there could be many false data due to unawareness and inexperience, leading to wrong conclusions. Therefore, **AE1-CM** and **AE3-CD** claimed that, *"it is only possible to conduct feasibility studies properly, as the industry does not have a sample with required experience"*. Therefore, it is difficult to pick up a good sample from the industry to work upon high-level management theories. The cases further stated that the theories, which are at the high-end, would not be applicable to local industry. Hence, the applied research for global industry may still be pure research for the local industry.

The experts further stressed that **the scale of the industry** matters, when moving ahead with global research focus. This is an issue for the local industry since it is small and not much developed. Sometimes academics' progress gets hindered due to this barrier, as the industry is at basic level, when it comes to management practices. Besides, the experts claim that the **research needs to be marketable**, irrespective of the fact, whether the research is with the global focus or not.

Therefore, the researchers should shape the identified global research focus into the face of the problem of the local industry to bring innovation through **localised versions of new developments**. Further, **AE1-CM** and **AE3-CD** uncovered another appearance of the issue, as following the global focus all the time may possibly **deviate the academics from their subject expertise**. That will lead to loss of trust and interest from the industry, as the research outcome may not be much useful. Further, the industry may doubt about the researcher's capacity in finding solutions for some issues, beyond his/her subject expertise.

Hence, the researchers should check the industry need before setting the research problem. However, it is good to bring on new developments in the global context, but the research should serve the local needs also. Apart from this 'think global-act local' challenge, academics are required to develop research, which can make quick impacts on industry. The next section discusses the necessities of such research in detail.

Developing research with visible industry impacts

Obtaining interest of the industry to disseminate the research outcomes is identified as a challenge for academic researchers, as the impact of the research is claimed to be invisible for long periods from the application. The methods used by successful research disseminators in developing research with visible, industry impacts are discussed below.

All experts stated that moving into **collaborative research** makes opportunity to create visible research impacts. Besides, **AE1-CM** positively stated that, *"the industry is ready and willing to cooperate, if the research outcomes reach them and, if worthy to adopt"*. ***Industry links*** of the academics are important in obtaining industry interest. The experts emphasised that the academics with personal industry links get a better chance of disseminating research outcome to the industry. Thus, throughout the time, the academics should maintain an active relationship with the industry. **AE1-CM** and **AE3-CD** mentioned that having a good ***research profile*** created through high quality publications would attract industry interest and the industry may request research support from particular affiliations. Further, it was stated that publications create interest of the industry towards further funded research, which was personally experienced by **AE1-CM**. Moreover, applying for research bids would allow industry to identify the academic researchers' research capability. **AE1-CM** and **AE3-CD** were with such experience.

According to the experts' views, ***publicity upon the research capacity of the university*** is important. **AE1-CM** and **AE3-CD** stated that, publicity on university research capacity is essential for the industry to know the academic's caliber. **AE1-CM** and **AE3-CD** stated the necessity for ***university support,*** when moving towards a research culture, based on research projects. However, for highly specific projects, the industry funders may keep the intellectual rights with them. Hence, the experts emphasised that the industry-funded research may require ***agreements*** upon publications.

All the experts proposed that the research issues must be **real world problems** for successful dissemination. In parallel, **AE3-CD** mentioned that, there is no issue with the industry acceptance of research, if the academics do market oriented research. Industry corporate enthusiastically, if the academia is in the correct line of research.

Moreover, the experts accentuated the need for **proactive researching,** when coping with an industry such as construction. **AE1-CM** and **AE3-CD** further explained the background stating that, the industry is traditional and they operate in a way familiar to them. However, there are instances, where the industry is interested in researching. Hence, when the industry has issues that cannot be solved by them, the proactive researchers can assist the industry.

Further, it was claimed that the construction industry is not being much innovative; however, they follow the trends. Therefore, if researchers can introduce innovations to a single point, it would spread over the industry. Since proactive thinking is rare in the industry, the academic should take the lead. Still, R&D is a less priority of the industry; hence, academics being proactive are necessary to lead innovative developments of the construction management. Proactive research has a high caliber to attract industry sponsorships.

Apart from gaining the industry interest, obtaining resources for research is a challenge for academia. The next section presents discussions under such challenges.

Obtaining resources for research

Obtaining resources required for research were identified as a major challenge faced by the academics. Therefore, the cases were inquired upon the possible ways and means of acquiring resources for research. **AE1-CM** highlights the importance as; a good research needs a good student which in turn necessitates a good payment. In addition, it requires modern resources for the research; even the publications need money. Acquiring the resources is, therefore, a real issue for academic researchers at present.

All the experts acknowledged the use of **university resources, and grants** for research requirements. However, university resources can be used only for research projects, which are undertaken via the university. University research grants are also available for academic researchers. In such case, the researcher has to show the outcome and the research needs to be completed within the given period. Moreover, **AE1-CM** and **AE2-CE** highlighted the possibility of collaborating among departments to share resources, if necessary. Moreover, **AE1-CM** stressed the need of healthy university stiffen for PhD research students to attract good students.

All the experts acknowledged the use of **industry sponsorships** for research purposes. When researching upon an issue specific to a particular company, such research are funded by the beneficiary. Further, **AE1-CM** explained such situations by stating, *"when a research project is obtained via a bid, the research bid includes all the expenses, hence the sponsoring company bears the costs in such case"*. However, industry links matter in obtaining such sponsorships. Yet, market oriented research has a high caliber to attract funding from the industry. Therefore, as per all the experts, ***profile of the academic*** matters in attracting resources for research. Even to employ good research students, academics need to have a good profile. Industry collaborations are important to secure the future of research students.

In case of collaborative research, supervisors can work on increasing the student payment via extracting money from the industry, as a reward for the student's efforts through proper ***agreements***. **AE2-CE** and **AE3-CD** further stated that consultancy fee can be converted into a research sponsorship, if the academic is interested, generous, and smart. In such case, fee obtainable for a consultancy work will be interchanged for a research student payment, where the student will get the opportunity to work as a part of the particular company, to obtain data. There, the issue of the consultancy needs to be converted into a research issue by the academic.

When such relationships are created, the industry may extend further assistance such as, buying necessary equipment for the research. The company will receive the benefit of testing and the researcher will get data leading to win-win situations. According to **AE1-CM,** development of regulations inside agreements is necessary to secure the return on research investment. Obtaining long-term research students for PhDs is risky, as some students may leave without completing the research. Therefore, regulations need to assure that the student does not leave unless for a reasonable reason, or else he/she may have to pay the loss created by incomplete research.

All three (03) cases emphasised that the ***marketable research output*** has the caliber to acquire resources for research itself. Therefore, **AE2-CE** suggests that the research output needs to be developed into a format, which can be directly used by the industry. The absence of this step makes industry to lose interest in sponsoring research. Moreover, **AE2-CE** and **AE3-CD** use grants of research institutions such as; National Research Council (NRC) and National Science Foundation (NSF).

Hence, the discussions lead to identify many research resources sources, which can be obtained by enthusiastic academic researchers.

Therefore, the experts have come up with possible mechanisms to overcome the barriers, as discussed. Figure 5.10 displays the suggestions in a summarised format through a mind-map created based on the discussions.

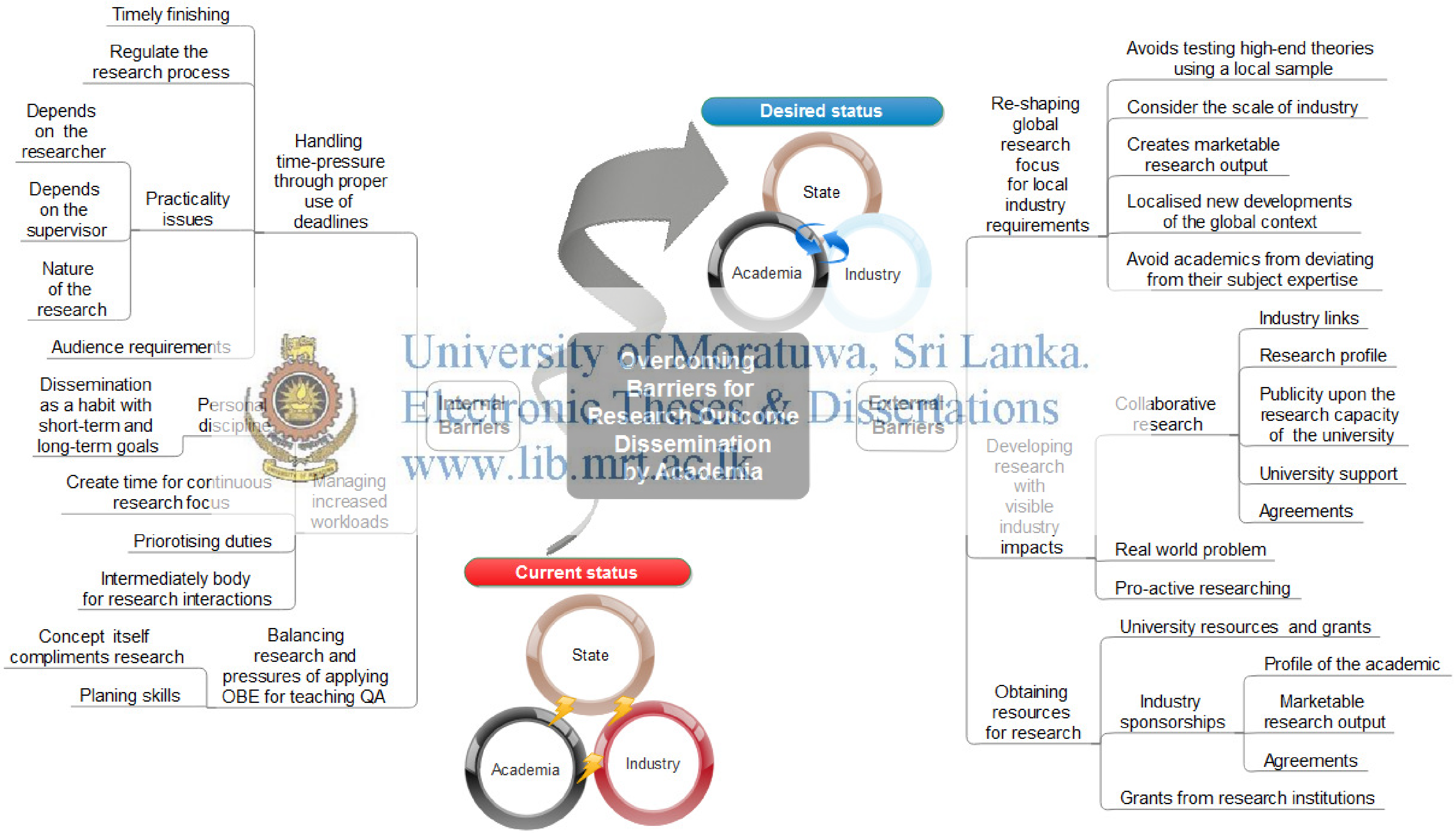


Figure 5.10: Overcoming Barriers for the Academia

The suggested actions will dissolve barriers for the industry and academia in research utilisation and dissemination. Further, the study has revealed CSFs for the merge. Therefore, the next section of the research presents the discussions in terms of development of such CSFs.

5.3.5 Success factors of research knowledge utilisation for industry

Success factors were identified in the Phase I, to be implemented by the industry and academia separately, and collaboratively. This section presents the success factors, to be implemented by the industry in detail. The discussions are presented in two (02) subsections as success factors to be implemented as organisations/individuals and as an industry.

a. Success Factors to be Implemented as Organisations/Individuals

The most influential success factors to be implemented as organisations were identified as; serving opportunities for employees to be exposed to innovations, developing a mechanism to identify important innovative management practices, and increasing senior management's awareness on benefits of innovations. Therefore, the main success factors identified in Phase I (refer Table 4.12) lead to develop many actionable CSFs, and the node structure developed in terms of the discussion is presented in Figure 5.11.

- a. Success factors to be implemented as individual organisations, practitioners
  - a. Serving opportunities for employees to be exposed to innovations
    - a. Training and development
      - a. Participation for seminars, courses etc.
        - a. Funds
        - b. Leave
      - b. Exposure to innovative adoptions
        - a. Overall work experience
    - b. R&D unit
    - c. Promote and support innovative moves
  - b. Mechanism to identify important innovative management practices
    - a. Meetings
      - a. Brainstorming between the directors
      - b. Project managers meeting
      - c. Informal discussions
    - b. Company reviews
      - a. Issues in the practice
        - a. Assigned teams
      - b. Remedial measures taken by the other units.
      - c. Reviewing industry developments and new trends
      - d. QA practices
      - e. Audits
    - c. Training and development division input
  - c. Senior management assistance for innovations
    - a. Reviews industry development
    - b. Pro-active thinking
    - c. Active relationships with the academia
    - d. Experienced on innovations
    - e. Setting goals for innovations
      - a. Takes calculated risks
      - b. Flexibility for changes
      - c. Allocate necessary funds

Figure 5.11: Node Structure of the Theme 'Success Factors to be implemented as Industry Organisations/practitioners'

Serving opportunities for employees to be exposed to innovations

The cases were inquired upon the opportunities that organisations provide to the employees to get exposed to innovations. The facts revealed are discussed herein.

All three (03) cases mentioned the **training manager's service** under which, employees are selected and sent to ***participate in seminars and similar knowledge disseminating arrangements***. Training and development acts as a task of the human resource management unit. In **case 03*,*** the employees are encouraged to participate in short courses conducted by universities and professional bodies. Moreover, **CS1-1** and **CS2-2** stated upon the allocation of *funds* for research-related activities of employees. The organisation funds for higher studies, seminars, CPDs, short courses, and annual fees of the professional institution memberships for the employees. Further, the organisations grants *leave* for higher studies, seminars, and CPDs participation.

Moreover, the respondents mentioned that the innovative companies provide employees ***exposure to innovation adoptions***. Further, in **case 01**, with the changes such as ERP system implementation, the organisation trains employees to make them armed with new development. The employees are provided annual trainings to make them capable of performing as company requirements. Further, safety manager handle OSHA related issues in **case 03**. Similarly, for new innovative practices, a manager would be appointed for maintenance activities. Hence, **CS2-3** mentioned, *"employees need to receive an overall work experience, but should not be kept framed for a long time, as it will fade the innovativeness of them"*.

Further, all three (03) cases claimed the importance of **R&D units**. There are proposals to establish R&D units for **case 02** and **case 03**. Moreover, **case 01** is highly interested in innovative people and **promotes and supports innovative moves** of employees. Hence, if any employee is enthusiastically trying new things, the company gives fullest support for the employee to proceed. This leads to personal developments of the employees and for the overall development of the company.

Hence, the innovative companies identify the significance of exposing employees for knowledge dissemination occasions. Additionally, the cases were further inquired upon the identification of innovation opportunities and the discussions are presented in the next section.

Mechanism to identify important innovative management practices

As the second question under the section, the cases were inquired upon the mechanisms of identifying innovation opportunities at organisations. The answers given are presented herein.

Frequent **meetings** between the directors will lead to develop an updated picture of the company, which allows detecting issues and required changes more clearly. Consequently, **case 01** and **case 02** interviewees mentioned feedback from monthly meetings lead to identify needs of innovations. Further, **CS1-4** stated that, the monthly meetings create space for employees at any level to come up with new ideas for improvements. Company encourages such proposals and if feasible, the proposals will convert into action plans. Moreover, if the progress is good, the units are requested for value-engineering proposals at **case 01**.

In **case 01**, ***brainstorming among the directors*** leads to identify innovation opportunities. There are different directors such as; business director, technical director, and development director, appointed within **case 01** company profile to identify issues in different areas. Brainstorming among directors leads to identify the need of changes, where necessary. However, **CS1-1** mentioned that, *"this kind of practice would be challenging for a smaller company with a small director board"*.

In addition, all three (03) cases stated that project managers can report on such innovation opportunities at monthly ***project managers' meeting***. Moreover, **case 01** interviewees suggest that ***informal discussions*** sometimes able to be the starting point of innovations.

As per **case 01** and **case 02** interviewees, **company reviews** allow identifying issues with the management practices. However, **case 01** interviewees stated that the companies are somewhat poor in this regard. Therefore, individual company reviews by researchers to find issues will be highly useful. **Case 01** and **case 02** interviewees explained of ***issues in the practice*** disturbing company's innovative movements. Moreover, **case 01** interviewees explained that the small companies identify issues, when the issue has developed into the level that it affects the financial stability of the company. Therefore, innovations are inevitable thereon. Further, **case 02** *assigns persons/teams* to study and learn newly identified good practices/tools/systems in solving existing issues.

Remedial measures taken by the other units also provoke thoughts. Since **case 01** keeps the company situation open to all employees; it allows understanding common problems and remedial measures taken by other units. In addition, ***reviewing industry developments and new trends*** leads to initiate innovative changes. **Case 01** interviewees stated that ***QA practices*** might lead to understanding opportunities and requirements for innovative changes. In **case 01**, ISO - QA process guides identifying grey areas of the company management. Further, the annual external ***auditing*** process reveals company's financial related development requirements in such a way.

In **case 02**, **training and development division** seeks opportunities for employee knowledge development, which, sometimes lead to innovations.

Hence, the discussions revealed several mechanisms an organisation can use in identifying opportunities for innovations. Further, the cases were inquired upon the role of senior management in assisting innovations within organisations. The next section presents the findings.

Senior management assistance for innovations

All three (03) cases suggested having an enthusiastic top management, who **reviews industry development** frequently, as a plus factor for innovative development. Moreover, leading companies need to be innovative, as the low profile companies will follow them in due course. In **case 01**, management searches feasible construction innovations. **CS1-1** explained the situation by stating, *"if we find something with a visible potential it will be implemented and taken forward thereon"*.

All three (03) cases suggest senior management needs to have a **proactive thinking habit** to assist an innovative management practice. Further, **case 01** and **case 03** interviewees stated seniors of an industry should create more **active relationships**

with the academia, to keep updated on knowledge development. It will help in capacity building toward collaborative researching with the academics. **Case 03** interviewees further mentioned that, mostly the companies are managed by experience based decisions. Hence, the senior management should need to widen their minds to probe into the existing knowledge levels. Hence, the senior management need to be **well-experienced**.

Case 02 interviewees further suggested, senior management should **set long term and short term goals** considering the opportunities for innovations. Therefore, according to **case 01** and **case 02** interviewees, the organisation management must be ready to ***take calculated risks*** and commend ***flexibility for changes,*** as a necessity. In **case 01**, within the company, units enjoy a high level of freedom to operate and achieve success. That allows unit to be innovative, if they are interested. Such flexible management styles, therefore, promote necessary innovations. However, different organisations have different management styles, and even within the same group, different units practice different management styles. Yet, the level of autonomy with a unit matters in adopting innovations. Therefore, the management need to be suitably flexible to allow sufficient freedom to a unit upon its own development efforts. Moreover, case 01 interviewees stated that, management should be prepared to ***allocate necessary funds*** for the innovations.

Therefore, the study suggests that management should owe a broader vision and dedication for continuous improvement through innovations. It requires patience, as such management deviations take time to show results. Hence, the findings confirmed the utmost importance of senior management's role in being innovative, as a company.

The next section presents the expert views on implementation of success factors into the construction management system as an industry.

b. Success Factors - To be Implemented as an Industry

The most influential success factors to be implemented as an industry were identified as; creating networks with other/foreign industries to collaborate in developing construction management skills, developing approaches to promote R&D, and including research soundness into job-descriptions to develop an innovative work force (refer Table 4.13). Therefore, the explorations of main success factors in Phase II lead to propose many actionable CSFs and the node structure developed in terms of the discussion is presented in Figure 5.12.

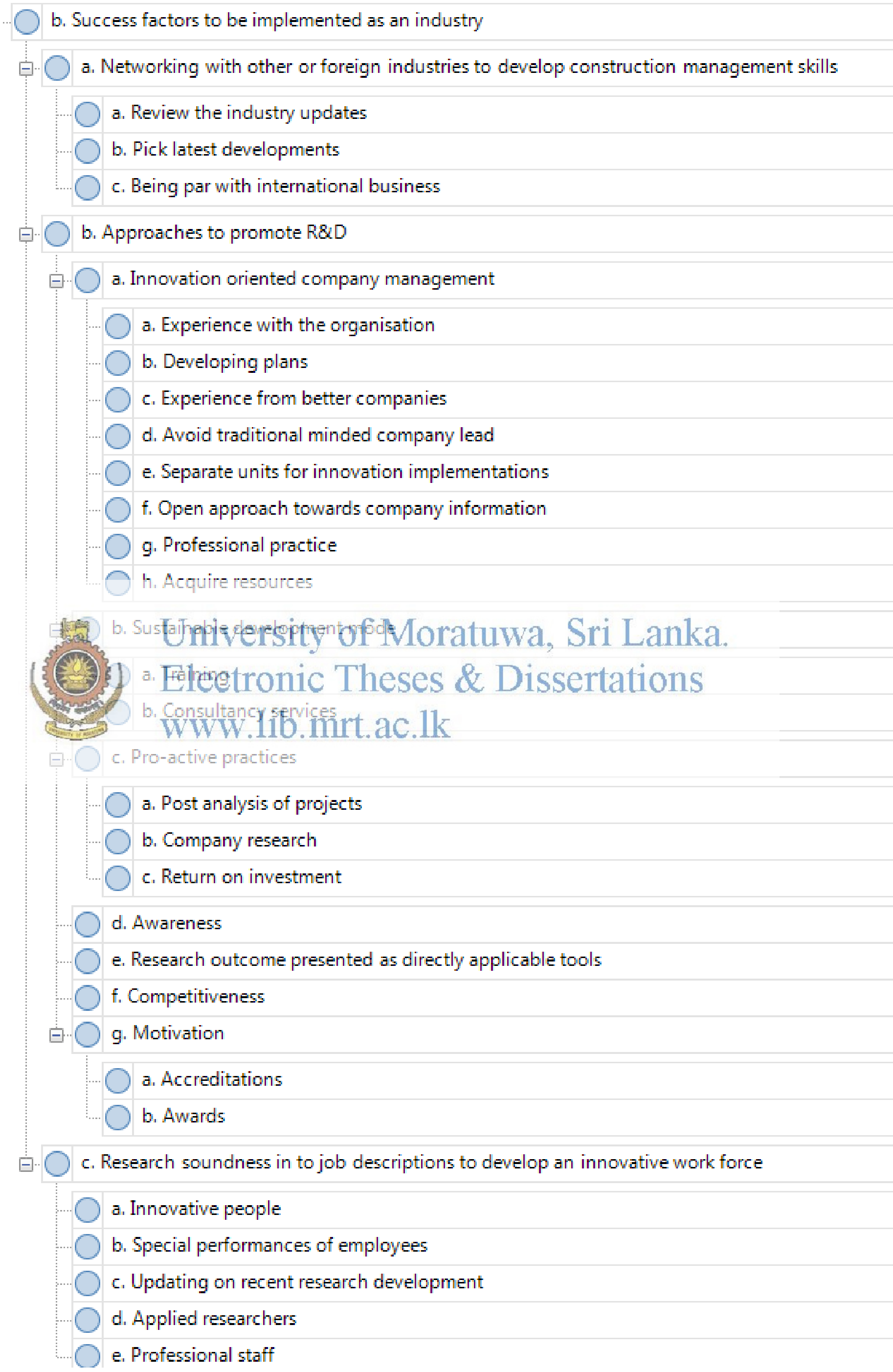


Figure 5.12: Node Structure of the Theme 'Success Factors to be implemented as an Industry'

Networking with other/foreign industries to develop construction management skills

All three (03) cases accepted the significance of networking with other/foreign industries to collaborate in developing construction management skills. **Case 02** and **case 03** identify this step to be very useful and frequently practised at respective companies. Therefore, at **case 02** and **case 03***,* top management always **review the industry updates** and tries to bring on new developments into the company. Moreover, **CS1-1** stated that, *“when the industry develops, companies follow successful innovations happening in the subordinate companies”*. As such, SAP in data processing project implementation at **case 01** has been followed by other companies and further, 'horizontal drilling' was introduced to the local industry by **case 01**.

It is important to have a good knowledge and a global network to **pick latest developments** in the sector. Similarly, 'soil nailing' is identified as a technique with monopoly inside the local industry, and **case 01** has brought it up to the level of a new business.

Case 03 has originated with a Japanese company, thus, the international practice integrates with management practice. Such basis is a highly positive point for the company to be innovative. Since, the company is in **international business, case 03** needs to keep up in-line with the international standards. Hence, such relationships lead local companies to be innovative and updated. In addition, operating in international projects allows learning new practices. The company adopted such innovative practices, when it brings good returns. Besides, **CS1-2** stated that, *“like ISO has become a general practice as the whole industry has gone for it, innovativeness also will spread, if the companies are in a proper network with foreign innovative industries”.*

Hence, the cases consider networking with other/foreign industries as a plus factor and suggest many positive returns. The next section presents the discussions upon possible approaches for promoting R&D within the construction industry.

Approaches to promote R&D

According to the experts, **innovation oriented company management** is critical in becoming innovative. **Case 01** operating as a bunch of subunits with self-financial responsibilities allows the company to be more innovative. **Case 02** and **case 03** interviewees mentioned that, the management team should be highly experienced and possess current knowledge developments in the field. Further, **case 03** interviewees stated that, the paperwork alone is inadequate for a person to perform at management level.

According to **case 02** and **case 03** interviewees, ***experience with the particular organisation*** matters, when it comes to construction management developments. Further, **case 02** interviewees mentioned that, the knowledge developers must work closely with the construction organisation for long periods, when implementing innovative changes. Therefore, persons at the top must be smart enough to ***develop plans*** that encourage innovative changes. Further, the initial planning is present at **case 02** with project-based management. Moreover, ***experience from better companies*** will add value to the new company, as the knowledge is mostly transferred to an organisation via people. However, experience may sometimes miss-match with the company need, as different companies' needs of innovative changes are diffident. Further, **case 01** and **case 02** interviewees highlighted the need of ***avoiding traditional minded company lead***. Otherwise, the innovative people will be in trouble since there would be a huge resistance to change.

According to **case 01** and **case 02** interviewees, establishing ***separate units*** to work on adopting innovative management practices are also important. In **case 01,** a separate unit was created to handle implementation of ERP system. In addition, **case 02**'s ***open approach towards company information*** allows employees to suggest solutions for company issues. Some employees do small research themselves to solve company issues. In addition, **CS1-2** stated the need of a dynamic staff, who corporate loyally to reach company goals. Further, the company need to support innovative ideas coming from the employees, and complement each other. Moreover, **CS2-2** stated that, the industry needs to understand the importance of ***professional practice***. At present, value addition is there for companies with research inputs flowing in via professionals. Yet, the industry has not recognised it. In addition, **CS1-3** pointed the need to plan for ***acquiring necessary resources*** for innovations.

Further, **case 01** and **case 03** interviewees urged the need of companies shifting from the survival mode to a **sustainable development mode**. **CS3-1** mentioned that, value-engineering practice also to support sustainable development. **Case 01** searches recognition through innovative solutions. A company's concern for long-term survival and being a brand within the industry leads to innovations. For instance, the company has applied for CIDA recognition for 'soil nailing' technology application, as an innovative solution. **CS2-1** further mentioned the importance of ***training employees*** based on the experience of ERP system implementation in sustaining the industry innovations. Further, a training manager is appointed by the company to find opportunities offered by the stakeholders for the employees to develop their knowledge. In addition, **CS2-1** mentioned the need of ***consulting services*** in guiding sustainable innovation adoptions. In **case 02**, a consultant was appointed to assist on ERP system implementation as such.

In addition, **case 01** and **case 03** interviewees emphasized **proactive practices** as an essential in becoming innovative. Moreover, proactive decision-making is present at **case 03**. Risk analysis also happens together with issue predictions, which have helped the company to be innovative. However, as per **case 01** interviewees, company alone steered developments are mostly reactive and solutions are fine-tuned only after several failures, due to lack of proper researching knowledge. Further, the industry operates in an imperial way, handling daily issues. This practice often leads companies to stagnate.

According to **case 01** interviewees, ***post analysis of projects*** via discussions also allows finding better answers for possible future issues for the company.

Moreover, **case 01** company structure promotes ***research within the company*** to solve issues and to find best practices to take and edge, which give a competitive advantage over other companies. In **case 03**, even within the company, unofficial research efforts attempt to manage unit cost, leading to maintain positive cash flows. **CS3-2** mentioned friendly units as a better approach over hierarchical structures for innovative developments. Further, **CS1-4** stated that, *“organisations should give freedom to the units to find required innovative projects by themselves, and let the units to bear the results”*. Further, **case 01** encourages company research. In **case 01**, there are various divisions under a single unit, which support sustainable development of the unit. Divisions do research to solve problems and to save costs, even by developing machinery and tools.

The ***return on investment*** also matters, and thus, **CS1-3** explained the need of reviewing innovation investments closely and unsuccessful initiatives demands remedial actions. Further, it is important to attempt to convert innovations into business. In **case 01**, the company converts innovations into business, if the innovations are successful, which brings direct monitory profit for the company. Further, **case 02** searches for new business opportunities, even though the new opportunities need innovations to happen within the company. Implementation of ‘soil nailing’ is a good example. Further, the company keeps an eye on quality of the innovations ensuing within the company. Company is interested in maintaining the quality of innovations. For an example, the 'Geo lab' has obtained a certification for testing facilities provided by the lab.

Moreover, **CS2-1** and **CS1-3** highlighted the fact that **awareness** upon innovative developments is less with construction companies. Hence, **CS2-1** suggested that, the knowledge creators should make the organisations aware about new developments. **CS1-2** further mentioned that, the academics should convey the findings to the industry. **Case 03** try outs available new developments in the field as packages. Moreover, **case 01** and **case 03** interviewees highlighted the importance of **directly applicable research tools**. Hence, the knowledge needs to be delivered in a processed, user-friendly mode, but not as raw knowledge. Further, **case 03** interviewees suggested that **competitiveness** leads following industry innovations to be in competition.

Finally, **CS1-3** highlighted the importance of **motivation**. Organisations should create an environment for employees to feel as part of the company. This makes employees interested in performing research and creating innovations for betterment of the company. Additionally, **CS3-2** mentioned of providing ***accreditations*** motivates industry, leading to better practices. Moreover, **case 01** tries to receive ***awards*** from the CIDA. This may be giving the company self-satisfaction for being a highly dynamic company. In such case, company makes plans from the initiating onwards. When, **case 01** implement a new practice, that is expected to receive awards, the company informs the regulatory body at the beginning itself. They keep records on the development of the new practice and this is a rarely seen proactive practice at the local industry.

Hence, the discussions lead to identify many approaches towards promoting R&D within the construction industry. The next section discusses the influences of integrating research soundness into job descriptions.

Research soundness in to job descriptions to develop an innovative work force

It was inquired whether it would be helpful to have research soundness in job descriptions as an industry practice, to develop an innovative workforce. All three (03) cases agreed the suggestion as a good move since it would promote construction **practitioners to be innovative**.

Yet, **case 01** practice is to study job candidate closely to understand the interviewee in deeper, so the panel can decide whether the new person is able to fit-in to the company. The practice has helped **case 01** to gain current top position from the starting point of a labour supply company. Moreover, **case 01** considers staff as the company's main competency. Therefore, the suggested move would be able to add value to the company. Besides, all three (03) cases stated that the companies are interested in any **special performance** of employees. Hence, **CS2-1** mentioned, any special performance in the field of research would add marks to the interviewee at the job interviews. Further, **case 03** searches for the strengths of the interviewees in terms of openness to change. As the company has an innovative mode, it is necessary to recruit employees, who can support the processes.

Moreover, **case 01** is interested in recruiting people with knowledge of **recent research developments**. **CS2-2** explained that, *"not much earlier, but nowadays, the knowledge upon recent areas like sustainability is checked"*.

In addition, **case 02** is interested in **applied research** performed by the job candidates. If the new recruits have conducted some practically applicable research, it would benefit the organisation (e.g. construction managers with sound research knowledge in the field of site management). Such capabilities are identified as plus points for the interviewee. Further, **case 03** is interested in a **professional staff,** therefore, **case 03** would welcome the action.

Therefore the discussions have revealed a detailed view upon the success factors for the industry in merging with the academic research. Figure 5.13 presents a summary of the views provided by the three (03) cases displayed as a mind-map.

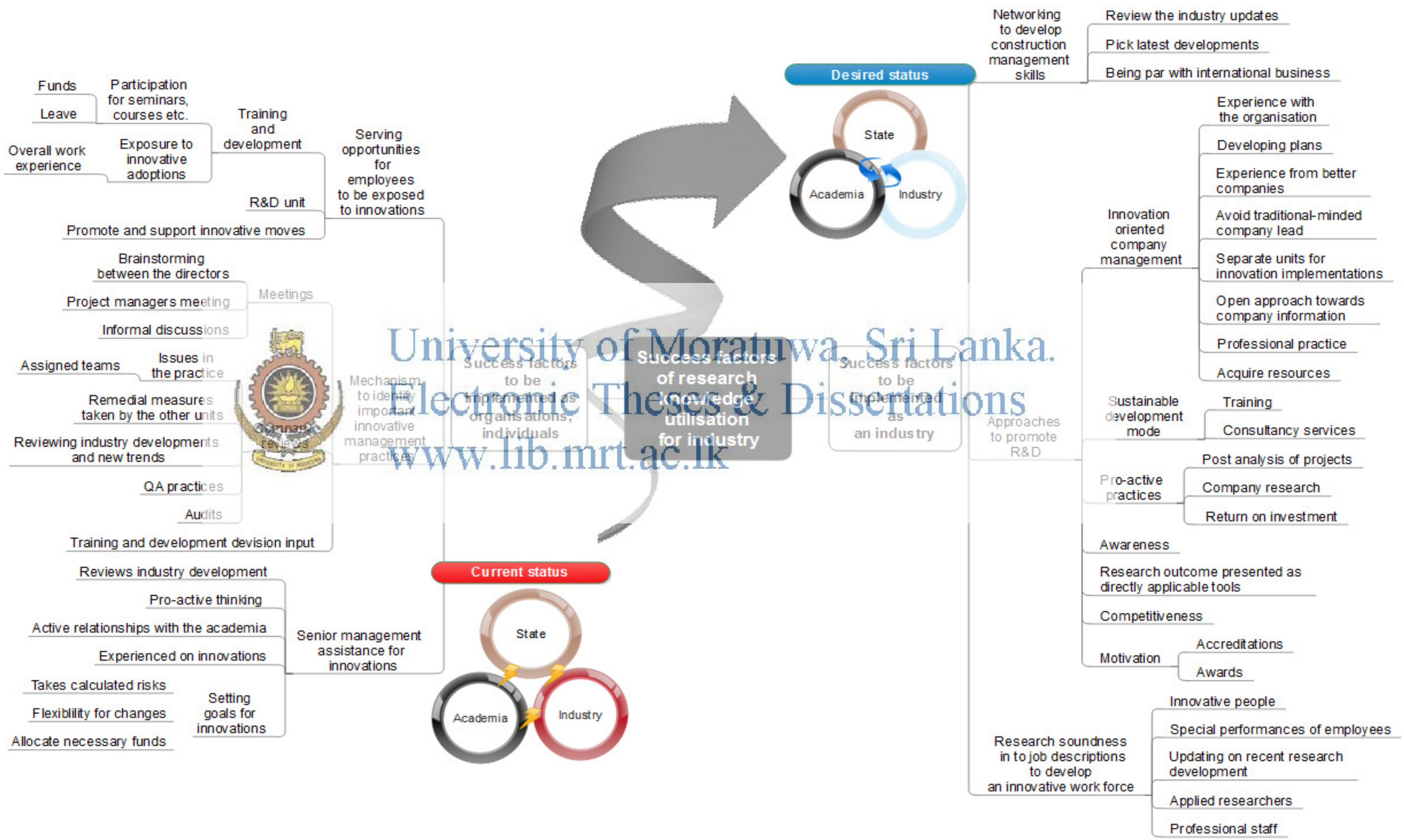


Figure 5.13: Success Factors for Construction Industry in Utilising Research Knowledge

5.3.6 Success factors of research knowledge dissemination for the academia

This section presents success factors to be implemented by the academia in conducting research with the intention of disseminating to the industry. The discussions are presented in three (03) subsections as; success factors of research initiation, execution, and dissemination. The discussions upon the success factors were developed based on the node structure presented in Figure 5.14.

Figure 5.14: Node Structure of the Theme 'Success Factors of Research Dissemination by Academia'

a. Success Factors of Research Initiation

The most influential success factors of research initiation were identified as; establishing networks of research expertise, developing dissemination plans, and selecting more of applied research as per the results of Phase I of the data collection and analysis (refer Table 4.9). The discussions upon the applicability of suggested success factors are presented herein.

Establish networks of expertise on research

The experts were inquired about the possible value addition of having the support of a network of expertise at the initial stage of a research for active knowledge sharing between academia and industry. The retorts by the academics are discussed below.

All the experts agreed that the involvement of network of expertise brings strong **recognition** to the research, researchers, and to the affiliation. Further, **AE1-CM** stated that, *"high citation numbers can be achieved via such moves. It is good for the country and to the institution"*. Moreover, **AE3-CD** mentioned, high level research, such as PhDs need to be linked to global expertise, to provide a good exposure to the local students. However, such links cannot be established by the student, but requires assistance from the affiliation. The experts also stated that ***dissemination is easier*** with a link to a network of expertise and ***better publications*** would be created.

Importantly, **AE1-CM** and **AE3-CD** pointed that, such links can provide **access to better resources** for the local researchers. Hence, the experts mentioned it as good to be connected since foreign research institutions initiate many research projects, where locals can contribute in creating knowledge. This is a good opportunity for academics since the resources are provided by the international partner, which are most difficult to acquire locally.

AE1-CM and **AE3-CD** further stated that the guidance and support from a network of expertise will help to **avoid limitations due to the country development level**, where the research is being physically conducted. Therefore, this kind of research would create knowledge, which is not limited by the level of development of the country, and display the global picture of the issue leading to accurate predictions and planning generating ***internationally applicable knowledge***.

Hence, the significance of the suggested success factor in the Phase I was proven by the opinions of the experts exposed in Phase II. The experts were inquired further on the importance of dissemination plans. The responses are reported subsequently.

Dissemination plan into initial academic research proposal

The experts agreed on the value of the suggestions, as the action would lead researchers to conduct **final outcome oriented research**. However, it would not be possible to have a vast amount of details on dissemination actions at the research proposal level. Further, **AE1-CM** and **AE3-CD** stated such kind of requirement would lead researchers to think about the market, for which their research would cater.

However, giving a time frame would be difficult since the nature of the outcome mostly **depends upon the research type**. **AE2-CE** further noted that, *"the research at the end of positivism would be able to make a pre-say at initial stages upon the findings. Yet, with the management research, this will not be feasible"*.

Further, the experts suggested the need of **regulations** to implement as a rule to have a dissemination plan at the initial research proposal level.

Contradictorily to the suggestion, **AE1-CM** and **AE3-CD** have stated that the practical success of the action may **depend upon the researcher**.

Further, the opinions were analysed to understand the importance of moving toward applied research. The findings are presented in the next section.

Conduct more applied research

The experts conveyed that, moving towards applied research would make **easier to disseminate research outcome**. Further, **AE3-CD** explained that, *"too much of pure research is becoming a burden to the sector"*. The high biases towards pure research have led to the current failure of local research dissemination. Further, experts have stated that, it is difficult to **attract funding** for pure research. Therefore, moving towards applied research will resolve the issue of obtaining research resources. In addition, **AE1-CM** and **AE3-CD** highlighted the importance of **validated findings**. The research should reach the stage of validation, as the outcome means to be usable for the industry, when it is applied research. Moreover, **AE2-CE** and **AE3-CD** noted that the **academic's relationship with the industry** is important in initiating applied research. Therefore, academics should aim to develop good industry relationships.

Similarly, the experts were inquired upon the validity of the suggested success factors of research execution. The findings are presented in the next section.

b. Success Factors of Research Execution

Phase I of data collections and analysis revealed the most influential success factors of research execution as relate to ethics, methodology, and research reporting (refer Table 4.10). The discussions upon the three (03) areas with the intention of obtaining detailed explorations on identified success factors are reported herein.

Being ethical in researching

It was suggested that 'ethics' matter in creating value through research in bringing innovations to the construction management practice. The experts suggested that the correct **priority** should be placed upon ethical concerns. **AE1-CM** mentioned that, *"ethics are not given with the correct priority at the moment"*. However, **AE2-CE** states that ethics may matter sometimes, yet, not a highly important factor in the construction context, compared to other disciplines. Further, **AE1-CM** and **AE3-CD** urged the necessity for a proper ethical **agreement** between the afflation and the researcher. Such arrangement can save the parties involved with the research from many unnecessary behavioural troubles.

Therefore, the experts identify the importance of research being ethical for proper dissemination. Further, the expert views were examined upon the research methodology concerns, where the developed discussions are presented in the next section.

Importance of following a clear method based on research methodology

Experts suggested that research with the philosophical stance of **interpretivist, and qualitative research** need to be conducted in the research arena of construction management. The experts further stated that ***case studies*** and ***action research*** as the suitable research methods for an industry such as construction. Moreover, it was explained that, methodological soundness would help to market the research outcome in collaborative research. However, generalised results of positivist-approached research are less useful as the construction companies operate individually with unique management styles. **AE3-CD** mentioned that, *“positivist-approached research will contribute to the general knowledge hub, but will not give a cutting edge to a particular company”*. Therefore, in such a case, companies would not be interested funding, as direct return for the investment is absent.

The experts highlighted the fact that, the research methodology being restricted by **resource constraints** in practical scenario. The experts further explained the situation as, *“funding matters deter selecting strong research methods. Resource limitations matter, when developing a methodology for a research. Quality of the research get affected by the available level of funding, therefore, the local research is being kept at a low profile due to funding issues”*. Moreover, **AE2-CE** and **AE3-CD** stated that the limitations of methods due to funding issues may lead to low chances for dissemination.

Hence, the experts stated that, it is important to follow a sound methodology to create **trust** upon the outcome, which is highly important in disseminating research knowledge.

Further, **AE1-CM** and **AE3-CD** pointed that, the **time bars** may affect selecting a proper methodology. However, the experts argued that the academics need to be practical enough to manage time. Especially in the case of industry linked research, less time is allowed to come up with solutions; therefore, the academics must solve the issue firstly and form the experience into a research later on, managing the time wisely.

Hence, comprehensive knowledge of research methodology was concluded as vital for an academic to conduct research and deliver the output back to the industry. Thereafter, the expert views were examined upon the concerns of research reporting.

User-friendly research reporting

The experts urged the utmost importance of **professional academic writing** in reporting a research without harming its value. Further, the cases confirmed the presence of issues with the writing in terms of ***language skills*** at present. Moreover, the cases suggested establishing a ***linguistic support cloud*** with eligible staff to support report writing, and academic paper writing, which is an essential component for a university. **AE1-CM** further added to the discussion, *"absence of professional academic writing bring a lot of dis-advantages to the academics, especially in terms of dissemination"*. The discussions about the success factors of research execution lead to conversations upon the success factors of research dissemination. The next section presents the arguments brought forward by the experts on such actions in the dissemination stage.

c. Success Factors of Research Dissemination

Out of the suggested success factors for research dissemination; ensuring the availability of research outcome to the target audience, tailoring research outcome to the target audience, and communicating higher-level research to broader communities were identified as the most influential success factors according to Phase I (refer Table 4.10). Therefore, the factors were explored further in terms of requirements in practical implementations. The discussions are presented in the next three (03) sections.

Ensure availability of research outcome to the target audience

Researchers should develop **company specific solutions** via proper research methods**,** which can be directly reverted to relevant companies. **AE1-CM** and **AE3-CD** argued that use of experiments, action research, and case studies, as appropriate to create knowledge, which could be used by specific organisations. However, **AE2-CE** argued stating, *"high end research done using local samples are with very low intergraded value in terms of publications"*. Hence, developing publications will be difficult since the research is structurally weak. Therefore, ***proper sampling*** is important to make research available for the target audience.

In addition, experts suggested moving towards **market oriented research,** which can be easily made available to the target audience.

The experts were further queried about, how to tailor research outcome to a target audiences to influence policy development. The facts presented by the experts are discussed below.

Tailoring research outcome to target audiences in order to influence on policy development

The experts highlighted that achieving the required **research quality** is important to influence the policies. Hence, firstly it needs to solve internal issues with the academic research quality, before influencing upon policies. Further, it was noted that bias research samples should not be used and appropriate sample sizes need to be used in performing such research aiming to influence policies. **AE3-CD** further highlighted the issue by mentioning, *"academic research never reaches the final stage of implementation, which aborts the chances of affecting policies"*.

Moreover, the experts proposed the research knowledge to be developed into **directly applicable outputs,** which can be easily used by the industry.

The experts have accepted the importance of **academic profile,** when aiming to influence on policies, since it is important for academic researchers to develop professional links with construction stakeholders.

Besides, the experts suggested that the interested research academics can **contribute to national policy developers;** locally NIE, where national policy planning research are conducted.

Further, **AE1-CM** and **AE3-CD** have highlighted the possibility of seeking help from an **intermediary body,** if established, to assist researchers in linking with policy developers. Hence, the research management unit can deliver the output to necessary organisations, without making dissemination a burden to the research academics.

Hence, the experts have revealed requirements of tailoring research outcome in contributing to national policies. Moreover, the experts were questioned on the ways and means of delivering research outcome to a broader community. The suggestions are discussed in the next section.

Communicating higher level research outcomes to the broader community

The experts suggested that considering the **industry need** is of utmost importance to deliver the research outcome to the broader community. It was suggested to consider the industry need, when initiating a research. This practice was claimed to be completely absent at current situations. Moreover, **AE2-CE** stated that, *"researchers must have **industry links** to disseminate outcome to the industry"*.

Further, **AE1-CM** and **AE2-CE** highlighted the necessity of **collaborations with the international expertise** in disseminating to a broader community since such collaborations with the international expertise facilitates a broader dissemination.

In addition, **AE1-CM** and **AE3-CD** emphasised the need for using **proper dissemination mechanisms** to reach a broader audience. Publications alone would not serve the needs of dissemination to a broader industry community.

Therefore, the experts' opinions elaborated the identified success factors further and highlighted the practical requirements of implementing the success factors. Figure 5.15 presents the summarised output of the section via a mind-map.

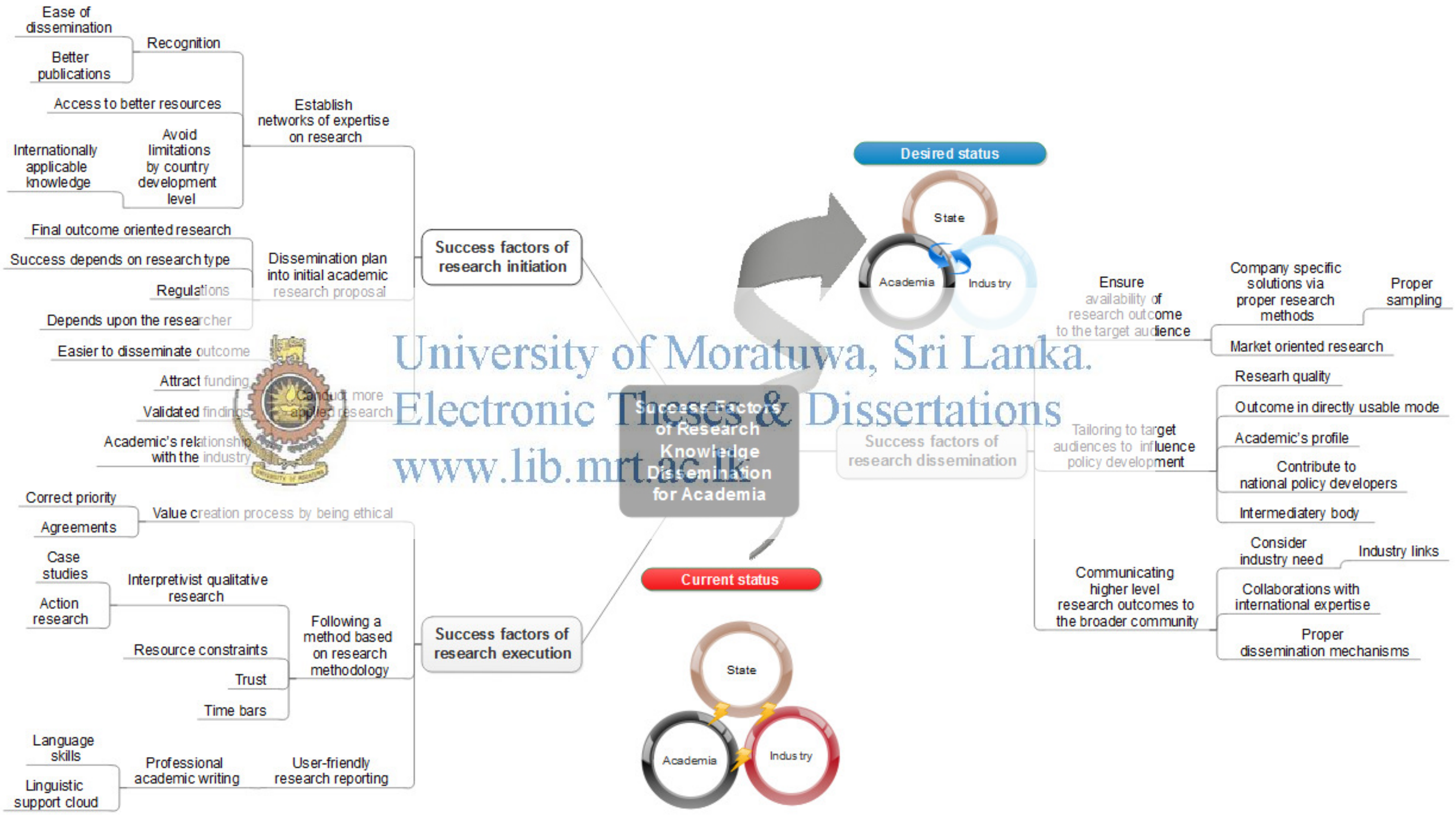


Figure 5.15: Success Factors for Academia

Therefore, as the final stage of the data collection and analysis of Phase II, the academia and the industry were questioned upon the success factors need to be undertaken collaboratively for merging academic research and industry development requirements. The next section presents the findings.

5.3.7 Success factors to be implemented collaboratively by the academia and the industry

This section presents the success factors to be implemented collaboratively by the academia and industry. The discussions are presented in two (02) subsections as; 'industry perspective', and 'academic perspective'.

a. **Success Factors to be implemented Collaboratively – Industry Perspective**

Taking the results of the data analysis Phase I (refer Table 4.15) into further discussions, industry cases were inquired upon suggestions for promoting collaborations with the academia. The industry cases highlighted the necessities of promoting collaborations to link knowledge production to development goals, increasing communication, and creating strategic partnerships. The node structure for the section is presented in Figure 5.16, which forms the basis for analysing three (03) success factors in detail.

Figure 5.16: Node Structure of the Theme ‘Success Factors to be Implemented Collaboratively – Industry Perspective’

Promoting collaborations to link knowledge production to development goals

According to all three (03) cases, **recessions lead to think of survival**; therefore, the innovations become a less priority at such times. Hence, development goals of the country's matters; if the industry reaches recession, interests may deviate towards survival. Further, **case 02** interviewees mentioned the difficulty to focus on innovations, when country's development goals are set away from the construction industry.

Therefore, the government should maintain economic stability, where construction industry can retain in an ***economic boom***. Furthermore, the country's economic development goals matter to **case 02**. It was proposed to establish a R&D unit for the company, but the proposal has collapsed with the change of development directions of the country. Booms get the companies interested in management innovations. Further, **CS2-3** stated that, the need for knowledge sharing appears only with the economic development of the country. Differently, **case 03** does not involve much with the government projects, but focuses more on international projects. Therefore, the government's involvement as a client does not affect much for **case 03**, yet, the stability of the local and global economies are important.

Moreover, **case 01** interviewees mentioned that, when industry is in recession, the management innovations are the first to censor. According to **CS2-1**, *"recessions increase the **risks** hindering innovations"*. Moreover, **CS2-2** stated that small companies will be totally out of interest on innovations at recessions, and ***de-recruitments*** may happen due to recessions. This leads to creating very low attention to the management related innovations at such times.

Further, **case 01** and **case 03** interviewees stated the need of developing a dialog between the industry, academia, and the government for a **sustainable construction management development**. In parallel, **case 03** has participated in the meetings conducted by the ministry to set such goals for the industry.

Hence, the arguments prove the impact of national development goals upon construction management innovations. This urges for industry, academic, and government collaborations to avoid negative impacts upon construction practice, by creating a proper political environment allowing wealth generation for innovations.

Increasing communication

All three (03) cases urged the issue of research outcome **dissemination mechanisms** not matching with the industry requirements. **Case 01** and **case 02** interviewees emphasised the need of considering the ***business background of the companies,*** when delivering research outcome. In addition, the academics, at least, should use the web to deliver outcomes, which may reach the industry. Publications are rarely of interest for the industry practitioners and organisations. Disseminations should be through using ***multi-mechanisms*****,** which are again should be ***user friendly***. Moreover, **CS2-3** stated that, it requires delivering research output in a way that industry can directly apply. Therefore, research outcomes need to be presented as a processed ***marketable*** piece of work. However, the industry would search for ***evidence upon success*** of such innovations.

All industry cases urged the need of **an intermediary body** for research collaborations and stressed that a ***link*** need to be developed in between the academia and industry, which is missing at the moment. **Case 03** interviewees indicated that there is a very poor coordination between the industry and the academia. Therefore, the industry is unaware about the research knowledge generated at the universities. Simultaneously, academics have no idea on what the industry needs are. This gap led to the separation of the two ends, which is currently visible. Hence, a closer link must to be developed so that industry will feel less averse to refer to the universities to solve their problems.

Case 01 and **case 03** interviewees highlighted the importance of conducting ***practically applicable research*** implemented within the actual industry settings. Mostly, the industry considers academic research is not practical to be implemented within the actual industry settings. Hence, **CS2-3** and **CS1-4** highlighted the importance of applied research. Further, **case 03** interviewees stated that, research performed with the purpose of just researching would not be in the interest of the industry. In addition, **case 02** and **case 03** suggested the need for a balance between pure and applied research. Hence, **CS2-2** mentioned that, during the recessions, the industry would not be much cooperative unless the research can help them to survive the recession itself. However, at such times, academics can focus into pure research and that will allow them to have a balance between pure and applied research.

All the three (03) cases stated ***knowledge brokering*** as a good concept in return of the need of an intermediary body. Hence, **case 03** interviewees suggested that, the knowledge brokers can arrange meetings to deliver the completed research outcomes to the industry. Interested companies like **case 01** will send representatives, if an intermediary body is functioning actively. Further, the companies can transfer their research needs via the knowledge brokers.

Further, **CS1-1** and **CS3-2** mentioned that *research needs to start with an industry issue*. If the research issues arise from existing literature, at least it needs to be pilot tested to identify the real form of the issue in the industry practice. Academic research, which generate knowledge, which is not related to industry issues, will be of no interest to the industry. Further, **case 03** interviewees mentioned such research as time wasters since the industry involvement is purely for data supply. Hence, the intermediary body can identify industry issues that academics should research. Hence, CS1-1 suggested, if the academics collaborate more with the industry, the research might get more into real industry needs. Hence, the solutions will be suggested with the knowledge on actual barriers of the industry.

Industry will be very cooperative, especially if the research conduct using *proper research methods.* Hence, the knowledge dissemination will be quite easier and highly effective. Further, **CS3-2** urged the need of research being logical, as much as possible. Further, **CS3-1** explained that, research need to be balanced between technicality and management**.** In addition, **CS3-2** highlighted the importance of using customised research methods, which can attract the interest of engineering minded construction leaders. However, all three (03) cases denied the quantitative research approach.

Case 01 interviewees explained that, the research sampling would not represent industry structure, as the number of companies is less. Even the sampling is performed considering the CIDA grading; huge differences prevail between company managements. Further, the companies operate in different business management styles. There is a high risk of not getting a considerable output from implementing such research outcomes. Further, generalised knowledge is less useful for companies to develop, but would make the competition among companies more severe. Moreover, **CS3-1** mentioned that quantitative research outcomes are in very less use since there is no true operating unit as an industry, but it is an umbrella term given to a set of individually managed units interacting with each other. Hence, **case 03** interviewees suggested case studies and action research, as the more suitable research methods.

The industry and the academics can enter into *strategic partnerships* with the assistance of knowledge broker. The research solutions thereby need to be customised. **CS2-2** and **CS1-3** highlighted the importance of firm specific solutions developed via a proper study. Further, **CS2-1** mentioned the importance of studying a company's system before proposing changes as the ERP system implementation consultants did in **case 01**. **Case 01** interviewees revealed that, the industry mind set is not quite positive upon the academic research into management aspects. Yet, there is a high chance of organisations sponsoring for research in developing strategic partnerships, which would overcome above barriers.

Case 01 and **case 03** interviewees stated that industry ***awareness*** needs to be improved to develop collaborations. Since the local construction market is small, **CS2-1** explained that fewer innovations arrive as a requirement. However, if academics can make the industry aware upon competitive advantages of being innovative, companies would be interested in R&D.

Further, all three (03) cases explained that collaborations can be initiated with **student research** suggesting small developments to the construction companies. In such a case, **case 01** interviewees mentioned that the industry could support in pooling research ideas. Moreover, if students can stay attached to a company while the research is in progress, the knowledge transfer would be highly convenient. Further, the students can use the training period to study an issue and to create a link to collect data on that issue. In addition, **CS3-2** mentioned, such inter-relations might create opportunities for undergraduates to get recruited by the same company. In contrast, **CS3-1** stated that, student research might be of a very low use, as they are unaware of the industry practice.

Yet, all the cases expressed that the research should make a **significant impact**. Since the industry can survive being traditional, research needs to show real impacts to get the systems changed. Nevertheless, **CS2-1** mentioned that in the case of successful organisations, it would not be easy for the academics bring in novelties unless the findings are well established. Moreover, issues that can solve by the experience of management need no research unless, if the research outcome leads to further value addition. However, **case 03** interviewees stated that, no huge resistance arise from the industry for research, yet, the research should be able to add value to the company.

Further, all the cases emphasised the importance of **proactive practices**. Since the research processes are lengthy, if the academics can proactively develop solutions before in hand, industry would be enthusiastic to buy such solutions. However, **CS3-2** explained that the industry as well, needs to be proactive to understand the worth of such research, which would bring solutions/avoidance for future issues.

Further, **CS1-2** stated that it would be important, if the **academics work in the industry**. If academics work in the industry, it may create natural knowledge transfer, as they can help solving even the daily issues in a better research informed manner. According to **CS1-3,** initiating a collaborative research will be easier, if the researchers are high profile academics known in the industry. Such links will gain trust from the industry to attract funding for research. In addition, research knowledge coupled with a consultancy service would be able to fit nicely into construction companies. Moreover, academics would be able to learn from the industry upon the behaviour of theories within actual construction environments creating a win-win situation for both parties.

Complementing the academics' view, **CS1-2** stressed the importance of **ethical research**. Academics need to be ethical in concluding research findings. Researchers sometimes seem to be dishonest, when the conclusions do not reveal the actual situation, where the efforts are made to prove some hypothetical fact, pre-assumed by the researcher. Further, researchers need to be very sceptical to avoid being entrapped in their own assumptions. Therefore, the researchers should be open-minded to accept the truth, irrespective of their original assumptions. The situation matters, if the industry loses trust upon research at the beginning of the merge itself, and will be hard to develop further collaborations.

Finally, to initiating above communications, **CS3-1** urged the need of a ***dialog*** between the academia and the industry by stating; *"a dialog needs to be developed between the industry and the academia, which would lead to create understanding between the parties"*. However, **CS3-2** claimed that, first the academia need to identify the industry capacities and the willingness for innovations.

Further, the cases were inquired upon, how strategic partnerships/formal alliances with academia can help industry in achieving goals, which industry cannot achieve alone. The explanations of the cases are presented here on.

Strategic partnerships/formal alliances with academia

Research experts explained that, strategic partnerships will create a culture of collaborative research. Hence, if innovations bring proper developments, **CS1-4** stated that, they are highly willing to cooperate. The company would provide the full support to bring the partnership into a strong state. Further, **case 01** and **case 03** interviewees urged the need of **agreements** in establishing strategic partnerships. Hence, contract agreements will ensure a smooth relationship during the research period and thereon.

Still, business and legal arrangement will require developing ***trust*** between the parties in ensuring both parties contributing in agreed capacity.

Moreover, ***time frames*** should be defined within such agreements. Academics should be careful in meeting deadlines, as industry operates under tough schedules. Delayed answers would not give any return for companies. Moreover, in case of funded projects, agreements to retain the findings unpublished for an agreed period of time may be preferred.

Case 01 interviewees mentioned that, companies would prefer to have formal agreements, to be more open with the researchers, as the internal data will be secured inside the agreement. **CS1-3** mentioned that**,** *"otherwise it will not be ethical to reveal internal data, since companies have information that cannot keep open as public knowledge"*. Hence, the partnerships will safeguard the ***privacy*** of a company. Unless, companies would not prefer to reveal their success secrets, as it might cause them losses; therefore, the company-inherited knowledge should not make public unless it is identified as harmless.

All three (03) cases mentioned that, the partnerships would help to develop **company specific solutions** after studying the context. Hence, **CS1-2** stated that, this would be good as the different companies have different business arrangements. Therefore, the industry expects academics to conduct research attached to a particular company. Further, **case 01** and **case 02** interviewees stated ***case studies*** and ***action research*** to be more helpful in this scenario.

In addition, **case 01** and **case 02** interviewees pointed out that the strategic partnerships would give **competitive advantage** to companies. **CS3-1** mentioned that, arrangements of this kind would allow companies to solve their issues and keep the knowledge un-published for an agreed period; therefore, the funding company can have a competitive advantage, over other companies. Further, **CS1-3** stated establishments of this kind of relationships will help to avoid pure academics and pure industry practitioners. Each category would learn the values of the other category, developing **hybrid professionals,** who can help each other in a better way. However, **CS1-4** stated that it would be challenging at the beginning, yet, if the efforts are earnest it would be possible to accomplish.

In addition, **case 01** interviewees explained the non-presence of professional approach to work. Hence, these kinds of relationships will bring the professional approach to work, ensuring the **sustainability** of the company. **CS1-1** mentioned, at present the companies just 'drag-on' considering only the survival. There are challenges even for well-established companies. This kind of arrangements will be able to help companies to solve the survival related issues in a more sustainable manner. Moreover, **case 02** interviewees stated that, the partnerships may be able to ***guide industry in recessions***. At present, management innovations only happen, when the industry is in a boom. If researchers can guide industry in recessions to perform over surviving, that would be a considerable value addition.

Further, **CS1-1** stated that, this kind of partnerships with proper dedication from both sides would create **win-win situations**.

Moreover, **case 02** interviewees stated that the partnerships will provide ***better solutions for problems***. **CS1-2** mentioned that, at present, industry practice is to search solutions, when the issue has reached a worst level. Hence, the solutions are chosen while the management panics. Therefore, this kind of partnerships would be able to remove such negative practice. Academics can understand, analyse, and develop solutions more scientifically and to deliver to the company employees in a better way. Hence, the companies would also trust academically researched outcomes, as the academics being the right person to do research and the research execution being methodologically and ethically sound.

Further, **case 01** and **case 02** interviewees stated that the strategic partnerships will *save time and money* for companies by correcting the company operational issues. Hence, case 01 interviewees explained that the current industry practice is more into 'do and learn' oriented. Therefore, proper knowledge transfer can help to reduce the length of the learning cycle of a specific company. This kind of arrangements will help companies to stop re-inventing the wheel by each company, wasting time and money, leading the overall industry's development into a slower pace. Further, **CS1-3** explained of instances, that the experience based decisions taken by the management led to failures. The research informed decisions would give companies better management solutions, but the research out-put need to add value to the company, as construction is a business.

Case 01 and **case 02** interviewees stated that, the practice will lead to ***better publications***. **CS2-3** explained that the process will not disturb publications of the academics. Since the horizontal trends creation, other construction companies would also be requesting the academics to do the same research with different companies, as ERP system implemented following SAP in data processing project. Therefore, the academics can develop better publications, summarising a few case studies generating valid data. Further, the interviewees stated that the partnerships would provide *learning for academics* and **CS2-1** also claimed that it will help researchers to be futuristic in predicting issues. However, according to **CS1-2**, it is better for academics to do different projects with different companies for better research profiles.

Further, **case 01** interviewees suggest that the process will increase the ***standards of research***. **CS3-1** mentioned that the researchers could be attached to companies under this kind of partnerships. Masters research of the industry practitioners can use as a starting point. The quality assurance upon the standard of a Master's thesis needs to be maintained by the academics, so that research would create valuable outputs for the companies they serve at. In addition**, CS1-2** stated that the strategic partnerships will lead to win-win situations for students. Under such partnerships, linking students to companies for researching will give an additional advantage for students to find job opportunities. The industry would also be able to identify graduates with high calibre for recruitment.

Apart from the industry view upon the collaborative success factors, the academia's views were also captured in Phase II. The next session presents the discussions upon the academic expert opinions.

b. Success Factors to be implemented Collaboratively - Academic Perspective

The successful research academics were inquired on collaborative success factors implementation. Data Analysis - Phase I (refer Table 4.14) has identified promoting collaborations to link knowledge to development goals, as the first priority. Further, judging research programmes by industry impact and tangible benefit, and practicing the concept of knowledge brokering were identified to be necessities of research collaborations. The node structure developed by the N-Vivo under this section is presented in Figure 5.17.

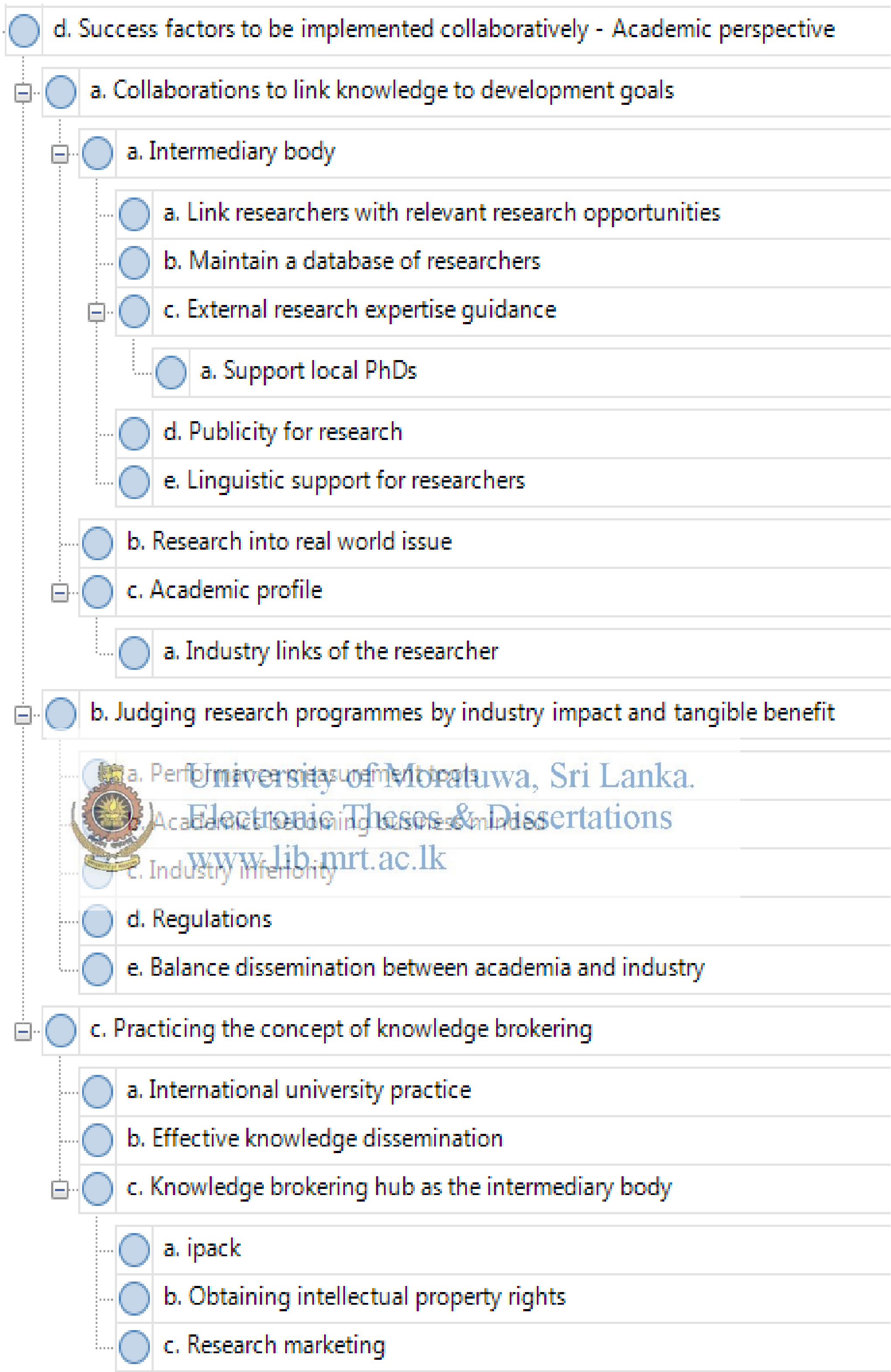


Figure 5.17: Node Structure of the Theme ‘Success Factors to be implemented Collaboratively - Academia’s Perspective’

Collaborations to link knowledge to development goals

Parallel to the suggestions made by the industry, **AE1-CM** and **AE3-CD** stated the utmost importance of an **intermediary body** to manage research interactions between the university and the industry. However, **AE1-CM** claimed that, *"intermediary body must actively engage in the service, unless just establishing 'another centre' will not make any difference from current situation"*. Hence, the mediatory centre should be equipped with a dedicated staff with research capacity. Further, the mediatory centre should have a separate director and staff dedicated for the purpose. If the academics are appointed, their teaching and administrative burdens need to be released allowing them to work on the development of the mediatory centre dedicatedly. Further, transparency should be ensured with the new initiative, or else, it will not give the expected results; as the cases suggested that the favouritisms and biases have led to fail the previous similar efforts.

The intermediary body should ***link researchers with relevant research opportunities*** by reviewing advertised research opportunities and forwarding to relevant academic researchers with the proper research capacity. Further, according to **AE2-CE,** the unit could make links with the industry and identify industry issues. Further, the unit should not allow taking projects by the wrong researchers, who does not process required qualifications. Therefore, the intermediary body can call for proposals from interested academics to select suitable teams for the projects, avoiding the involvement of unqualified academics in terms of the research expertise. The unit should, therefore, maintain a comprehensive ***database of researchers*** comprising updated academic research profiles to connect the industry requirement with the correct academic researcher.

Experts highlighted the edge could be created by ***external research expertise guidance***. Further, **AE1-CM** and **AE3-CD** claimed that existing external research expertise guidance is not active enough. Further the university postgraduate units need to be active in order to give students a better support. Moreover, **AE1-CM** explained that the unit could identify and link the international research expertise to *support local PhD students*. This will not be much difficult, as there are fewer number of PhD students present at local universities. Initial proposal reviews also can be done via such expertise. However, it is required to manage experts in a way that does not make them exhausted. Such links will create opportunities to do high quality publications with the experts and it will create win-win situations for both the parties. The duties of the expert need to be clearly expressed. The university can issue a contributory letter to the external expert to acknowledge the service. However, the letter may not be that strong in validity, as the local universities have not reached higher rankings. Yet, there would be experts willing to collaborate, as a helping hand for less privileged countries. Therefore, the university academics' contacts can use to initiate the process.

Further, the unit should work on ***publicity for research*** and market the service provided by the intermediary body showing the specialisations of the academics, together with the university research capacity. In addition, the unit should give a good publicity upon the completed projects to gain trust from the industry. Further, the research unit can put forward research results to the industry, and find organisations that are willing to allow test-runs for validation of the results. Further, the results could pass over to the relevant organisations in the industry and to the policy development units of the government ministries by the intermediary body. This may trigger industry organisations' interest for further research.

AE1-CM and **AE3-CD** highlighted, since English is a secondary language in the country, it is essential to have ***linguistic support*** for the academics. If the unit can have a selected set of language checkers that can be accessed to when required, it would be really helpful for the academics. However, it will not be possible to recruit such editors due to institutional issues. Yet the establishment can create a cloud of English editors upon the intermediary body, where researchers can access, when required.

Further, all the three (03) cases suggested that the academics should research upon the **real world issues,** which identified from the industry practice. When the research problem is not a real world issue, the dissemination to industry would not happen and the research process stops halfway. Further, it was suggested that academics should conduct research, which helps the local industry to overcome their specific barriers. Moreover, **AE1-CM** and **AE3-CD** suggested using local industry support to get the research problems shaped in the way that the research outcomes can be used by the industry. In addition, **AE2-CE** and **AE3-CD** stated that the researches need to be industry oriented. Further, the research need to be stronger, as to cater a dynamic industry like construction, especially to bring innovations in management. At present, the academic research has not reached the expectations of the industry; therefore, the industry depends on foreign consultancy. Moreover, the academic research needs to go beyond basic research, so that it can help industry to develop. Since the required quality is not met, therefore, there is no trust upon the capacity of the academic research from the industry, at the moment.

According to **AE1-CM** and **AE3-CD**, collaborations will help academics to create industry impact, which will uphold the **profile of the academic**. However, **AE1-CM** mentioned, 'publications' as equally important to develop a strong profile for an academic. All three (03) cases mentioned that the ***industry links of the researcher*** are important, as transferring knowledge to industry needs higher efforts, than just publishing. Finally, **AE2-CE** and **AE3-CD** emphasised that the link between the industry and the academia as missing at the moment. Hence, the suggested intermediary body should be developed to link researchers with the industry as a must in merging academia and the industry.

Further, **AE2-CE** and **AE1-CM** highlighted the importance of dedication and patience**.** Collaborations may take some time to develop into strong relationships; hence, the academics need to have initial dedication and patience. If not, it will move back to the practice of research, done only to fulfil the requirement as **AE2-CE** mentioned. With such characteristics, a newly developed intermediary unit can play an active role to support the merge.

Judging research programmes by industry impact and tangible benefits

Publications being the measurement of research dissemination efforts discourage the academics to create industry impacts via research. Hence, the cases were inquired on the possibility and benefits of measuring research performance based on industry impact. The answers provided are presented below.

Three (03) cases accepted the capacity of the suggested mechanism's to create a positive impact. However, it would be difficult to measure the industry impact and thus, there is a need to find **performance measurement tools** for measuring the impact. **AE2-CE** further mentioned that, in other countries, measuring research performance is based on the income created by researchers via projects. Contradictorily, **AE1-CM** stated that, *"the suggestion is good, but there may be an issue of **academics becoming money minded** with such kind of move"*.

Moreover, **AE2-CE** and **AE1-CM** claimed that this would be difficult, as the **industry is inferior,** therefore, not supportive enough, yet.

Even if it is difficult to initiate the practice; it may improve over the time. However, provided the support of the industry, **regulations** can make an annual research project a mandatory for research academics.

However, **AE1-CM** accepted that there is the need of maintaining a **balanced dissemination between academia and industry**.

Further, the academics were inquired upon the possibility and the benefits of practicing the concept of knowledge brokering. The answers are presented herein.

Practicing the concept of knowledge brokering

Knowledge brokering is an **internationally proven practice**. Moreover, all three (03) cases suggested that the concept would help to deliver the knowledge to a broader community creating **effective knowledge dissemination** practice. Since transferring research outcome to the industry by the researcher is not a mandatory, university may be able to take the responsibility of dissemination via such practice.

Importantly, the foremost suggestion of establishing an **intermediary body** from both academia and industry complements the concept of knowledge brokering. **AE2-CE** and **AE1-CM** agreed with the suggestion and mentioned the presence of such practice at other academic disciplines. **AE2-CE** provided with an example by stating, *"for an example 'Intellectual Property Advisory Committee (**IPAC**)' is currently doing a similar practice up to a certain extent at the university in engineering disciplines, but not in the construction management"*. This is a good move to construction management researchers to follow. Via such practices, university ***obtain***

intellectual property rights together with the researchers and works on ***research marketing*** thereon.

Hence, the cases accepted the suggestion to practice the concept of knowledge brokering as an important step in developing academic and industry interactions. The concept is, therefore, would be helpful in merging academia and the industry.

Therefore, Phase II of data collection and analysis allowed exploring the cases of successful management innovators and successful disseminators. Figure 5.18 presents the explored success factors to be implemented collaboratively by the industry and the academia in the form of a mind-map.

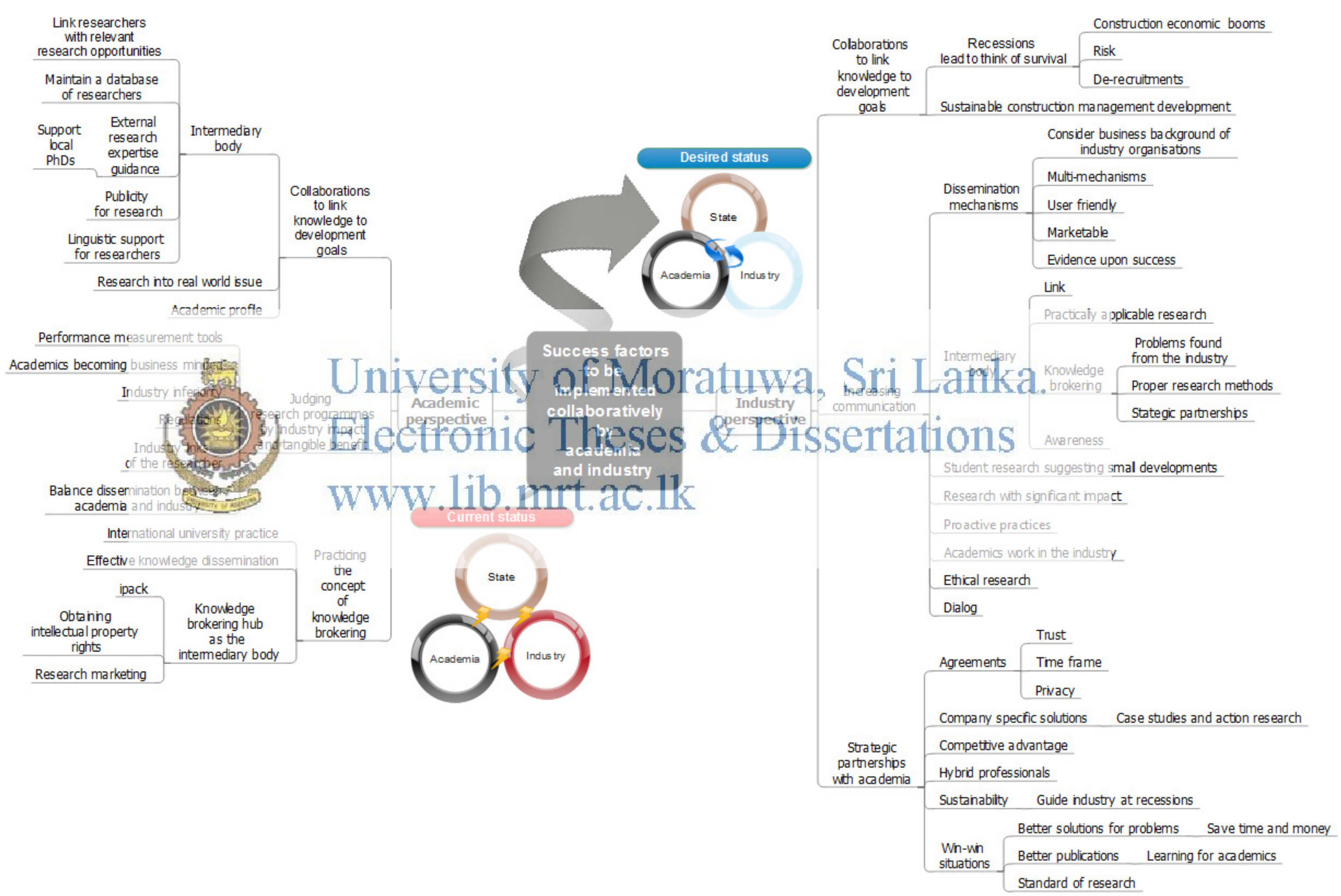


Figure 5.18: Success Factors to be implemented Collaboratively

Hence, the data collection and analysis Phase II explored into the findings of the data collection and analysis Phase I, revealing many possible success factors in generating THM effect in construction industry context. The discussions on the operation of such factors are presented throughout Chapter 5 of the thesis, while summaries are presented via the mind-maps. Hence, the Chapter 5 provides the content for determining the CSFs of merging academic research and industry development requirements for an innovative construction management practice. Therefore, the content data feed into the conceptual framework of the study, was externally validated in determining the CSFs. The process is presented in detail in the next section.

5.4 Validated CSFs for Research Driven Innovations in Construction Management Practice

The findings of the qualitative approached data analysis led to identify many possible CSFs for research driven innovations in construction management practice. However, the initial factors of finally developed CSFs were identified from literature in the form of possible barriers and success factors. Deductive approached Phase I of the study revealed the most influential barriers and success factors through statistical analysis.

The selected factors were, therefore, brought forward to the inductive approached Phase II of the study, and explored in detail. Each question of the interviews conducted within the Phase II lead to develop a few possible CSFs, arose either in the form of a mechanism of overcoming suggested barriers, or mechanism of implementing success factors into the system of research interactions. However, in progressing with the qualitative data analysis, initially increased number of factors were categorised and developed into a cohesive manageable number of CSFs together with the feedback received in validating the data externally.

Hence, the narrative developed based on the emerging patterns of qualitative data analysis was very much aligning with the theoretical suggestions. Therefore, in presenting the CSFs in terms of a model, the underlying mechanisms were developed in parallel to the suggestions of Etzkowitz (2011) and Leydesdorff, (2005), who revealed the stages leading creation of a space for innovations, and the necessary roles of the three (03) contenders in activating a THM.

Yet, a basic model, therefore, was initially developed based on the conceptual framework of the study, including suggested CSFs into major three (03) categories, as; CSFs creating a knowledge space, CSFs creating a consciences space, and CSFs creating an innovation space following the stages of knowledge-based economic development (refer Figure 2.7) as identified by Etzkowitz (2011). The basic model further divided possible CSFs based on respective actionable stakeholders, creating each of the three (03) spaces as per Leydesdorff, (2005)'s suggestions. The developed basic model was validated via expert opinions finalising the CSFs at each space.

The next three (03) sub-sections (5.4.1, 5.4.2 and 5.4.3) present suggested CSF in the form of a discussion in relation to the creations of necessary spaces for innovation, with references to the each contender's role at each space, while final CSFs derived through validation are presented in the respective tables.

5.4.1 CSFs creating a knowledge space

Knowledge space, as per, Etzkowitz (2011), puts the initial foundation for innovations via regional innovation spaces comprising different actors, who would improve local conditions for innovation through R&D related activities. Further, Leydesdorff, (2005) identifies three (03) major actors in THM interactions as; novelty producers, legislative controllers and wealth generators (refer Figure 2.8) creating, knowledge infrastructure, political economy and finally, innovation. Hence, in the studied context, it was emerged from the narratives; university as the novelty producer, government/regulatory bodies as the legislative controllers, and construction industry as the wealth generator, respectively.

Hence, a dialog between the academia, industry and the government/regulatory bodies is fundamental. There are various possible CSFs to be operated between the three (03) parties to the dialog that could be practised thereon. Further, the missing knowledge infrastructure, and political economy at present due to poor efforts from the universities, regulatory bodies, and construction industry could be created through a Knowledge Brokering Hub (KBH), which would host the creation of an innovation space.

Therefore, the universities can contribute to the policy development and in return the government/regulatory bodies can provide funding for the academic research. Industry can give feedback to the government/regulatory bodies in developing policies and in return the government/regulatory bodies can regulate the industry in terms of R&D, establish R&D benchmarks for company upgrading, create motivations, increase awareness, and offer R&D accreditations to the industry.

Further, government/regulatory bodies should play an active role by setting development goals for the construction sector, while bringing in necessary construction projects to the country. The government should keep the economy stable and get connected to construction companies in deciding development requirements. Further the regulatory bodies can act as an intermediately body to increase awareness of the industry upon the value addition of R&D in sector development.

Moreover, construction industry should start solving issues in management practice with a scientific approach and hence, should avoid paradigm discrimination. Further, the industry should manage change resistance and promote value engineering practices. Further, the industry should develop a professional approach to the work and low profile firms should follow leading companies. Hence, industry should promote competitiveness for innovations and, therefore, should switch from survival mode to sustainable development approach. Moreover, the industry should invest in innovations and provide motivation for employees thereby.

Auxiliary, the university should provide the necessary guidance for the academics thorough generating tools to measure industry impact of research and putting up regulations to lead academic research towards industry collaborations via dissemination requirements. The university can bring in regulations to maintain research quality and generate agreements upon research ethics. Further, the academics should need to be provided with the necessary resources and research grants by the university, by allocating enough funds for research. Moreover, the university should establish time frames for research and should reduce administrative burdens from the research academics.

Further, the university should maintain enough staff to avoid overloading the research academics and may mandate vacation leaves for the academics for continuous research focus. Further, the university should maintain agreements with both the research students, and industry researchers to endow necessary guidance, resources, and regulations. Moreover, the university should maintain positive relationships with the international expertise. Hence, the international expertise as well can interact with the research students to generate high quality publications and contribute to upholding the profiles of academia and the student research quality. While at the same time, the university should synchronise with the intermediary body to release academic workload of the mutual staff and to attach staff on vacation leave on a roster to the intermediary body.

Out of the possible CSFs as discussed above, validation screened the final CSFs separately for university, government/regulatory bodies, and construction industry. Hence, Table 5.2 presents the CSFs creating a knowledge space.

Table 5.2: CSFs creating a knowledge space

CSFs creating a knowledge space		
CSFs for Universities	***CSFs for Government /Regulatory Bodies***	***CSFs for Construction Industry***
• Prioritise research in academic job description	• Establish development goals for construction industry	• Avoid research paradigm discrimination
• Provide resources for research	• Include R&D benchmarks into contractor grading criteria	• Manage change resistance
• Provide administrative assistance to Knowledge Brokering Hub (KHB)	• Provide R&D accreditations	• Switch from survival mode to sustainable development mode
• Include industry impact into research performance measurement criteria	• Practice research informed policy development	• Include research soundness into job descriptions
• Standardise research via regulations	• Ensure national research bodies functioning	• Use research to avoid re-inventing the wheels at practice

Therefore, the above presented CSFs will create a knowledge space, providing the base for creation of a consensus space through generated knowledge infrastructure with the compliments of political economy. The next section presents the identification of CSFs creating a consensus space.

5.4.2 CSFs creating a consensus space

Conesus space requires ideas and strategies to be functionalised through Triple helix of multiple reciprocal relationships among institutional sectors (academic, industry, government/regulatory bodies) as per Etzkowitz (2011). Hence, a new role is required in maintaining the corporate responsibility of activated THM, to ensure the sustainability of the consensus space. Though, the new roles of focused research academia and interested construction organisations are available physically, the link in the middle was hypothetical, yet, vital for the completion of the consensus space. Hence, a Knowledge Brokering Hub (KHB) was suggested to be established in parallel with the major suggestion to establish an intermediately body to maintain interactions between the academia and the industry.

It was recommended to bring up the concept of knowledge brokering into practice via the intermediary body. Therefore, the university must initiate a KHB, and with the time, the intermediary body will develop into a self-funded institution via developing strategic partnerships of research, which would lay the flat-form for creation of an innovation space. Yet, KHB should administer under the university guidance.

Hence, KHB at the middle intermingles with both the academia and the industry organisations in a variety of ways and work on delivering the research output to the target audience. KHB should cooperate with the academia to collect research proposals and in return academia should provide updated research profiles and capacities to support creating external expertise links. Further, KHB need to be linked with the industry to identify industry issues in order to provide academic recommendations to the industry. Moreover, KHB should play an active role in delivering research outcomes to the industry, while increasing awareness. KHB should guide academics in meeting industry deadlines for research knowledge generation via coordinating academic consultancy work. KHB should supports obtaining intellectual property rights and guide providing expert opinions service to the industry. In return the industry should provide sponsorships for research via the KHB and agree upon the academic publication rights.

KHB should also identify the possible research opportunities and link such research projects to the researchers having suitable qualifications. Hence, a capable and dedicated staff for the KHB is essential and the KHB should maintain an updated database of research academics. Further, the KHB should work on marketing research capacities and create publicity upon completed projects. In addition, the KHB should update a real time research progress database and should develop and maintain linguistic support cloud upon the academia to assist user-friendly research reporting. Moreover, the KHB should operate with transparency, and should create links with the international expertise via proper agreements in order to add value to the local academic and student research.

Further, the senior management of the innovation prone industry organisations play a vital role in terms of organisation development. Therefore, to bring in innovations, the organisation management should be proactive thinkers. Moreover, the senior management should frequently review the related knowledge and developments and should be willing to take calculated risks, where necessary. The management should keep active relationships with the academia and should have a broader vision. Management, therefore, need to be well experienced to establish goals for innovative developments. Since brainstorming among the director board will be necessary in identifying innovation directions collectively. Further industry can support for research data collections and assist curriculum developments to maintain closer link with the academia. The interest for continuous improvement, therefore, is a must for the target construction companies.

Accordingly, validation phase screened the final CSFs of creating a consensus space separately for academia, KHB, and industry organisations. Table 5.3 presents the CSFs creating a consensus space in summary.

Table 5.3: CSFs creating a consensus space

CSFs creating a consensus space		
CSFs for Academia	***CSFs for KHB***	***CSFs for Industry Organisations***
• Maintain active relationships with the industry	• Develop academic-industry strategic research partnerships in front of legal and business arrangements	• Maintain active relationships with the academia
• Develop strong research profiles	• Obtain intellectual property rights on research knowledge	• Establish goals for innovative development
• Develop time management skills	• Link international research expertise with local research	• Establish R&D units
• Network with research community	• Create a linguistic support cloud	• Create space for innovation investments through proper company structure
• Practice dissemination as a habit	• Attract resources for research through marketing	• Develop professional approach to organisation management

The CSFs would create a consensus space, leading towards the creation of an innovation space through developing strategic research partnerships between the academia and the industry organisations. The next section, therefore, presents the discussions on identification of CSFs creating an innovation space.

5.4.3 CSFs creating an innovation space

Innovation space is created realising the goals articulated in the previous phases and with the intermingling of capital, technical knowledge and business knowledge (Etzkowitz, 2011). In parallel to the requirement, the concerned context calls for strategic partnerships to be established via the established KBH. Hence, the strategic partnerships will link properly researched knowledge to the innovation oriented industry organisations cultivating innovations in the construction management practice.

Hence, KBH should generate strategic partnerships and formal alliances established based on agreements in front of legal and business arrangements. The agreements will secure the internal data and confirms ethical requirements. Further, the agreements required to define timelines and funding arrangements as well. Such strategic partnerships will lead researchers being attached to companies, which will offer chances for creating validated data. The arrangements will further provide comparative and competitive advantages to the specific company via company specific research. Hence, the research relations between the academia and industry will breed hybrid professionals, who are capable of bringing in and maintain innovations to management practice, which leads the industry towards sustainable innovative development. However, the academics and industry practitioners should be dedicative and patient since the process may take a considerable time to create expected win-win situations.

Under the guidance from KBH, academic responsibility towards such collaborations could provide within all the three (03) stages of a research; initiation, execution and dissemination. At the initiation stage, the academic researchers should move beyond basic research to applied research. Academics should accept a manageable number of research students and project future issues proactively. Further, the academic researchers should localise global trends of research with the support of industry links. Academics could identify research issues from the industry and guide industry in recessions and crisis periods. Moreover, the academics should conduct marketable research, which can add value to business organisations. Further, the academics should convert consultancy work into researches, which are final outcome oriented. Thereby, the academics could develop dissemination plans as part of proper research planning.

Moreover, at the execution of research, the academics could align research with their individual subject expertise and maintain balance between research and teaching. Further academics could use OBE as a support for research, while having effective personal time management. These practices lead academics engaged in more of applied researches, which are conducted methodologically and ethically. Moreover, the academics would be bias towards interpretivist qualitative research using appropriate research methods such as; case studies, action research, and quasi-experiments, appropriately.

Further, at the dissemination stage, the academics should practice dissemination as a habit with pre-set goals and utilise proper dissemination mechanisms. However, the academia should maintain balanced dissemination between academia and industry via user-friendly dissemination mechanisms for each category. Hence, the research knowledge should be developed either into high standard publications or directly to applicable tools.

With the guidance from intermediary body, the industry organisations also required to change the organisation development culture. Therefore, to identify opportunities for innovations, the industry organisations should proactively identify issues. Besides, keeping active quality assurance practices and bringing in international connections/practices are also important. Organisations/practitioners should participate for research dissemination occasions; hence recruiting innovative people with knowledge on recent developments is promoted. Following successful innovations need to be developed as a habit within the industry and informal discussion upon improvements are necessary. Feedback from meetings and internal reviews can be used to identify issues together with company audits. Moreover, post analysis of projects as well companies' aims for awards in the sector leads for identifying innovation opportunities. Firms maintain accreditations and recruit people with experience of innovations, where necessary are also possible CSFs for being innovative.

In maintaining the innovative moves, firms should closely review innovation investments. Conducting test-runs and feasibility studies prior innovation adoptions are necessary. Risk analyses need to be conducted and acquiring resources for innovations, timely is also a possible CSF. Further, the firms should evaluate vendors in selecting innovative products. In addition, the industry should assure the quality of the innovations. The practice of training employees following innovative moves to keep the knowledge, as a shared resource is important. Moreover, an opportunity to gain overall experience is necessary for the employees.

Further, the companies with a motive of innovation should operate, as friendly units over hierarchical authority. Innovative organisations within the industry used to develop versatility in business and have an open approach to company information. Companies should have a strong company set-up to develop an open approach to innovations. Firms should operate as units. The units can adopt and maintain innovations with the support of a cooperative dynamic staff. Keeping continuous recruitment and establishing R&D units is also required. Active HRM units should be present and training managers need to be appointed. Since innovations lead branding of the company, it promotes employers to stay longer with the company. Hence, employees with own company experience can keep at the top positions, yet, continuous recruitments is also a necessity.

Hence, the validation phase screened the final CSFs of creating an innovation space, where practicing the CSFs would develop an innovative construction management practice. Table 5.4 presents the CSFs creating an innovation space.

Table 5.4: CSFs creating an innovation space

CSFs creating an innovation space		
CSFs for Research Conducted under Strategic Partnerships		
CSFs for Research Initiation	*CSFs for Research Execution*	*CSFs for Research Outcome Dissemination*
• Proactively identify research issues	• Conduct research ethically	• Use proper dissemination techniques considering the target audience
• Localise global research focus	• Follow a methodologically sound research method	• Develop research outcome into directly applicable tools
• Identify issues for research from industry practice	• Maintain quality	• Balanced dissemination for academia and industry
• Include research output dissemination into initial research proposal	• Use proper samples for research	• Deliver high level research output to the broader community
• Keep biased toward applied research	• Balance academic duties to allocate required time for research	• Develop high-quality publications
CSFs for Organisations Partnering Strategic Partnerships		
CSFs for Innovation Orientation	*CSFs for Innovation Initiation*	*CSFs for Research Innovation Maintenance*
• Maintain open approach to innovation	• Solve issues in practice with a scientific approach	• Assure quality of innovations
• Support research with data	• Conduct post analysis of projects	• Train employees following adapted innovations
• Maintain a cooperative dynamic staff	• Maintain accreditations	• Conduct feasibility studies prior innovation adoptions

CSFs creating an innovation space Cont.		
CSFs for Organisations Partnering Strategic Partnerships		
CSFs for Innovation Orientation	*CSFs for Innovation Initiation*	*CSFs for Research Innovation Maintenance*
• Identify chances for gaining comparative advantage though innovations	• Aim for award for the sector	• Review innovation investments closely
• Acquire resources for innovations	• Network and follow successful innovations	• Evaluate options in selecting innovative solutions

Hence, the developed CSFs will create the necessary space for construction management innovations. The next section presents the final model developed based on the identified CSFs.

5.5 Development of Model of CSFs for Research Driven Innovations in Construction Management Practice

The major claim behind this research study was identified as the non-alignment of academic research directions and the industry development directions. The deviation was explained relating to many arguments of various researchers in Chapter 02, via the literature review. Yet, THM of Etzkowitz and Leydesdorff, (2000) suggest the possibility of bringing innovative development to economic sectors through the merge of universities, industries, and regulatory bodies. However, academia's poor research orientation towards industry collaborations and construction industry operating under a ROS of Kim and Mauborgne, (2005), create vast barriers for construction management innovations, restricting academia and industry reaching higher levels of MCKU and PMKD of Alker (2008), respectively. Hence, due to non-presence of required knowledge infrastructure, and political economy, the construction industry remains under-developed.

Therefore, in enabling THM operation in the construction industry, it was vital to create a knowledge space, and a consensus space leading to the creation of an innovation space. Importantly, the study uncovered CSFs of creation of such spaces through a thorough four (04) staged effort. Firstly, possible barriers and success factors were identified via literature review, and secondly, the factors were screened through a field survey. Thirdly, the selected factors were explored in detail via qualitative interviews, developing informative discussions on selected factors, which were summarised into a basic model. Finally, through an external validation phase, the CSFs were finalised in three (03) main domains completing the final model, presented in Figure 5.19 below.

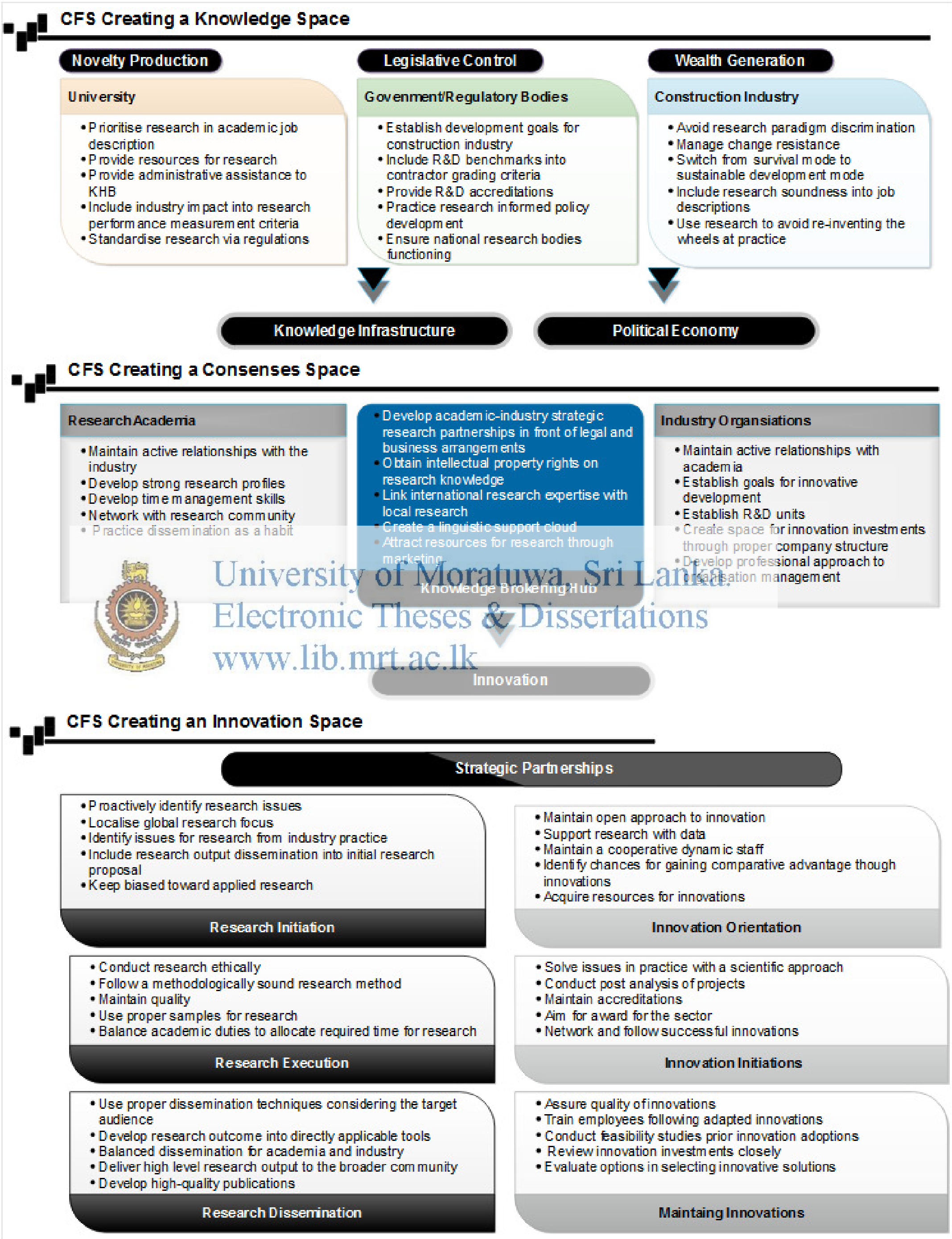


Figure 5.19: **M**odel of CSFs for **R**esearch Driven **I**nnovations (MRI) for Construction Management

Ultimately, the application of the developed model would enable THM operation cultivating an innovative construction management practice guided by the academic research.

5.6 Summary

In this chapter, discussions of the findings of Phase II are presented. Findings of Phase II of the study have explored the screened data of Phase I. Data findings were described as correlations to the study variables, and presented as a narrative developed based on the content analysis. Hence, explored findings revealed a strategy for disseminating research knowledge to the construction industry, to develop an innovative management practice, which is presented as a model called MRI. The conclusions of the overall study are presented in Chapter 06.

CHAPTER 6 – CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

Chapter 06 integrates and synthesises various issues raised in Chapter 04 and Chapter 05, whilst reflecting the introductory research problem statement. Chapter 06 provides methodologically developed answers to the thesis research questions, which were raised based on the research objectives. Further, the section identifies the theoretical and policy implications of the study with respect to the overall study area of 'academic research for construction management innovations'. Finally, the chapter highlights the study limitations and provides direction and areas for future research.

6.2 Conclusions

The study was set out to investigate the CSFs of merging academic research with the industry development requirements to cultivate an innovative construction management practice. Therefore, the research has identified; the significance of research as a duty of the academia in leading construction management towards innovative developments, a need of an innovative construction management practice for the construction industry development, barriers to the research interactions between the academia and the construction industry, and CSFs for merging the academic research and the industry development requirements. Finally, a model to demonstrate CSFs to be implemented by the stakeholders in establishing an innovative construction management practice was developed.

The literature findings led to four (04) RQs:

RQ1. Why academic research is significant in cultivating an innovative construction management practice?

RQ2. How innovative management practices assist construction industry development?

RQ3. What are the barriers for merging academic research and industry development requirements?

RQ4. What are the CSFs for the construction stakeholders in developing an innovative management practice?

Next, the concluded answers upon each RQ as presented in an order explaining the achievement of each objective.

In response to the objective 1 to 'identify the significance of research as a duty of the academia in leading an industry towards innovations', the RQ1 was devised and the related findings are explained below.

The field study conducted based on existing knowledge confirm the significance of academic research in cultivating an innovative management practice. Different possible resolutions of the relations among institutional spheres of university, industry, and government can help to generate alternative strategies for economic growth and social transformation. However, the general research practice is deviated much from the requirement at current status leading to poor level research based innovations in construction management.

Reasoning to the gap, poor knowledge dissemination and utilisation efforts are present in local context. Stages suggested by Chain of Knowledge Utilisation (MCKU) and Pipeline Model of Knowledge Dissemination (PMKD) of Alker (2008) helped to identify the construction management academics' success of dissemination of research knowledge in general at the local academia. The results revealed that the dissemination efforts are mostly in line with the theoretically suggested flow in the MCKU of Alker (2008).

The *Reception* and the *Cognition* levels are well within the reach of the academic researchers, therefore, the academics are currently being able to reach the desks of the recipients and people understood the research. However, *Reference*, and *Effort* stages are moderately reached. Hence, half of the researchers only, have been able to change the way people think and to shape action. The dissemination flow is disturbed at the fifth stage**.** Hence, the researchers in general, fail in*; bringing tangible benefits* to the industry, creating *direct influences upon actual policy/practice* and influencing ***policy/practice development*.** Therefore, the academic research utilisation by the industry is at a primitive level, revealing the inefficiency of the academia's dissemination efforts and industry apathy in research informed management practice.

Further, construction industry indicates poor research knowledge utilisation. The industry is 'Aware', and 'Accept' the research conducted by the academia, yet, rarely see research as 'Locally applicable'. Therefore, do not 'Adhere' into research based innovations, disturbing the reach of further stages.

Reasoning the gap between the dissemination and utilisation, the industry collaborations with academia in terms of research are highly underdeveloped. Interactions between the academia and the industry are limited mostly to academics' teaching and consultancy services. Research interactions were limited only to supporting research students in common and rarely construction firms are into the practice of having academics appointed into the director board and reviewing recent academic research solutions in problematic situations.

Hence, the level of 'research informed' decision-making practised in construction organisations is significantly low. The construction firms make decisions along the organisation hierarchy. However, firms are interested in tools developed based on research. Yet, currently, the local academia does not meet such needs of the industry. Besides, some companies promote research within the company, seek the services of consultants. However, frequently, the overall industry decision-making is reactive and understands the importance of proactive decision-making.

Hence, the failure in academia's research dissemination efforts and the industry's apathy of capturing research outcome in general have led the industry's unawareness upon the research outcome and its' capacity for bringing in innovations. Therefore, the challenge was to improve the accessibility of desired knowledge products by those, who are intended to reach. As such, simply initiating the dissemination mechanisms is insufficient; the transfer needs to adopt an end-user perspective. Therefore, researchers should need to have proper knowledge dissemination plans.

However, researchers use many different mechanisms to disseminate research knowledge. The field study revealed that 'publications', as the foremost successful mechanism in disseminating research outcome to the academia. Differently, collaborations with the industry were suggested as the strongest mechanisms to disseminate research outcome to the industry. Further, delivering the outcome to a company at the end of a research and attaching a research student into a company as a researcher, a product developer, or to the R&D division, were also effective dissemination mechanisms. Obtaining patents create strong chances of disseminating research outcome to the industry, yet patents are difficult to acquire for construction management type social research. However, the uses of industry friendly mechanisms are rare at present, while the publications being the priority.

Hence, in answering RQ1, the study identified the significance of research, as a duty of the academia in leading the industry towards innovations achieving the first objective of the research.

In response to objective 2 to 'critically review the necessity of an innovative construction management practice for the construction industry development', the RQ2 was devised and the related findings are explained below.

The literature comprised of many theories that explain the positive relationship between innovation and development. Thus, knowledge and experience become important intellectual assets; hence the related community need to be updated with the changes happening in the global environment to avoid the industry intellectual drivers' knowledge base getting obsolete, since they are an integral part of the value creation process. However, there is a lack of evidence that construction industry adopt new findings of academic research into their practice.

The situation is explained by Red Ocean Strategy (ROS) and Blue Ocean Strategy (BOS) of Kim and Mauborgne (2005). The construction market is characterised by a typical "Red Ocean" environment, where companies compete on the overhead rather than the ability to reduce production cost and create value. Further, the companies have a reactive practice towards development, where it follows development in the market, rather than shaping an own market.

Hence, the theory concludes that business development represents an important but an unacknowledged practice for innovation of the building industry and suggests that, strategy processes should be facilitated and subjected to more detailed research, to escape the present unhealthy market practices in the construction industry. Therefore, answering the RQ2 revealed the necessity of an innovative construction management practice for the construction industry development leading to achieve the second objective of the study.

In response to the objective 3 to 'investigate the barriers for research interactions between the academia and the construction industry', the RQ3 was devised and the related findings are explained below.

The research revealed the presence of many deterrents for both the academia and the industry in merging academic research and industry development requirements, which are within the control and beyond the control of the individuals/affiliations.

The highest influencing internal barriers for the academics are; **time pressure, increased workload due to a raised number of universities, colleges, and students,** and **increasing pressure from stakeholder groups upon quality assurance and OBE,** where all three (03) factors are basically related to time management. Time pressure creates negative impact upon research since long period research would most probably affected by the researcher's personal life events. Moreover, the impacts of the time pressure depend on the researcher, supervisor, and the dissemination requirements.

The highest influencing external barriers for academic researchers are; **goals and paradigms of trans-national research driven by the perspectives of economically advanced countries, the impact of research taking considerable time to appear** and **inadequate allocation of resources for research**. Aligning global research focus with the local industry requirements is challenging for researchers in general since, testing high end theories using a local sample is quite questionable in terms of the quality of the research output generated. Further, the scale of the industry matters, when moving ahead with the global research focus. However, it is good to bring on new developments in the global context. Yet, following global focus may deviate academics from their subject expertise.

Out of the internal barriers for construction organisations/individual practitioners; **academic research focused on subjects, which are not crucial for the**

construction industry, constantly changing team compositions disturbing the information flow and methods of innovation diffusion, and **no proper structure to accumulate financial capital to invest in research** are the most critical hindrances. Constantly changing team compositions are inevitable by the nature of the construction industry.

Further, the field study confirms; **industry timidity in adapting management innovations** and **construction industry lacking leadership to direct towards research,** as the main external barriers for the construction industry.

The study, therefore, revealed the barriers for the research interactions between the academia and the construction industry, in answering the RQ3, which directed to the achievement of third objective of the study.

In response to the objective 4 to 'determine the CSFs for merging the academic research and the industry development requirements', the RQ4 was devised and the related findings are explained below.

Triple Helix Model (THM) of Etzkowitz and Leydesdorff, (2000) proves the significance of academic research in leading industry innovations. Subsequently, innovations play a vital role in the development of an economic sector. Yet, an industry operating under a ROS of Kim and Mauborgne, (2005), poses heavy threats for innovative development. Hence, the management practices of the construction industry, traditionally operating under a ROS, show a slow development with less interest into academic research based innovations. Complimentary, no academic researchers entertain a considerable level of research dissemination, neither construction industry shows significant utilisation of research and only the basic stages of MCKU and PMKD of Alker (2008) are reached, respectively.

In developing space for innovation, creation of a knowledge space, and a consensus space are precursors, as per to Etzkowitz (2011). Correspond to the argument, Leydesdorff, (2005) identifies three major actors in THM interactions as; novelty producers, legislative controllers and wealth generators creating, knowledge infrastructure, political economy for innovations. Hence, CSFs of merging academic research and construction industry development requirements for an innovative construction management practice were developed separately for each contender under each of the knowledge, consensus and innovation spaces, respectively.

Knowledge space is the initial foundation for innovations via regional innovation spaces comprising novelty producers, legislative controllers and wealth generators, who would improve local conditions for innovation through providing necessary knowledge infrastructure and the political economy. In construction management context, universities play the role of novelty producers, government/regulatory bodies are the legislative controllers, and construction industry is the wealth generator, respectively.

Hence, CSFs creating a knowledge space developed for three contenders separately. The CSFs for universities are as; **Prioritise research in academic job description, Provide resources for research, Provide administrative assistance to KBH, Include industry impact into research performance measurement criteria,** and **Standardise research via regulations.** Simultaneously, the CSFs for Government/ regulatory bodies are; **Establish development goals for the construction industry, Include R&D benchmarks into contractor grading criteria, Provide R&D accreditations, Practice research informed policy development**, and **Ensure national research bodies functioning.** In response, the CSFs for the construction industry are; **Avoid research paradigm discrimination, Manage change resistance, Switch from survival mode to sustainable development mode, Include research soundness into job descriptions,** and **Use research to avoid re-inventing the wheels at practice.**

Since necessary knowledge infrastructure and political economy are generated within created knowledge space, the prerequisites of creation of a consensus space are available. One indicator of this shift from knowledge space to consensus space is the increased involvement of universities and other knowledge producing and disseminating institutions. Establishment of a Knowledge Brokering Hub (KBH) to intermingle research academia and construction organisations, therefore, creates the consensus space.

Hence, the CSFs, for each of the contenders in the consensus space were revealed. The CSFs for research academia are; **Maintain active relationships with the industry, Develop strong research profiles, Develop time management skills, Network with the research community**, and **Practice dissemination as a habit**. The success of the established KBH will be assured through practicing the CSFs; **Develop academic-industry strategic research partnerships in front of legal and business arrangements, Obtain intellectual property rights on research knowledge, Link international research expertise with local research, Create a linguistic support cloud,** and **Attract resources for research through marketing.** CSFs for industry organisations are identified as; **Maintain active relationships with the academia, Establish goals for innovative development, Establish R&D units, Create space for innovation investments through proper company structure**, and **Develop professional approach to organisation management**.

The operations of the consensus space leads creation of space for innovation in the specific context, majorly through strategic research partnerships in between research academia, and industry organisations, brokered by KBH. Hence, the CSFs for researching, and CSFs for industry organisations inside such partnerships were developed separately.

The CSFs of research were identified in three (03) segments, considering the stages of a research as; CSFs of research initiation, execution, and dissemination. The CSFs of research initiation are; **Proactively identify research issues, Localise global research focus, Identify issues for research from industry practice, Include research output dissemination into the initial research proposal**, and **Keep biased toward applied research.** Hence, the successful research initiation should be followed by successive execution of research by performing the CSFs; **Conduct research ethically, Follow a methodologically sound research method, Maintain quality, Use proper samples for research,** and **Balance academic duties to allocate required time for research**. Finally, in disseminating research outcome, the CSFs are: **Use proper dissemination techniques considering the target audience, Develop research outcome into directly applicable tools, Balanced dissemination**

for academia and industry, Deliver high level research output to the broader community, and **Develop high-quality publications**.

In response to the earnest efforts of the academic researchers, industry organisations should be properly oriented themselves for developing strategic partnerships and should be interested in searching opportunities for innovations followed by proper maintenance of adapted innovations. Hence, the CSFs of organisation orientation for innovations are: **Maintain open approach to innovation, Support research with data, Maintain a cooperative dynamic staff, Identify chances for gaining a comparative advantage through innovations**, and **Acquire resources for innovations.** The CSFs of innovation initiations are; **Solve issues in practice with a scientific approach, Conduct post analysis of projects, Maintain accreditations, Aim for awards for the sector**, and **Network and follow successful innovations**. Finally, in maintaining the adapted innovations the CSFs are; **Assure quality of innovations, Train employees following adapted innovations, Conduct feasibility studies prior innovation adoptions, Review innovation investments closely**, and **Evaluate options in selecting innovative solutions**.

In answering the RQ4, the study achieved the fourth objective of the research by determining the CSFs for merging academic research and the industry development requirements.

In response to the objective 5 to 'develop a model to demonstrate the CSFs for strategic research collaborations in merging academic research and industry development requirements', the answers derived for RQ1-RQ4 were synthesised as follows:

Overall, the study has revealed the CSFs, which need to be implemented to merge academic research and industry development requirements for generating an innovative construction management practice in response to the research problem. A final model was developed in mapping the location and application of the CSFs. Figure 5.19, therefore, presents the developed final model, 'The **M**odel of CSFs for **R**esearch Driven **I**nnovations (MRI) for construction management', achieving the final objective of the study, which ultimately completed the achievement of research aim ' to investigate the Critical Success Factors (CSFs) of merging academic research with the industry development requirements to cultivate an innovative construction management practice '.

The CSFs identified in the model are applicable to the local context (Sri Lanka) and beyond to different construction contexts, where poor academic research lead management innovations are present. The structure of the model can be applicable to any construction industry along with the timeline, yet the CSF may need to be refined through external validation of the data. In addition, the basic theories integrated into the model (pre-requisite spaces and stakeholder roles) could be genaralised irrespective of the industry, yet in applying to a particular industry it would require to identify the relevant parties to play each stake holder role.

Importantly, the application of the discussed model would enable THM operation, developing an innovative construction management practice guided by the academic research, as discussed in the next section, which presents the contributions of this research.

6.3 Contribution to Knowledge – Theoretical Implications

The research presents the major contribution to theory via the developed model, 'The **M**odel of CSFs for **R**esearch Driven **I**nnovations (MRI) (refer Figure 5.19) embodying CSFs for merging academic research and industry development requirements for an innovative management practice. In the process of determining CSFs, the study has identified the significance of academic research in cultivating an innovative management practice in the construction industry in line with the THM of Etzkowitz and Leydesdorff (2000). Further, the study has identified ROS (Kim and Mauborgne, 2005) operation in the construction industry, and poor industry orientation of academic research, as the major reasons behind the slow progress through PMKD, and MCKU of Alker (2008) in construction management context.

Therefore, CSFs in creating knowledge, consensus and innovation were identified separately, with reference to the actionable contenders of each space, which are essential in enabling a THM operation in construction management context. Hence, the study concludes, the necessity of universities, government/regulatory bodies, and construction industry, playing the roles as; novelty producers, legislative controllers, and wealth generators in creating the knowledge space for enabling THM operations. Therefore, the interactions between the academia and government/regulatory bodies will generate the knowledge infrastructure, while interactions between the construction industry and government/regulatory bodies will generate the political economy leading to creation of consensus space for construction management innovations. Resultantly, KBHs was demanded to be established for the operation of consensus space in linking research academia and industry organisations. Innovation space will be created through KBHs generating strategic research partnerships, in between academic researchers and industry organisations.

6.4 Contribution to Knowledge - Practical Implications

In contribution to the practice, the developed model 'The **M**odel of CSFs for **R**esearch Driven **I**nnovations (MRI) for construction management' (refer Figure 5.19) presents CSFs, which should be followed by the stakeholders in construction management, in cultivating an innovative management practice. Therefore, the study revealed CSFs for universities, government/regulatory bodies, and construction industry in creating the initial knowledge space. Further, in creating the consensus space, CSFs, were developed to be practised by academic researchers, the resultant KBH from knowledge space operations, and the willing construction organisations. Finally, in the innovation space, strategic research partnerships will be developed and CSFs for researching and CSFs for industry partners under such partnerships are revealed. The CSFs of research initiation, execution, and dissemination were developed separately in conducting research inside an innovation space. Finally, CSFs for the industry partners for innovations were revealed in three (03) segments as; CSFs for organisation orientation for research based innovations, CSFs for innovation initiations, and CSFs for maintaining adapted innovations.

In conclusion of the contribution to knowledge, the ultimate results of the application of the model are shown in Figure 6.1.

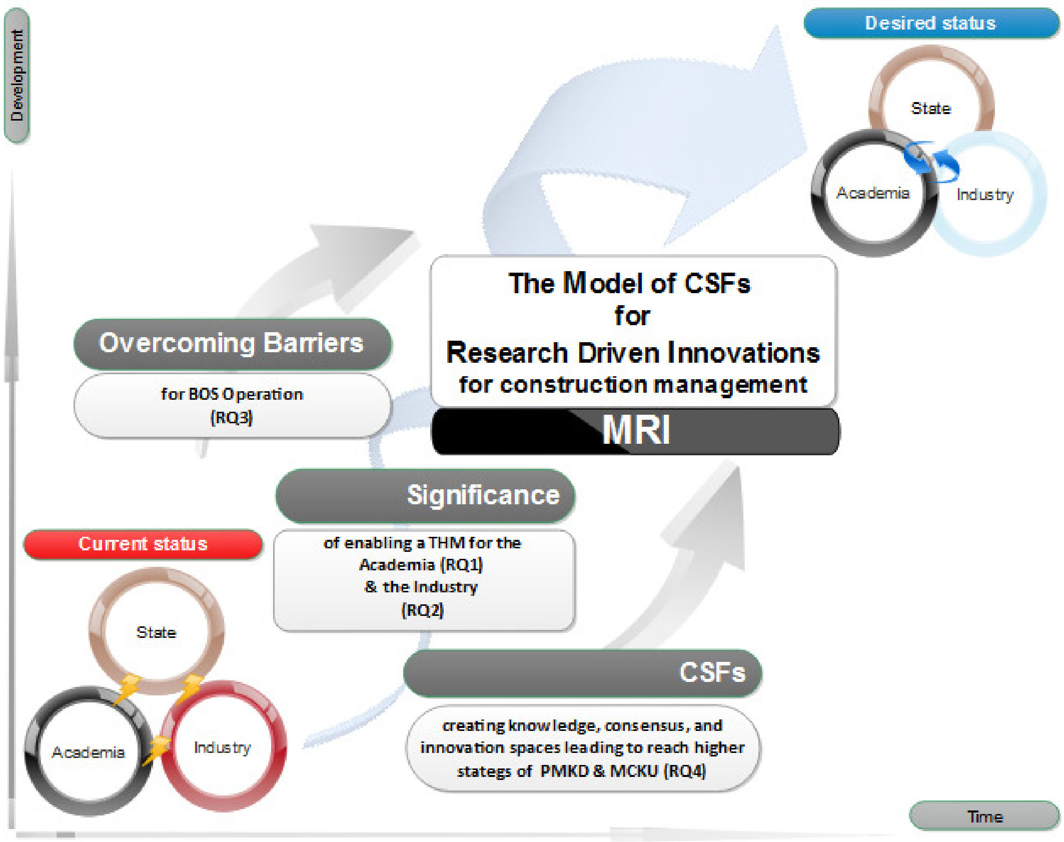


Figure 6.1: Impact of the Application of the Model - SRC

Since the model – MRI (refer Figure 5.19) will guide industry in following a BOS of Kim and Mauborgne, (2005) from the current ROS. Eventually the higher stages of MCKU and PMKD of Alker (2008) will be reached by the academia and the industry. Accordingly, the sector will reach development as suggested by THM of Etzkowitz and Leydesdorff (2000). Hence, the model – MRI fill in the blanks of the conceptual framework presented in Chapter 02. Finally, the changed operational behaviour of stakeholders via the CSFs will enable an innovative construction management practice, which complements the construction industry's development.

6.5 Recommendations for future research

The scale of this debate is, therefore, extensive and multifaceted, even at the local level. To generate achievable policy strategies and development targets with regard to research based innovative construction management; there is a need for more case studies at the local level to allow further assessment of local dimensions of the subject. Exploring the following as future research areas, can facilitate the attainment of this goal.

- Policy changes required for developing knowledge infrastructure and political economy in assisting construction management innovations
- Sustainability of KBHs in the built environment context
- Necessities of shifting paradigms in management research for industry research collaborations
- Mechanisms of converting construction organisations from survival mode to a sustainable development mode to avoid 're-inventing the wheel' at practice
- Requirements of developing hybrid professionals to avoid paradigm discrimination in construction management arena

6.6 Limitations of the study

The study offered an evaluative perspective on an important economic sector's development requirements, and was conducted in a developing country environment through sampling construction management academic and construction organisations/individual practitioners. As a direct consequence of this method, the study encountered several limitations that need to be considered.

- The findings rely on cross-sectional data rather than longitudinal data. This may not reflect the changing situations and deep relationship that would develop between the academia and industry over time. The cross-sectional data may affected by the respondent's predisposition of any events that have happened in the past or by the mental position at the period of providing data.

- The data were collected from a single country. This facilitated data collection and controlling diversity, but limited the generalisability of the findings.

- The data upon organisation perspective were collected only from the contractor organisations rather than consultancy and client organisations. Yet, the individual practitioners were not limited to a particular section. This might not represent the construction industry organisations in proportion. Nevertheless, the contracting organisations' view was considered as highly important since they process both the qualities of prevailing long- term in the industry and with capacity for funding and benefiting from research.

- The data were collected with respect to a respondent’s most significant contribution towards an innovative management practice, where necessary, which might not reflect the overall life experience of the researcher/practitioner/organisation.
- The data were collected only from the academic and industry perspectives due to the absence of a proper population to collect data upon the government/regulatory body’s perspective. However, to integrate the agreement of latter perspective, the experts for data validation were selected, who are extensively engaged in industry regulatory activities.

6.7 Final Note

The research study, therefore, concluded the CSFs for research based innovations in construction management practice via the developed model in answering the RQs methodologically with a pragmatist philosophical stance. The application of the model – MRI (refer Figure 5.19) will enable the operation of THM spirals via academic and industry practitioners reaching the higher levels of PMKD, and MCKU of Alker (2008) respectively, through the creation of necessary knowledge, consensus, and innovation spaces, converting the ROS of current construction practice into a desired BOS of Kim and Mauborgne, (2005).

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APPENDICES

Appendix - A: Linkages of Variables to the Literature Review

Appendix - A1: Significance of disseminating research knowledge – Academia's perspective

Significance	References
Internal Significance	
Research being a major responsibility, academics should carry out research that serves educational needs	Postlethwaite (2005)
As it benefits to the human, financial and intellectual resources of the university	Houston (2008)
To improve employment skills of the next generation of professionals	Fielden (2008); OECD (2010)
To attract new research students	Cullen (2003)
As an integral part of the career development of academia	Postlethwaite (2005)
To become a research-led university	Boyer Commission (1998)
Linking Research to improve Teaching	Boyer Commission (1998)
As communicating research outcomes lies at the heart of academic endeavour and to guide further research	Sparrow*et al.,* (2009)
To support individual professional development	Virolainen (2007)
For the advancement of the academic careers of the research graduates	Hays (2007)
External Significance	
Research being a major responsibility academics should carry out research that serves the development of the region and its economy	Postlethwaite(2005); Virolainen (2007)
Add new knowledge in order to serve the wider society	Houston (2008)
To bringing in innovation to the particular industry the academia involved with	OECD (2010)
Responsibility in shaping the culture, paradigms and practices of the related professions	Fielden (2008)
To accommodate and respond to key external parties in reaching their expectations	Houston (2008)
Dissemination of knowledge to the existing industry becomes a duty to the academics	Brown (2005)
Research institutions being a source of new ideas and collaborating with industry to maximising the use of these ideas	European Commission (2007)
For the advancement of research in a particular field of interest	Hays (2007)

Appendix – A2: Significance of research knowledge utilisation – Industry perspective

Significance	References
Internal Significance	
To address the economic, environmental and resource constraints	Kulatunga et al. (2005)
Community need to be updated with the global environment	Brown (2005)
Trends polarize the financial and technical superiority of the developed countries	Steele & Murray (2004)
Address the economic, resource and environmental constraints	Kulatunga, Amaratunga & Haigh (2005)
To survive and proliferate through innovation	Hughes & O'Rourke (2009)
Develop new products, materials, advanced construction processes	Kulatunga et al. (2005)
To avoid the Industry intellectual drivers' knowledge base getting obsolete	Brown (2005)
Requirement of commitment to improve the delivery of projects	Egan (1998)
Deliver better value for money	Fairclough (2002)
Less innovation adaptation as a possible reason for lack of productivity improvement of construction labour forces compared to the other industries	Sabol (2007)
Increase construction industry productivity, design and performance quality	Maqsood & Walker (2007); Le & Bronn (2007)
Finding solutions to the challenges faced by the construction industry	Barrett (2007)
Making it highly valued by its customers	Barrett (2007)
External Significance	
In order to sustain long-term competitive advantage of organisations	Sparrow *et al*., (2009)
Guide on effective management of human resources	Jones & Robinson (1997)
'Knowledge economy' is an emergent reality for many organisations	Laszlo & Laszlo (2002)
For continuous performance improvement	Hughes & O'Rourke (2009
To become more profitable	Fairclough (2002)
To be competitive through technological advances	Kulatunga, Amaratunga & Haigh (2009)
Cost efficiency improvements	Le & Bronn (2007)
Enhances the effectiveness of construction organisations	Kulatunga, Amaratunga & Haigh (2005)
Managerial developments	Kulatunga, Amaratunga & Haigh (2005)
Lead project team deliver high quality projects at lower costs in shorter times	Oyedele (2010); Sexton *et al*,.(2007)

Appendix – A3: Barriers for research dissemination – Academia's perspective

Barriers	References
Internal Barriers	
Demand to involve in both pure and applied research	William *et al*. (2004); Kassel (2009)
Maintaining traditional role in public science while partnering with a commercial entity with a tradition of proprietary science	William *et al*. (2004)
Increased work load due to raised number of universities and colleges and the number of students	Brezis & Crouzet (2004)
Increasing pressure from stakeholder groups to demonstrate relevant, quality-oriented processes and outcomes related to teaching	Payne (1996)
Tensions arise among academics due to the funding mechanisms and the iniquity of rewards for research and for teaching	McLernon & Hughes (2003)
"Think global, act local" challenge	Kassel (2009)
Time pressure	Havnes & Stensaker(2006)
Highly qualified disciplinary specialists might feel incompetent when they enter the challenges of the pedagogical discipline	Havnes & Stensaker(2006)
Poor planning and the absence of a proper dissemination strategy	Ordoñez & Serrat (2009)
Low success in getting a substantial share of research funds from abroad	Meek et al. (2009)
Poor use of communication mechanisms	Pheng & Hua (2002)
External Barriers	
Continuing financial demands arising out of diminishing financial support from public sources of finance together with the high requirement of funds for developing activities	OECD (2010); Abbott, Aouad & Madubuko (2008)
Passive and low dissemination	Brown (2005); RD Direct (2009)
Separation of quality assurance mechanisms for teaching and research has created critical problems with regard to choosing a mission and also allocation of resources as R&T requires different type of resources	Senaratne et al. (2005);
Distributed autonomy in higher education is a barrier to open communication, debate and critique	Havnes & Stensaker (2006)
Popularity of fashionable management concept which is virtually ignored by practitioners discouraging the applied research in a way	Hambrick (1994)
Changes brought by research will be seen over a long period of time rather than immediately at some points	Marsh (2010)
Increased global competition in higher education and research	Meek et al. (2009)

Barriers Cont.	**References**
External Barriers Cont.	
Commercialization of university research is the threat it poses to "open science" and academic freedom	Meek et al. (2009)
Related information systems on "World-Class Universities" and indicators of "cutting-edge" research are more likely to underscore gaps than to motivate the less privileged to 'catch up'	Meek et al. (2009)
Trans-national education provided or assisted by economically advanced countries might be low in quality, and might exploit those paying for it in many cases; the low- and middle- income countries have limited capacity for reviewing the quality of programmes and preventing the obvious low-quality programmes from spreading on their territory	Meek et al. (2009)
Resource pools for research in many low- and middle-income countries, even if financially sufficient, might be too small to compete with the larger pools of other countries	Meek et al. (2009)
Changes in funding mechanisms	Senaratne et al, (2005)
Programme goals of trans-national education programmes and the paradigms of research so driven by the perspectives of economically advanced countries that the needs of low- and middle-income countries are neglected or even suppressed	Meek et al. (2009)
Practitioners often do not entertain innovative research ideas	Azhar (2007)

Appendix – A4: Barriers for research knowledge utilisation – Industry perspective

Barriers	**References**
External Barriers	
Difficulties with moving away from the traditions and going ahead with current development trends	William et al. (2004)
Not considering themselves being in a position to make the necessary investments	Meek et al. (2009)
Ignorance about good quality academic research	Pheng & Hua (2002)
Although educational research provides useful information, insights, and ideas for improvement, it does not often lead directly to practical advances	Burkhardt & Schoenfeld (2003)
Poor definition of construction product quality attributes	Toakley & Marosszesky (2003)
Not very influential and useful, especially when less-funded and consulted	BERR (2008)
Very unique nature of its own	Steele & Murray (2004)
Ignorance of the knowledge worker and their skills and slow to recognize the importance of skills agenda	O'Donnell (2008)
More fragmented than many other industries	Pathirage, *et al,*. (2007)
Nature of the way in which the construction services are purchased	NZCIC (2006)
Product complexity	Toakley & Marosszesky (2003)
"One off" nature of many projects	Toakley & Marosszesky (2003)
Clients who insist on a dominance of lowest-price criteria to award contracts	Latham (1994)
Pace of developments are integrated and implemented in the sector is slow	Hughes & O'Rourke (2009)
Low responsiveness to the changes	Bettelle (2010); Sabol (2007);
Lack of investment on R&D by the industry	Bettelle (2010); NZCIC (2006)
Impractical to use in real- life construction projects	Azhar (2007)
Culture of conservatism, Lack of appropriate leadership and Timidity in leading the adaptation of new technologies	Jones &Saad (2003 cited Maqsood & Walker, 2007)
Driven by technology push rather than demand pull	Barrett & Barrett (2003)
Industry's short-term focus on achieving project goals	Dubois & Gadde (2002)
Industry as a whole is featured as a loosely coupled system	Dubois & Gadde (2002)
Structure of the industry is seen to inhibit innovation	Sexton et al, (2007)
Limited resources and reduced opportunities for supply chain driven innovation	Sexton et al, (2007)
Risk averse	Sexton et al, (2007)
Industry mind-set that academic research is not directly usable and valid	Pheng & Hua (2002)
Industry lacking direction and resources to test and implement new research outcomes	Pheng & Hua (2002)

Barriers Cont.	References
Internal Barriers	
Lack of skilled people in construction organisations	Kulatunga et al. (2005)
Less adoption of new findings of R&D activities	Pheng &Hua (2002)
Services offered by the professional organisations are highly tacit knowledge intensive in nature	Løwendahl (2000)
Low profit levels	Latham (1994)
R&D expenditure as a proportion of turnover	Fairclough (2002)
Unawareness	Hughes & O'Rourke (2009)
Less knowledge	Hughes & O'Rourke (2009)
Competences among construction companies	Hughes & O'Rourke (2009)
Less incentives	Hughes & O'Rourke (2009)
Out-dated skills of professionals	O'Donnell (2008)
Increasing costs to train employees in today's high technology environment	Wall & Ahmed (2008)
Constantly changing team compositions and lack of team-mate to team-mate familiarity	Sabol (2007)
Academic research is more focused on subjects and issues which are not crucial for the industry	Azhar (2007)
Academic research results are sometimes inapplicable	Azhar (2007)
Poor learning organisational orientation, Lack of investment in people and Lack of training for professionals	Jones & Saad (2003 cited Maqsood & Walker, 2007)
People have to adapt to a number of changes at a personal and professional level at rapid pace	Reissner (2005)
More mature workers already active in the workforce	Hall & Sandelands (2009)
Findings of research are published in research journals that are difficult for practitioners to access	NCTM (2010)
Construction organisations providing services are not properly structured to accumulate sufficient financial capital to invest in research, nor do they have R&D infrastructure	NZCIC (2006)
Reported in an academic style that makes them difficult to interpret	NCTM (2010)

Appendix – A5: Success factors for academia in research knowledge dissemination

Success Factors for Academia	References
Research Initiation	
Partnerships amongst governments, the economic sector and research universities to make new knowledge linked to development goals	Kassel (2009); Teichler & Keanrney (2009)
Research conducted in higher education should be more biased towards applied sciences	Virolainen (2007)
There should be conceptual research undertaken by researchers, as they will ultimately develop to be relevant and useful research outcomes for practice. In fact, such research though may not be immediately usable, will in the long run gradually penetrate to the industry	Barrett & Barrett (2003)
Balance the need to be seen as research institutions contributing new knowledge to society with the need to be seen as effective teaching institutions which are engaged with the community	Haughton et al (2003)
Prioritise	Havnes & Stensaker (2006)
More pedagogical research need to be carried out in order to address the issues of teaching and community engagement relationship	Postlethwaite (2005)
More 'research' and for re-shaping of research culture in order to align with the changing nature of industry behaviour	Brown (2005)
Need to play a more active role in relationship with industry	European Commission (2007)
Focus not only to overcome global challenges, but also to improve individual industries	Marsh, (2010)
Establishing networks of expertise on research	Abbott *et al*,(2008)
Transfer needs to adopt an end-user perspective therefore researchers should need to have a proper knowledge dissemination plan	Davenport & Prusak (1998 cited Senaratne et al, 2005)
Dissemination plan into initial academic research proposals	Ordoñez & Serrat (2009)
Practical relevance	Dean & Bowen (1994)
Dissemination exercises have milestones that must be identified and set early	Ordoñez & Serrat (2009)
Academic research could be made more useful if its structure and organisation were better linked to the practical needs of the industry	EN (2011)
Clarifying objectives; and how they are translated into the supported activities, while maintaining flexibility to respond to emerging policy needs	EN (2011)

Success Factors for Academia Cont.	**References**
Research Execution	
Quality researching	OECD (2010)
Need to play a more active role in relationship with industry	European Commission (2007)
Re-shape in academic research culture with better compatibility with the industry	Virolainen (2007)
Establishing networks of expertise on research	Abbott *et al*., (2008)
Research with high dissemination capacity	Alker (2008)
Balance the characteristics such as teach-ability, complexity and specificity of research	Bogers (2011)
Improve trust upon research findings	Bogers (2011)
Include summary documents	Ordoñez & Serrat (2009)
Letters of thanks to study participants	Ordoñez & Serrat (2009)
Newsletters to study participants	Ordoñez & Serrat (2009)
Quality control to ensure the information content is accurate, relevant, representative, and timely	Ordoñez & Serrat (2009)
Value creation process	Le &Bronn (2007)
Academic research could be made more useful if its structure and organisation were better linked to the practical needs of the industry	EN (2011)
Reduce complexities of research funding: Research and innovation funding should provide more added values, increase its leverage effect on other public and private resources and be used more effectively to support the strategic alignment and pooling of national and regional funds to avoid duplication. Further, administrative burdens should be lowered by timely grants	EN (2011)
Academic research development centres	Havnes & Stensaker (2006)
Research Dissemination	
Packaging dissemination techniques	Meek (2009)
Specialist staff to identify and manage knowledge resources with business potential, i.e. how to take a new idea to market, resources to make it happen, and to obtain adequate buy-in by all stakeholders	European Commission (2007)
Establishing networks of expertise on research	Abbott *et al*., (2008)
Ensuring physical availability of the product to as large a proportion of the target audience	Ordoñez and Serrat (2009)

Enablers for academia	**References**
Research Dissemination cont.	
Bigger the project and the higher the level of the degree, the more likely it is that research outcomes that would be worth communicating beyond the basic requirements to the broader research community	Hays (2007)
Transfer needs to adopt an end-user perspective therefore researchers should need to have a proper knowledge dissemination plan	Davenport & Prusak (1998 cited Senaratne et al, 2005)
Interactive dissemination process, allowing feedback from audiences according to a cyclical model of communications flow	Alker (2008)
Active dissemination by tailoring research findings to a target audience with a dynamic flow of information from the source to increase the uptake of research in policy making	RD Direct (2009)
Shared vision and common understanding of what one wants to disseminate together with a way of describing that to those who stand to benefit from it	Ordoñez & Serrat (2009)
Clearly identify the target audience and to map it to one of the categories in the awareness, understanding, and action to be taken	Ordoñez & Serrat (2009)
Presented as a benefit and solution to users	Ordoñez & Serrat (2009)
Communicating the results of research to a wider community beyond immediate research reports, theses and research products	Hays (2007)
Effective communication channels	Alker (2008)

Appendix – A6: Success factors for industry in research knowledge utilisation

Success Factors for Industry	References
Success Factors to be implemented as an Industry	
Develop open innovation approaches to R&D	European Commission, (2007)
Use public research as a strategic resource	European Commission, (2007)
Capacity building to access and use research	Alker, (2008)
Development of procurement	Hall &Sandelands (2009)
Industry investments out of self-interest or to respond to the demands of clients and government policy	Koebel et al, (2004)
Move beyond the traditional practices to adopt new practices	Kulatunga et al. (2005)
Research use included in job-descriptions	Alker (2008)
Skills agenda - the ability to attract, retain and develop skilled people is a required core competence	Hall &Sandelands (2009)
A network through which members could collaborate with each other	Egan (1998)
Updating knowledge of the workers comparatively with the new knowledge generation	Amaratunga*et al.*,(2010)
Development of strategic and professional leadership	Hall &Sandelands (2009)
Success Factors to be implemented as Organisational/Individuals	
Change internal dynamics of construction organisations to be able to respond to change	Steele & Murray (2004)
Use as criterion for staff appraisal	Alker, (2008)
Combining in-house and external resources	European Commission, (2007)
Aim to maximize economic value through intellectual property rights	European Commission, (2007)
Asking project managers to identify and report on innovation opportunities	Ward (2003)
Increase senior management awareness on benefits of external knowledge can bring to the organisation budgets	Ward (2003)
Rewarding research-informed decision-making	Alker, (2008)
Organise events with employees returning from a conference to share knowledge to other employees	Ward (2003)
Develop a mechanism to identify important innovative management practices from research	Ward (2003)
Offer chances to attend conferences as a reward for deserved employees	Ward (2003)
Publish, how new knowledge has contributed to improved performance at the personal and/or organisational level so that there is an explicit cause-and-effect link between being open to knowledge-pull and adopting an innovation	Ward (2003)
Knowledge workers	Green, Newcombe, Fernie& Weller (2004)

Appendix – A7: Success factors for academic - industry research collaborations

Success Factors to be implemented Collaboratively	References
Collaboration where the interests and values of each partner were articulated in advance and conflict of interest issues are resolved before legal and business arrangements are established in a contract would be essential	Azhar (2007)
Incentives in the system that motivates staff and institutional leaders to participate in, or initiate, development	Havnes & Stensaker (2006)
Undergraduate research more into actual issues in the industry	Blackman & Kennedy (2009)
Communication between researchers, research funders and research users in a number of different ways	Alker (2008)
Review how research can be more effectively connected to real-world activity and policy setting	Marsh (2010)
Research programs should be judged not just by the quality and quantity of science produced, but by the industry impact and tangible benefit resulting from the research	Marsh (2010)
Joint publications between university researchers and those based in industry and government	Meek (2009)
Knowledge broker	Alker, (2008)
Embedding researchers within companies as part of existing research activity	Aouad *et al*., (2010)
Strategic partnerships	Meek (2009)
Collaborations and partnerships amongst governments, the economic sector and research universities to make sure that new knowledge becomes linked to development goals	Meek (2009); Kassel (2009)
Enhance the researcher-practitioner collaboration to conduct research on problems which are vital for the construction industry and to find out adoptable solutions	Meek (2009); Azhar (2007)
Broadening participation in programmes: The ultimate users of innovations should be involved much earlier in the process to accelerate and broaden the exploitation of results and to encourage greater public acceptance	EN (2011)
Increasing the competitiveness and societal impact: This would require better uptake and use of results by companies, investors, public authorities, other researchers and policy makers	EN (2011)
Understanding the process and of building systems for innovation	Meek (2009)

Appendix - B: Research Directions from Academic Research for Sustainable Construction Practice

Research Drivers for Construction Sustainability	
Procurement	Whole life value, Best practices, Supply chain integration (Vadera et al., 2008)
Design	Build-ability, Purposive, Resource efficient, Sustainable, Resilient, Adaptable, Attractive, Quality assessment tools (Vadera et al., 2008)
Innovation	Enhancing industry's capacity to innovate (Vadera et al., 2008)
Work force	Skills pledges, Training plans, Invest in people or other business support tools, Continuous professional development, Lifelong learning (Vadera et al., 2008); Productivity enhancing mechanization, Modernization, Technology upgrading, Changes in financing and management practices, Labour intensive practices, Wages and welfare, Quality consciousness, Motivation, Awareness, Concern on sustainability issues, Living habits, Economic pursuits, Global-local interdependence, Attitude and actions of an individuals, Consciousness building (Shah, 2002)
Better regulation	Reduction in the administrative burdens (Vadera et al., 2008)
Climate change	Adaptation, Reducing carbon dioxide emissions (Vadera et al., 2008)
Biodiversity	Conservation, Enhancement (Vadera et al., 2008)
Automation, industrialisation and new technologies	New systems and processes, Modern methods, Up skill industry, Change out-dated perceptions, Emerging technologies, Appropriate BIM standards (Vadera et al., 2008)
Building better cities and communities	Standards and conformance review, Building Act/Code (Vadera et al., 2008); Meeting aspirations of residents, Affordable, Liveable, Vibrant city environments, Integrating urban planning requirements with individual property rights, Cities and towns for future needs (Crisp et al., 2012); Land conservation, Optimal and creative use, Equitable distribution and reuse of brown field areas, Creative land ownership and use policy(Shah, 2002)
Meeting the housing needs	Population change, Ageing population, Diverse population, Vulnerable groups, Tenure, Affordability (Vadera et al., 2008)
Productivity	Industry structure, Productivity measures, Industry processes, Skills, Technology, Client value, Regulatory environment (Vadera et al., 2008)
Water	Reduce per capita consumption (Vadera et al., 2008)
Sustainability	Measuring sustainability, Awareness for industry including benchmarking sector performance from a whole of life perspective, New technologies(Crisp et al.,2012)

Research Drivers for Construction Sustainability (Cont.)	
Waste	Reduction (Vadera et al., 2008)
Better buildings	Retrofit solutions, Building condition(Flint et al. 2008); Resilient buildings, Indoor air quality and moisture control, Insulation and air tightness, Ventilation, Dependably in fire situations(Crisp et al., 2012); Extending the working life of buildings(Shah, 2002)
Materials performance	Improvement of traditional materials, viability and applicability of new and innovative building materials, Best use of existing materials, Reuse, Indigenous materials, Low environmental and social impact materials, Performance Assurance (Vadera et al., 2008)
Informal housing	Settlements in the urban landscape, Recognizing role of the peoples' processes in producing them (Shah, 2002)
Disaster mitigation	Protection, Disaster preparedness, Disaster resistant designs Detailing, technology and construction(Shah, 2002)
Gender equality	Women status as owners, Recognizing their role as users, Respecting their contribution as producers(Shah, 2002)

Appendix - C: Survey Questionnaires Samples

Appendix - C1: Questionnaire devised to collect data from academic researchers under Phase I of data collection

Appendix - C2: Questionnaire devised to collect data from industry organisations under Phase I of data collection

Appendix - C3: Questionnaire devised to collect data from industry practitioners under Phase I of data collection

Appendix - D: Survey with Academics– Demographic Data Analysis

Appendix - D1: Analysis of academic sample in terms of positions held by the respondents

Position Held	Code	Frequency	Percentage
Head of the Department	AD1-1	4	13.33%
Professor	AD1-2	1	3.33%
Senior Lecturer	AD1-3	25	83.33%

Appendix - D2: Analysis of academic sample in terms of field of specialisation of the respondents

Field of Study	Code	Frequency	Percentage
Architecture/Town and Country Planning	AD2-1	8	26.67%
Building Economics	AD2-2	11	36.67%
Civil/ Technology/ Environmental/ Infrastructure Engineering	AD2-3	11	36.67%

Appendix - D3: Analysis of academic sample in terms of publication efforts

Publication Number Category	Code	Frequency	Percentage
< 40	AD3-1	20	66.67%
40 - 60	AD3-2	7	23.33%
>60	AD3-3	3	10.00%

Appendix - E: Survey with Industry Organisations – Demographic Data Analysis

Appendix - E1: Analysis of industry organisation sample in terms of positions held by the respondents

Position Held	Code	Frequency	Percentage
General Manager	OD1-1	10	32.26%
Deputy General Manager	OD1-2	12	38.71%
Other (Section Head, Chief Engineer, Chief Quantity Surveyor)	OD1-3	09	29.03%

Appendix - E2: Analysis of industry organisation sample in terms of CIDA grade of the organisation

CIDA Grade	Code	Frequency	Percentage
C1	OD2-1	19	61.29%
C2	OD2-2	7	22.58%
C3	OD2-3	5	16.13%

Appendix - E3: Analysis of industry organisation sample in terms of years of experience of the respondents

Years of Experience category	Code	Frequency	Percentage
0-10 years	OD3-1	14	45.16%
11-15 years	OD3-2	5	16.13%
16-20 years	OD3-3	8	25.81%
Beyond 20 years	OD3-4	3	9.68%

Appendix - F: Survey with Industry Practitioners – Demographic Data Analysis

Appendix - F1: Analysis of industry practitioner sample in terms of positions held by the respondents

Position Held	Code	Frequency	Percentage
Quantity Surveyor	ID1-1	30	33.33%
Engineer	ID1-2	30	33.33%
Architect	ID1-3	30	33.33%

Appendix - F2: Analysis of industry practitioner sample in terms of organisation stakeholder group

Organisation Stakeholder Group	Code	Frequency	Percentage
Contractor	ID2-1	45	50.00%
Consultant	ID2-2	24	26.67%
Client	ID2-3	21	23.33%

Appendix - F3: Analysis of industry practitioner sample in terms of years of experience of the respondents

Years of Experience Category	Code	Frequency	Percentage
0-10 years	ID3-1	59	65.56%
11-15 years	ID3-2	13	14.44%
16-20 years	ID3-3	9	10.00%
Beyond 20 years	ID3-4	9	10.00%

Appendix - G: Analysis of Model - Chain of Knowledge Utilisation

Appendix - G1: Weightings (values as per expanded scale) of stages of Model - Chain of Knowledge Utilisation

Stage Number	Stage of Research Utilisation	Code	Weighting (Based on Stage and Ranking)				
			1	**2**	**3**	**4**	**5**
1	Reception	DE1	-14	-7	0	1	8
2	Cognition	DE2	-13	-6	0	2	9
3	Reference	DE3	-12	-5	0	3	10
4	Effort	DE4	-11	-4	0	4	11
5	Adoption	DE5	-10	-3	0	5	12
6	Implementation	DE6	-9	-2	0	6	13
7	Impact	DE7	-8	-1	0	7	14

Appendix - G2: Median and Percentile statistics of Model - Chain of Knowledge Utilisation as per the results of academic survey data analysis

Statistics

		DE1	DE2	DE3	DE4	DE5	DE6	DE7
N	Valid	30	30	30	30	30	30	30
	Missing	0	0	0	0	0	0	0
Median		4.00	4.00	3.00	3.00	2.50	2.50	3.00
Percentiles	25	3.00	3.00	2.00	2.00	2.00	2.00	2.00
	50	4.00	4.00	3.00	3.00	2.50	2.50	3.00
	75	4.00	4.00	4.25	4.00	3.25	4.00	4.00

Reliability Statistics

Cronbach's Alpha	N of Items
0.613	7

Appendix - H: Analysis of Pipeline Model of Knowledge Dissemination

Appendix - H1: Weightings (values as per expanded scale) of stages of Pipeline Model of Knowledge Dissemination

Stage Number	Stage of Research Utilisation	Code	Weighting (Based on Stage and Ranking)				
			1	**2**	**3**	**4**	**5**
1	Aware	U1	-14	-7	0	1	8
2	Accept	U2	-13	-6	0	2	9
3	Locally Applicable	U3	-12	-5	0	3	10
4	Doable	U4	-11	-4	0	4	11
5	Act	U5	-10	-3	0	5	12
6	Adopt	U6	-9	-2	0	6	13
7	Adhere	U7	-8	-1	0	7	14

Appendix - H2: Median and Percentile statistics of Pipeline Model of Knowledge Dissemination as per the results of industry organisation survey data analysis

Statistics

		U1	U2	U3	U4	U5	U6	U7
N	Valid	31	31	31	31	31	31	31
	Missing	0	0	0	0	0	0	0
Median		3.00	3.00	2.00	3.00	2.00	3.00	2.00
Percentiles	25	2.00	1.00	1.00	2.00	2.00	1.00	1.00
	50	3.00	3.00	2.00	3.00	2.00	3.00	2.00
	75	4.00	4.00	4.00	4.00	4.00	4.00	4.00

Reliability Statistics

Cronbach's Alpha	N of Items
0.859	7

Appendix - H3: Median and Percentile statistics of Pipeline Model of Knowledge Dissemination as per the results of industry practitioner survey data analysis

Statistics

		U1	U2	U3	U4	U5	U6	U7
N	Valid	90	90	90	90	90	90	90
	Missing	0	0	0	0	0	0	0
Median		3.00	3.00	2.00	2.00	3.00	3.00	2.00
Percentiles	25	2.00	2.00	2.00	1.75	1.00	2.00	1.00
	50	3.00	3.00	2.00	2.00	3.00	3.00	2.00
	75	4.00	4.00	3.00	4.00	4.00	4.00	4.00

Reliability Statistics

Cronbach's Alpha	N of Items
0.871	7

Appendix - I: Analysis of Internal Barriers for Academics in Dissemination of Research Knowledge

Appendix - I1: Internal barriers for academics in dissemination of research knowledge, with assigned codes

Internal Barrier	Code
Research culture of the affiliation demanding to involve in either pure or applied research	IB1
Maintaining traditional research culture while partnering with a commercial industry	IB2
Increased work load due to raised number of universities, colleges and students	IB3
Increasing pressure from stakeholder groups upon quality assurance and outcome based education	IB4
Tension due to funding mechanisms	IB5
Iniquity of rewards for research and teaching	IB6
"Think global, act local" challenge	IB7
Time pressure	IB8
Poor planning and absence of a proper outcome dissemination strategy	IB9
Low success in getting research funds	IB10

Appendix - I2: Median and Percentile statistics of internal barriers for academics, in dissemination of research knowledge as per the results of academic survey data analysis

Statistics

		IB1	IB2	IB3	IB4	IB5	IB6	IB7	IB8	IB9	IB10
N	Valid	30	30	30	30	30	30	30	30	30	30
	Missing	0	0	0	0	0	0	0	0	0	0
Median		3.00	3.00	4.00	4.00	4.00	3.00	3.00	4.00	3.00	3.00
Percentiles	25	2.00	3.00	4.00	3.00	3.00	2.00	2.75	3.00	2.00	2.00
	50	3.00	3.00	4.00	4.00	4.00	3.00	3.00	4.00	3.00	3.00
	75	4.00	4.00	5.00	4.25	5.00	4.00	4.00	5.00	4.00	4.25

Reliability Statistics

Cronbach's Alpha	N of Items
0.774	10

Appendix - I3: Ordinal Regression analysis parameter estimates of internal barriers for academics, in dissemination of research knowledge as per the results of academic survey data analysis

Parameter Estimates								
							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Location	IB1W	.243	.361	.452	1	.502	-.465	.950
	IB2W	-.242	.486	.247	1	.619	-1.195	.712
	IB3W	.795	.735	1.171	1	.279	-.645	2.236
	IB4W	.086	.513	.028	1	.867	-.920	1.092
	IB5W	-1.094	.443	6.104	1	.013	-1.962	-.226
	IB6W	-.385	.506	.581	1	.446	-1.376	.606
	IB7W	-1.751	.539	10.565	1	.001	-2.807	-.695
	IB8W	.848	.805	1.111	1	.292	-.729	2.426
	IB9W	1.424	.497	8.224	1	.004	.451	2.397
	IB10W	.188	.343	.300	1	.584	-.485	.862

Appendix - J: Analysis of External Barriers for Academics in Dissemination of Research Knowledge

Appendix - J1: External barriers for academics in dissemination of research knowledge, with assigned codes

External Barrier	Code
Diminishing financial support from public sources for research	EB1
Passive and low opportunity for actual research outcome dissemination	EB2
Inadequate quality assurance mechanisms for research	EB3
Inadequate allocation of resources for research	EB4
Lack of autonomy in higher education	EB5
Ignorance of fashionable management concepts by practitioners	EB6
Effects of research takes long time to get appear even if adopted	EB7
Low- and middle- income countries inability in reviewing and preventing low quality of research programmes	EB8
Increased global competition in higher education and research	EB9
Indicators of "world-class universities" and "cutting-edge" research reduces the chances for less privileged universities	EB10
Commercialization of university research	EB11
Goals and paradigms of trans-national research driven by the perspectives of economically advanced countries	EB12

Appendix - J2: Median and Percentile statistics of external barriers for academics in dissemination of research knowledge as per the results of academic survey data analysis

Statistics													
		EB 1	EB 2	EB 3	EB 4	EB 5	EB 6	EB 7	EB 8	EB 9	EB 10	EB 11	EB 12
N	Valid	30	30	30	30	30	30	30	30	30	30	30	30
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Median		4.0	4.0	4.0	4.0	3.0	3.00	4.0	3.00	3.50	3.50	3.00	4.00
Percentiles	25	3.0	3.0	3.0	3.0	1.0	2.00	3.0	2.00	2.00	2.00	2.00	3.00
	50	4.0	4.0	4.0	4.0	3.0	3.00	4.0	3.00	3.50	3.50	3.00	4.00
	75	4.0	4.0	5.0	5.0	4.0	4.25	5.0	4.25	4.25	4.00	4.00	5.00

Reliability Statistics

Cronbach's Alpha	N of Items
0.793	12

Appendix - J3: Ordinal Regression analysis parameter estimates of external barriers for academics, in dissemination of research knowledge as per the results of academic survey data analysis

Parameter Estimates								
							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Threshold	EB1W	-.265	.566	.219	1	.640	-1.375	.845
	EB2W	.316	.478	.438	1	.508	-.621	1.254
	EB3W	-1.414	.581	5.922	1	.015	-2.553	-.275
	EB4W	.044	.397	.012	1	.912	-.734	.821
	EB5W	.570	.466	1.498	1	.221	-.343	1.484
	EB6W	.115	.486	.056	1	.813	-.837	1.067
	EB7W	.084	.458	.034	1	.855	-.814	.982
	EB8W	-.762	.388	3.844	1	.050	-1.523	.000
	EB9W	1.835	.739	6.162	1	.013	.386	3.284
	EB10W	-2.495	.731	11.651	1	.001	-3.927	-1.062
	EB11W	-.750	.475	2.493	1	.114	-1.681	.181
	EB12W	2.260	.556	16.502	1	.000	1.170	3.351

Appendix - K: Analysis of Internal Barriers for Construction Industry in Utilisation of Research Knowledge

Appendix - K1: Internal barriers for construction industry in utilisation of research knowledge, with assigned codes

Internal Barrier	Code
Lack of skilled people to promote innovations	BW1
Research outcome capturing is difficult as it is tacit knowledge intensive	BW2
Link between research & development and profit levels is not visible	BW3
Unawareness due to research outcome not reaching the industry	BW4
Competition among construction companies being highly price based	BW6
Less incentives for interest on research & development activities	BW7
Out-dated skills of professionals failing to match with requirements of innovations	BW8
High cost of training employees to match with requirements of innovations	BW9
Constantly changing team compositions disturbs information flow and methods of innovation diffusion	BW10
Academic research more focused on subjects which are not crucial for the construction industry	BW11
Poor organisational learning orientation	BW12
Challenging requirement of adapting to a number of personal and professional changes at a rapid pace	BW13
No proper structure to accumulate financial capital to invest in research	BW14
Research reported in an academic style making difficult to interpret	BW15

Appendix - K2: Median and Percentile statistics of internal barriers for construction industry, in utilisation of research knowledge as per the results of industry organisation survey data analysis

Statistics

		BW1	BW2	BW3	BW4	BW5	BW6	BW7	BW8	BW9	BW10	BW11	BW12	BW13	BW14	BW15
N	Valid	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Median		4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Percentiles	25	2.0	2.0	2.0	3.0	2.0	2.0	3.0	2.0	2.0	2.0	2.0	2.0	3.0	2.0	2.0
	50	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	75	5.0	4.0	4.0	5.0	4.0	4.0	4.0	5.0	4.0	5.0	5.0	4.0	5.0	4.0	5.0

Reliability Statistics

Cronbach's Alpha	N of Items
0.819	15

Appendix - K3: Median and Percentile statistics of internal barriers for construction industry, in utilisation of research knowledge as per the results of industry practitioner survey data analysis

Statistics																
		BW1	**BW2**	**BW3**	**BW4**	**BW5**	**BW6**	**BW7**	**BW8**	**BW9**	**BW10**	**BW11**	**BW12**	**BW13**	**BW14**	**BW15**
N	Valid	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
	Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Median		4.00	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.00	3.0
Percentiles	25	2.75	2.0	2.0	2.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	3.0	2.0	2.00	2.0
	50	4.00	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.00	3.0
	75	5.00	4.0	4.0	5.0	5.0	5.0	5.0	4.0	4.0	4.0	5.0	4.0	4.0	4.25	4.0

Reliability Statistics

Cronbach's Alpha	**N of Items**
0.868	15

Appendix - K4: Ordinal Regression analysis parameter estimates of internal barriers for construction industry, in utilisation of research knowledge as per the results of industry organisation survey data analysis

Parameter Estimates								
							95% Confidence Interval	
		Estimate	**Std. Error**	**Wald**	**df**	**Sig.**	**Lower Bound**	**Upper Bound**
Location	BW1W	-.179	.386	.214	1	.644	-.935	.578
	BW2W	.352	.466	.573	1	.449	-.560	1.265
	BW3W	.341	.475	.516	1	.473	-.590	1.272
	BW4W	1.227	.622	3.894	1	.048	.008	2.445
	BW5W	-1.857	.496	14.031	1	.000	-2.829	-.886
	BW6W	-1.658	.495	11.206	1	.001	-2.628	-.687
	BW7W	1.684	.502	11.251	1	.001	.700	2.668
	BW8W	-.599	.427	1.970	1	.160	-1.437	.238
	BW9W	-.486	.384	1.601	1	.206	-1.239	.267
	BW10W	.430	.349	1.519	1	.218	-.254	1.115
	BW11W	1.622	.451	12.910	1	.000	.737	2.506
	BW12W	.532	.353	2.275	1	.131	-.159	1.223
	BW13W	-1.655	.472	12.274	1	.000	-2.580	-.729
	BW14W	1.076	.436	6.100	1	.014	.222	1.930
	BW15W	.490	.405	1.465	1	.226	-.304	1.284

Appendix - K5: Ordinal Regression analysis parameter estimates of internal barriers for construction industry, in utilisation of research knowledge as per the results of industry practitioner survey data analysis

Parameter Estimates								
			Std.				95% Confidence Interval	
		Estimate	Error	Wald	df	Sig.	Lower Bound	Upper Bound
Location	BW1W	-.100	.196	.262	1	.609	-.484	.284
	BW2W	.341	.210	2.650	1	.104	-.070	.753
	BW3W	.012	.184	.004	1	.948	-.349	.373
	BW4W	-.214	.232	.851	1	.356	-.669	.241
	BW5W	-.097	.232	.175	1	.676	-.551	.358
	BW6W	-.042	.187	.050	1	.823	-.408	.324
	BW7W	-.181	.205	.774	1	.379	-.583	.222
	BW8W	.189	.285	.441	1	.506	-.369	.747
	BW9W	-.309	.180	2.950	1	.086	-.661	.044
	BW10W	.624	.214	8.530	1	.003	.205	1.043
	BW11W	.109	.168	.424	1	.515	-.220	.438
	BW12W	-.294	.201	2.145	1	.143	-.687	.099
	BW13W	.173	.197	.775	1	.379	-.213	.559
	BW14W	.121	.226	.287	1	.592	-.321	.563
	BW15W	.050	.183	.074	1	.786	-.308	.408

Appendix - L: Analysis of External Barriers for Construction Industry in Utilisation of Research Knowledge

Appendix - L1: External barriers for construction industry in utilisation of research knowledge, with assigned codes

External Barriers	Code
Difficulties in going ahead with current construction industry development trends	BB1
Reluctance to invest on research	BB2
Ignorance of good quality academic research	BB3
Educational research does not often lead directly to practical advances	BB4
Low attention given to construction product quality	BB5
Less funded/consulted research being low influential/useful	BB6
Very unique nature of construction industry	BB7
Ignorance of the knowledge worker and importance of skills agenda	BB8
Highly fragmented nature of construction industry	BB9
Complexity of construction industry production process	BB10
"One off" nature of many construction projects	BB11
Clients interest of 'lowest-price criteria' to award contracts	BB12
Slow pace of development in construction sector	BB13
Low responsiveness to change	BB14
Lack of investment on R&D by the industry	BB15
Research outcomes are impractical to use in real- life construction projects	BB16
Industry lacks leadership to direct towards research and development	BB17
Industry is timid in adapting management innovations	BB18
Industry is driven by the technology push over the demand pull	BB19
Industry's short-term focus on achieving project goals	BB20
Limited resources and opportunities for supply chain driven innovation	BB21
Risk averse nature of the construction industry	BB22
Industry mind-set that academic research is not directly usable and valid	BB23

Appendix - L2: Median and Percentile statistics of external barriers for construction industry, in utilisation of research knowledge as per the results of industry organisation survey data analysis

Statistics

		BB 1	BB 2	BB 3	BB 4	BB 5	BB 6	BB 7	BB 8	BB 9	BB 10	BB 11	BB 12	BB 13	BB 14	BB 15	BB 16	BB 17	BB 18	BB 19	BB 20	BB 21	BB 22	BB 23
N	Valid	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Median		4.0	4.0	4.0	3.0	2.0	2.0	3.0	4.0	3.0	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Percentiles	25	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	4.0	2.0	2.0	3.0	2.0	2.0
	50	4.0	4.0	4.0	3.0	2.0	2.0	3.0	4.0	3.0	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	75	4.0	5.0	5.0	5.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	5.0	5.0	5.0	4.0	5.0	4.0	4.0	4.0	4.0	4.0

Reliability Statistics

Cronbach's Alpha	N of Items
0.733	23

Appendix - L3: Median and Percentile statistics of external barriers for construction industry, in utilisation of research knowledge as per the results of industry practitioner survey data analysis

Statistics

		BB 1	BB 2	BB 3	BB 4	BB 5	BB 6	BB 7	BB 8	BB 9	BB 10	BB 11	BB 12	BB 13	BB 14	BB 15	BB 16	BB 17	BB 18	BB 19	BB 20	BB 21	BB 22	BB 23
N	Valid	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
	Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Median		3.0	4.0	4.0	4.0	3.0	3.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0
Percentiles	25	2.0	2.0	3.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	2.0	2.0	2.0	3.0	2.0	2.0	2.0
	50	3.0	4.0	4.0	4.0	3.0	3.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0	3.0	4.0	4.0	4.0	4.0
	75	4.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	5.0	4.0	4.0	4.0	4.0	5.0	4.0	4.0	4.0

Reliability Statistics

Cronbach's Alpha	N of Items
0.869	23

Appendix - L4: Ordinal Regression analysis parameter estimates of external barriers for construction industry, in utilisation of research knowledge as per the results of industry organisation survey data analysis

Parameter Estimates								
			Std.				95% Confidence Interval	
		Estimate	Error	Wald	df	Sig.	Lower Bound	Upper Bound
Location	BB1W	-7.336	2.003	13.414	1	.000	-11.261	-3.410
	BB2W	2.649	.792	11.194	1	.001	1.097	4.201
	BB3W	3.326	1.411	5.555	1	.018	.560	6.092
	BB4W	5.501	1.976	7.746	1	.005	1.627	9.374
	BB5W	.781	1.588	.242	1	.623	-2.331	3.893
	BB6W	-6.503	2.130	9.323	1	.002	-10.677	-2.329
	BB7W	-2.763	1.177	5.506	1	.019	-5.071	-.455
	BB8W	2.306	1.906	1.465	1	.226	-1.429	6.042
	BB9W	-8.485	3.680	5.318	1	.021	-15.697	-1.274
	BB10W	9.561	2.935	10.609	1	.001	3.808	15.315
	BB11W	-4.850	1.871	6.719	1	.010	-8.517	-1.183
	BB12W	13.083	3.865	11.460	1	.001	5.508	20.658
	BB13W	-3.384	1.123	9.084	1	.003	-5.585	-1.184
	BB14W	.055	.578	.009	1	.924	-1.078	1.189
	BB15W	-1.807	1.353	1.783	1	.182	-4.459	.845
	BB16W	-9.215	2.532	13.243	1	.000	-14.178	-4.252
	BB17W	5.103	1.549	10.848	1	.001	2.066	8.139
	BB18W	13.375	3.933	11.563	1	.001	5.666	21.085
	BB19W	8.420	2.523	11.140	1	.001	3.476	13.365
	BB20W	2.103	1.536	1.875	1	.171	-.907	5.113
	BB21W	-5.394	2.050	6.924	1	.009	-9.411	-1.376
	BB22W	-5.667	2.745	4.262	1	.039	-11.047	-.287
	BB23W	-.603	.915	.434	1	.510	-2.397	1.191

Appendix - L5: Ordinal Regression analysis parameter estimates of external barriers for construction industry, in utilisation of research knowledge as per the results of industry practitioner survey data analysis

Parameter Estimates								
							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Location	BB1W	.288	.179	2.599	1	.107	-.062	.638
	BB2W	-.125	.208	.364	1	.547	-.532	.282
	BB3W	-.509	.237	4.604	1	.032	-.973	-.044
	BB4W	-.014	.194	.006	1	.941	-.395	.366
	BB5W	.058	.175	.109	1	.741	-.285	.400
	BB6W	-.222	.196	1.281	1	.258	-.606	.162
	BB7W	-.190	.227	.702	1	.402	-.635	.255
	BB8W	.119	.240	.245	1	.621	-.351	.589
	BB9W	.438	.249	3.083	1	.079	-.051	.926
	BB10W	.056	.178	.098	1	.754	-.293	.404
	BB11W	-.039	.229	.029	1	.865	-.487	.409
	BB12W	-.014	.175	.006	1	.936	-.357	.329
	BB13W	.513	.222	5.318	1	.021	.077	.948
	BB14W	-.646	.253	6.545	1	.011	-1.142	-.151
	BB15W	.370	.248	2.223	1	.136	-.116	.856
	BB16W	-.203	.211	.925	1	.336	-.618	.211
	BB17W	.023	.202	.013	1	.908	-.373	.420
	BB18W	.319	.192	2.756	1	.097	-.058	.697
	BB19W	.243	.222	1.204	1	.273	-.191	.678
	BB20W	-.014	.211	.004	1	.947	-.428	.400
	BB21W	.179	.227	.620	1	.431	-.266	.623
	BB22W	.042	.233	.032	1	.857	-.414	.498
	BB23W	-.018	.227	.006	1	.936	-.463	.427

Appendix - M: Analysis of Success Factors of Research Initiation for Academia, in Dissemination of Research Knowledge

Appendix - M1: Success factors of research initiation for academia, in dissemination of research knowledge, with assigned codes

Success Factors of Research Initiation	Code
Create new knowledge linked to development goals	WI1
Select research more biased towards applied sciences	WI2
Undertake conceptual research with the ability to gradually penetrate to the industry	WI3
Give the correct priority to the research	WI4
Select research more related to the teaching discipline of the academic	WI5
Focus not only on global challenges, but also on individual industries	WI8
Establish networks of expertise on research	WI9
Consider end-user perspective in planning knowledge dissemination	WI10
Add a dissemination plan into initial academic research proposals	WI11

Appendix - M2: Median and Percentile statistics of success factors of research initiation for academia, in dissemination of research knowledge as per the results of academic survey data analysis

Statistics

		WI1	WI2	WI3	WI4	WI5	WI6	WI7	WI8	WI9	WI10	WI11
N	Valid	30	30	30	30	30	30	30	30	30	30	30
	Missing	0	0	0	0	0	0	0	0	0	0	0
Median		4.00	4.00	4.00	4.00	4.00	4.00	4.50	4.00	4.00	4.00	4.00
Percentiles	25	3.00	3.75	3.00	3.00	3.00	4.00	4.00	3.00	4.00	3.00	3.75
	50	4.00	4.00	4.00	4.00	4.00	4.00	4.50	4.00	4.00	4.00	4.00
	75	5.00	5.00	5.00	5.00	4.25	5.00	5.00	5.00	5.00	5.00	5.00

Reliability Statistics

Cronbach's Alpha	N of Items
0.060	11

Appendix - M3: Ordinal Regression analysis parameter estimates of success factors of research initiation for academia, in dissemination of research knowledge as per the results of academic survey data analysis

Parameter Estimates								
							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Threshold	WI1W	.274	.483	.322	1	.570	-.672	1.220
	WI2W	.237	.498	.227	1	.634	-.738	1.213
	WI3W	-.312	.339	.845	1	.358	-.976	.353
	WI4W	-.856	.440	3.780	1	.052	-1.719	.007
	WI5W	-.827	.513	2.592	1	.107	-1.833	.180
	WI6W	-.850	.581	2.144	1	.143	-1.988	.288
	WI7W	-1.331	.609	4.775	1	.029	-2.525	-.137
	WI8W	-.572	.487	1.379	1	.240	-1.527	.383
	WI9W	3.742	1.210	9.558	1	.002	1.370	6.114
	WI10W	-.246	.496	.246	1	.620	-1.219	.726
	WI11W	1.585	.573	7.658	1	.006	.462	2.708

Appendix - N: Analysis of Success Factors of Research Execution for Academia, in Dissemination of Research Knowledge

Appendix - N1: Success factors of research execution for academia, in dissemination of research knowledge, with assigned codes

Success Factors of Research Execution	**Code**
Maintain required quality of research	WP1
Balance teach-ability, complexity and specificity of research	WP2
Follow a clear method based on research methodology	WP3
Include summary documents	WP4
Send affiliation authorized thanking letters to study participants	WP5
Send newsletters to study participants	WP6
Treat research as a value creation process by being ethical	WP7
Reduce complications and administrative burdens of research funding	WP8
Establish academic research development centres	WP9

Appendix - N2: Median and Percentile statistics of success factors of research execution for academia, in dissemination of research knowledge as per the results of academic survey data analysis

Statistics

		WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9
N	Valid	30	30	30	30	30	30	30	30	30
	Missing	0	0	0	0	0	0	0	0	0
Median		4.00	4.00	4.00	4.00	4.00	4.00	5.00	5.00	5.00
Percentiles	25	4.00	4.00	4.00	3.00	3.75	3.00	4.00	4.00	4.00
	50	4.00	4.00	4.00	4.00	4.00	4.00	5.00	5.00	5.00
	75	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

Reliability Statistics

Cronbach's Alpha	**N of Items**
0.597	9

Appendix - N3: Ordinal Regression analysis parameter estimates of success factors of research execution for academia, in dissemination of research knowledge as per the results of academic survey data analysis

Parameter Estimates								
			Std.				95% Confidence Interval	
		Estimate	Error	Wald	df	Sig.	Lower Bound	Upper Bound
Location	WP1W	.057	.461	.015	1	.902	-.848	.961
	WP2W	.088	.456	.037	1	.846	-.805	.982
	WP3W	.585	.571	1.049	1	.306	-.534	1.704
	WP4W	.238	.414	.329	1	.566	-.574	1.049
	WP5W	.182	.423	.185	1	.667	-.647	1.011
	WP6W	-.114	.409	.078	1	.780	-.916	.688
	WP7W	.316	.728	.188	1	.664	-1.110	1.742
	WP8W	-.780	.815	.915	1	.339	-2.378	.818
	WP9W	-.107	.552	.037	1	.847	-1.189	.975

Appendix - O: Analysis of Success Factors of Research Dissemination for Academia

Appendix - O1: Success factors of research dissemination for academia, with assigned codes

Success factors of Research Dissemination	Code
Use multiple dissemination techniques	WD1
Recruit specialist staff with business potential to manage knowledge resources	WD2
Put stronger efforts to communicate outcomes of higher level research to a broader community	WD3
Ensure availability of the product to the target audience	WD4
Allow for feedback from audiences	WD5
In dissemination, tailor research findings to a target audience to increase use of research in policy making	WD6
Present research outcome as a benefit or a solution to a problem	WD7

Appendix - O2: Median and Percentile statistics of success factors of research dissemination for academia as per the results of academic survey data analysis

Statistics

		WD1	WD2	WD3	WD4	WD5	WD6	WD7
N	Valid	30	29	30	30	30	30	30
	Missing	0	1	0	0	0	0	0
Median		4.00	4.00	4.00	5.00	4.00	4.00	4.00
Percentiles	25	3.75	3.00	4.00	4.00	4.00	4.00	3.00
	50	4.00	4.00	4.00	5.00	4.00	4.00	4.00
	75	5.00	5.00	5.00	5.00	5.00	5.00	5.00

Reliability Statistics

Cronbach's Alpha	N of Items
0.647	7

Appendix - O3: Ordinal Regression analysis parameter estimates of success factors of research execution for academia, in dissemination of research knowledge as per the results of academic survey data analysis

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Location	WD1W	-.159	.548	.085	1	.771	-1.235	.916
	WD2W	.134	.411	.106	1	.745	-.672	.939
	WD3W	.706	.503	1.969	1	.161	-.280	1.693
	WD4W	.527	.559	.889	1	.346	-.569	1.622
	WD5W	-1.312	.726	3.262	1	.071	-2.736	.112
	WD6W	1.108	.535	4.288	1	.038	.059	2.157
	WD7W	.131	.371	.125	1	.724	-.596	.857

Appendix - P: Analysis of Success Factors of Research Utilisation, to be Implemented Internally by Construction Industry

Appendix - P1: Success factors of research utilisation, to be implemented internally by construction industry, with assigned codes

Success Factors to be implemented Internally	Code
Change internal dynamics of construction organisations to be able to respond to change	WW1
Use research literacy as a criterion for staff appraisal	WW2
Combine in-house and external resources	WW3
Aim to maximize economic value through intellectual property	WW4
Ask project managers to identify and report on innovation opportunities	WW5
Increase senior management's awareness on benefits of external knowledge can bring to organisation budgets	WW6
Reward research-informed decision-making	WW7
Organise events with employees returning from a conference to share knowledge to other employees	WW8
Develop a mechanism to identify important innovative management practices from research	WW9
Offer chances to attend conferences as a reward for deserved employees	WW10
Share how new knowledge has contributed to improved performance to create an explicit cause-and-effect link within the organisation	WW11
Promote the concept of 'knowledge worker'	WW12

Appendix - P2: Median and Percentile statistics of success factors of research utilisation, to be implemented internally by construction industry as per the results of industry organisation survey data analysis

Statistics													
		WW1	WW2	WW3	WW4	WW5	WW6	WW7	WW8	WW9	WW10	WW11	WW12
N	Valid	31	31	31	31	31	31	31	31	31	31	31	31
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Median		4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Percentiles	25	3.0	2.0	2.0	2.0	4.0	3.0	4.0	2.0	3.0	3.0	2.0	4.0
	50	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	75	5.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	4.0	5.0	5.0	5.0

Reliability Statistics

Cronbach's Alpha	N of Items
0.877	12

Appendix - P3: Median and Percentile statistics of success factors of research utilisation, to be implemented internally by construction industry as per the results of industry practitioner survey data analysis

Statistics													
		WW1	WW2	WW3	WW4	WW5	WW6	WW7	WW8	WW9	WW10	WW11	WW12
N	Valid	90	90	90	90	90	90	90	90	90	90	90	90
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Median		4.00	3.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Percentiles	25	3.00	2.00	2.75	3.00	3.00	2.00	3.00	2.00	3.00	3.00	3.00	3.00
	50	4.00	3.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	75	4.00	4.00	4.00	4.00	4.00	5.00	4.00	5.00	4.25	4.00	4.00	5.00

Reliability Statistics

Cronbach's Alpha	N of Items
0.885	12

Appendix - P4: Ordinal Regression analysis parameter estimates of success factors of research utilisation, to be implemented internally by construction industry as per the results of industry organisation survey data analysis

Parameter Estimates								
							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Location	WW1W	-.760	.427	3.162	1	.075	-1.598	.078
	WW2W	.187	.310	.366	1	.545	-.420	.794
	WW3W	.659	.352	3.515	1	.061	-.030	1.348
	WW4W	.658	.408	2.599	1	.107	-.142	1.457
	WW5W	-.286	.524	.298	1	.585	-1.312	.740
	WW6W	.713	.401	3.163	1	.075	-.073	1.499
	WW7W	-.321	.497	.418	1	.518	-1.296	.653
	WW8W	-.574	.361	2.529	1	.112	-1.281	.133
	WW9W	.435	.406	1.146	1	.284	-.361	1.231
	WW10W	.107	.451	.057	1	.812	-.777	.992
	WW11W	-.048	.345	.020	1	.889	-.724	.628
	WW12W	-.548	.453	1.466	1	.226	-1.435	.339

Appendix - P5: Ordinal Regression analysis parameter estimates of success factors of research utilisation, to be implemented internally by construction industry as per the results of industry practitioner survey data analysis

Parameter Estimates								
							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Location	WW1W	.354	.214	2.719	1	.099	-.067	.774
	WW2W	.095	.189	.256	1	.613	-.274	.465
	WW3W	-.329	.232	2.008	1	.156	-.783	.126
	WW4W	-.193	.240	.642	1	.423	-.664	.279
	WW5W	.019	.261	.005	1	.941	-.492	.530
	WW6W	.063	.221	.082	1	.774	-.370	.497
	WW7W	.261	.238	1.196	1	.274	-.206	.727
	WW8W	-.504	.361	2.529	1	.112	-.281	.133
	WW9W	.058	.212	.075	1	.784	-.357	.473
	WW10W	.018	.204	.008	1	.930	-.383	.419
	WW11W	.079	.245	.103	1	.748	-.402	.559
	WW12W	-.087	.222	.152	1	.697	-.522	.349

Appendix - Q: Analysis of Success Factors of Research Utilisation for Construction Industry, to be Implemented Externally

Appendix - Q1: Success factors of research utilisation for construction industry, to be implemented externally, with assigned codes

Success Factors to be Implemented Externally	Code
Develop approaches to promote Research and Development	WB1
Encourage industry to use research as a strategic resource	WB2
Direct industry in capacity building to access research	WB3
Encourage industry investments on research	WB4
Develop more innovative management friendly procurement methods	WB5
Move beyond the traditional practices to adopt new practices	WB6
Include research soundness into job-descriptions	WB7
Increase the ability to attract, retain and develop skilled people	WB8
Create networks with other/foreign industries to collaborate in developing construction management skills	WB9
Update knowledge of the workers in line with the new knowledge generation	WB10
Develop strategic and professional leadership for research and development through industry professional bodies	WB11

Appendix - Q2: Median and Percentile statistics of success factors of research utilisation for construction industry, to be implemented externally as per the results of industry organisation survey data analysis

Statistics

		WB 1	WB 2	WB 3	WB 4	WB 5	WB 6	WB 7	WB 8	WB 9	WB 10	WB 11
N	Valid	31	31	31	31	31	31	31	31	31	31	31
	Missing	0	0	0	0	0	0	0	0	0	0	0
Median		4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Percentiles	25	3.00	2.00	3.00	3.00	3.00	2.00	2.00	2.00	4.00	2.00	3.00
	50	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	75	5.00	4.00	4.00	4.00	4.00	4.00	4.00	5.00	5.00	5.00	5.00

Reliability Statistics

Cronbach's Alpha	N of Items
0.781	11

Appendix - Q3: Median and Percentile statistics of success factors of research utilisation for construction industry, to be implemented externally as per the results of industry practitioner survey data analysis

Statistics

		WB 1	WB 2	WB 3	WB 4	WB 5	WB 6	WB 7	WB 8	WB 9	WB 10	WB 11
N	Valid	90	90	90	90	90	90	90	90	90	90	90
	Missing	0	0	0	0	0	0	0	0	0	0	0
Median		4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Percentiles	25	3.00	3.00	3.00	3.00	3.00	3.00	2.00	2.00	3.00	3.00	3.00
	50	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	75	4.25	4.00	5.00	5.00	5.00	4.00	4.00	5.00	5.00	4.00	4.00

Reliability Statistics

Cronbach's Alpha	N of Items
0.899	11

Appendix - Q4: Ordinal Regression analysis parameter estimates of success factors of research utilisation for construction industry, to be implemented externally as per the results of industry organisation survey data analysis

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Location	WB1W	.186	.323	.334	1	.564	-.446	.819
	WB2W	.780	.439	3.156	1	.076	-.081	1.642
	WB3W	-.027	.438	.004	1	.950	-.887	.832
	WB4W	-.257	.393	.427	1	.514	-1.027	.514
	WB5W	.564	.362	2.434	1	.119	-.145	1.273
	WB6W	-.370	.298	1.535	1	.215	-.954	.215
	WB7W	.210	.419	.252	1	.616	-.611	1.031
	WB8W	-.465	.451	1.061	1	.303	-1.349	.419
	WB9W	.240	.468	.263	1	.608	-.678	1.157
	WB10W	.022	.318	.005	1	.944	-.602	.646
	WB11W	-.399	.323	1.521	1	.218	-1.032	.235

Appendix - Q5: Ordinal Regression analysis parameter estimates of success factors of research utilisation for construction industry, to be implemented externally as per the results of industry practitioner survey data analysis

Parameter estimates								
							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Location	WB1W	.195	.228	.738	1	.390	-.251	.641
	WB2W	-.283	.234	1.453	1	.228	-.742	.177
	WB3W	-.101	.219	.213	1	.644	-.531	.329
	WB4W	-.128	.225	.323	1	.570	-.570	.314
	WB5W	-.331	.237	1.955	1	.162	-.795	.133
	WB6W	-.303	.231	1.712	1	.191	-.756	.151
	WB7W	.399	.183	4.753	1	.029	.040	.758
	WB8W	.474	.220	4.647	1	.031	.043	.904
	WB9W	.127	.232	.300	1	.584	-.327	.581
	WB10W	-.113	.247	.210	1	.646	-.597	.371
	WB11W	.111	.218	.258	1	.612	-.316	.538

Appendix - R: Analysis of Success Factors to be Implemented by Academia and Construction Industry together for Research Collaborations

Appendix - R1: Success factors to be implemented by academia and construction industry together for research collaborations, with assigned codes

Success Factors to be Implemented together	Code
Resolve conflict of interest issues before legal and business arrangements	WT1
Introduce incentives to motivates staff and institutional leaders to participate in, or initiate, research collaborations	WT2
Direct student research more into actual issues in the industry	WT3
Increase communication between researchers, research funders and research users	WT4
Review how research can be more effectively connected to real-world activity and policy setting	WT5
Judge research programmes by industry impact and tangible benefit	WT6
Promote joint publications between university researchers and practitioners in industry and governing bodies	WT7
Practice the concept of knowledge brokering : an intermediary to develop relationships between producers and users of knowledge	WT8
Embed researchers within companies as part of existing research activity	WT9
Create strategic partnerships - formal alliance to help each other in achieving aims which cannot be achieved alone	WT10
Promote collaborations amongst governments, economic sector and research universities to link knowledge to development goals	WT11
Enhance researcher-practitioner collaboration to conduct research on vital problems to find adoptable solutions	WT12

Appendix - R2: Median and Percentile statistics of success factors to be implemented by academia and construction industry together for research collaborations as per the results of academic survey data analysis

Statistics

		WT 1	WT 2	WT 3	WT 4	WT 5	WT 6	WT 7	WT 8	WT 9	WT 10	WT 11	WT 12
N	Valid	30	30	29	30	30	30	30	30	29	30	30	30
	Missing	0	0	1	0	0	0	0	0	1	0	0	0
Median		4.00	5.00	4.00	5.00	4.00	4.00	4.00	4.00	3.00	5.00	5.00	5.00
Percentiles	25	3.00	4.00	4.00	4.00	3.00	3.00	3.00	3.00	3.00	4.00	4.00	4.00
	50	4.00	5.00	4.00	5.00	4.00	4.00	4.00	4.00	3.00	5.00	5.00	5.00
	75	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	4.00	5.00	5.00	5.00

Reliability Statistics

Cronbach's Alpha	N of Items
0.664	12

Appendix - R3: Median and Percentile statistics of success factors to be implemented by academia and construction industry together for research collaborations as per the results of industry organisation survey data analysis

Statistics

		WT 1	WT 2	WT 3	WT 4	WT 5	WT 6	WT 7	WT 8	WT 9	WT 10	WT 11	WT 12
N	Valid	31	31	31	31	31	31	31	31	31	31	31	31
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Median		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Percentiles	25	3.0	2.0	2.0	3.0	3.0	2.0	3.0	2.0	2.0	2.0	3.0	2.0
	50	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	75	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

Reliability Statistics

Cronbach's Alpha	N of Items
0.930	12

Appendix - R4: Median and Percentile statistics of success factors to be implemented by academia and construction industry together for research collaborations as per the results of industry practitioner survey data analysis

Statistics

		WT 1	WT 2	WT 3	WT 4	WT 5	WT 6	WT 7	WT 8	WT 9	WT 10	WT 11	WT 12
N	Valid	90	90	90	90	90	90	90	90	90	90	90	90
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Median		4.00	4.00	4.00	4.00	3.50	4.00	4.00	3.00	4.00	4.00	4.00	4.00
Percentiles	25	3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00	3.00	3.00	3.00	3.00
	50	4.00	4.00	4.00	4.00	3.50	4.00	4.00	3.00	4.00	4.00	4.00	4.00
	75	4.00	5.00	5.00	4.00	5.00	5.00	5.00	4.00	4.00	4.00	5.00	4.00

Reliability Statistics

Cronbach's Alpha	N of Items
0.918	12

Appendix - R5: Ordinal Regression analysis parameter estimates of success factors to be implemented by academia and construction industry together for research collaborations as per the results of academic survey data analysis

Parameter Estimates								
							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Location	WT1W	.085	.468	.033	1	.856	-.832	1.001
	WT2W	-.289	.493	.344	1	.558	-1.254	.677
	WT3W	-.219	.594	.136	1	.712	-1.382	.944
	WT4W	-.559	.638	.768	1	.381	-1.808	.691
	WT5W	-1.657	.702	5.571	1	.018	-3.032	-.281
	WT6W	1.341	.895	2.246	1	.134	-.413	3.095
	WT7W	.592	.470	1.587	1	.208	-.329	1.513
	WT8W	1.333	.422	10.004	1	.002	.507	2.160
	WT9W	-.218	.525	.172	1	.678	-1.247	.811
	WT10W	-1.371	.697	3.875	1	.049	-2.737	-.006
	WT11W	.775	.807	.923	1	.337	-.806	2.357
	WT12W	-.550	.480	1.310	1	.252	-1.492	.392

Appendix - R6: Ordinal Regression analysis parameter estimates of success factors to be implemented by academia and construction industry together for research collaborations as per the results of industry organisation survey data analysis

Parameter Estimates								
							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Location	WT1W	2.027	.497	16.605	1	.000	1.052	3.001
	WT2W	-1.207	.459	6.924	1	.009	-2.106	-.308
	WT3W	-.987	.592	2.782	1	.095	-2.148	.173
	WT4W	1.634	.944	2.995	1	.084	-.216	3.485
	WT5W	-1.630	.570	8.167	1	.004	-2.748	-.512
	WT6W	-1.392	.573	5.900	1	.015	-2.516	-.269
	WT7W	1.294	.703	3.390	1	.066	-.084	2.671
	WT8W	.502	.849	.349	1	.555	-1.163	2.166
	WT9W	-2.541	.633	16.098	1	.000	-3.782	-1.300
	WT10W	1.231	.690	3.179	1	.075	-.122	2.584
	WT11W	1.904	.877	4.714	1	.030	.185	3.623
	WT12W	-.202	.620	.106	1	.745	-1.417	1.014

Appendix - R7: Ordinal Regression analysis parameter estimates of success factors to be implemented by academia and construction industry together for research collaborations as per the results of industry practitioner survey data analysis

Parameter Estimates								
		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Location	WT1W	-.234	.249	.885	1	.347	-.722	.254
	WT2W	.631	.247	6.545	1	.011	.148	1.115
	WT3W	-.194	.253	.583	1	.445	-.690	.303
	WT4W	.018	.260	.005	1	.946	-.492	.527
	WT5W	.182	.255	.508	1	.476	-.318	.682
	WT6W	-.077	.262	.088	1	.767	-.590	.435
	WT7W	-.397	.258	2.379	1	.123	-.902	.108
	WT8W	.228	.258	.786	1	.375	-.277	.734
	WT9W	-.400	.276	2.102	1	.147	-.940	.141
	WT10W	.267	.261	1.052	1	.305	-.243	.778
	WT11W	.450	.308	2.132	1	.144	-.154	1.055
	WT12W	-.294	.298	.973	1	.324	-.878	.290

Appendix - S: Samples of Interview Guidelines

Appendix - S1: Interview guideline devised to collect data from academic experts under Phase II of data collection

Appendix - S2: Interview guideline devised to collect data from innovative industry organisations under Phase II of data collection