AN EMPIRICAL INVESTIGATION INTO INNOVATION IN THE UK RAIL INDUSTRY

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A thesis submitted to the University of Huddersfield in partial fulfilment of the requirements for the degree of Doctor of Philosophy

The University of Huddersfield

May 2019

Abstract

An empirical investigation into innovation in the UK rail

This research investigates the innovation landscape within the UK rail sector, in order to try and identify barriers to innovation, and to propose evidenced based recommendations. British railways are experiencing a huge increase in the number of journeys made and the number of passengers travelling (ATOC, 2013). In fact, demand in the UK sector is greater than other European countries, with passenger numbers growing by 62% between 1997-98 and 2011 (Rail Delivery Group, 2014). As such, the railway industry is supporting the continuous development and improvement of rail technology to satisfy this growing demand. For this purpose, the UK government and rail industry regard innovation as the key enabler of a beneficial and prosperous rail industry (TSLG, 2012). Innovations are essential in railways in order to satisfy the interests of its customers, both passengers and freight and to make railways financially and environmentally viable in the longer term. However, the industry is facing challenges to improve railway's competitive position and to contribute to the health and wealth of the society. As such, the central purpose of this research is to investigate the barriers to innovation in the UK rail industry, in order to support its vision to exploit a rich stream of innovations to meet future demands.

An exploratory research design, embracing a mixed-methods approach was used to analyse the issues associated with innovation development and implementation within the UK. The research engages both primary and secondary stakeholders to identify the current barrier to innovation. The qualitative data was gathered through 43 in-depth interviews with the UK rail professionals, comprising of the key stakeholders involved in innovation such as train operators, innovators, government bodies, regulatory bodies and manufacturing organisations, and diverse views and roles within the organisations. These included senior management, middle management, and the front of line employees such as engineers and innovators. Further an online survey was designed to collect the quantitative data of this research with 57 responses, which gave the qualitative results verisimilitude. In addition, qualitative secondary data analysis was conducted to compare the findings to the perceived issues identified by the industry. The analysis of the combined approaches enabled the researcher to develop a comprehensive understand of the barriers to innovation, identify gaps in industry knowledge and recommend solutions to accelerate innovation within the UK rail sector. The research finds barriers to innovation arise due to 6 main areas: fragmented structure of the industry; the innovation process; franchising in train operating companies, culture and people; funding; and external political/government and media related factors. The thesis further draws the interrelations and interdependencies of these core areas that cause barriers to innovation.

The research makes incremental contributions to the general body of knowledge of innovation (Nicholson *et al.*, 2018), about the neglected rail industry that maybe valuable to those working in the UK rail industry and wider transportation industry. The results led to the development of an Innovation Framework that provides a road map for successful integration and exploitation of the key elements of innovation, such that the barriers to innovation can be addressed, and value created for all stakeholders while gaining sustainable competitive advantage. In addition, an Innovation Model was developed to guide the industry to transform from its current innovation scenario to a desired ideal innovation led state, by means of short and long term measures to continuously create value for all stakeholders and lay foundations for long terms transformations to gain sustainable competitive advantage. Specific recommendations for future research have also been made.

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List of Abbreviations

ATOC	Association of Train Operating Companies
BIS	Department of Business Innovation and Skills
BR	British Railway
CaSL	Cancellations and Significant Lateness
CER	Community of European Railway and Infrastructure Companies
DfT	Department for Transport
FMEA	Failure Mode and Effects Analysis
GP	General Practitioner
IP	Intellectual Property
MAA	Moving Annual Average
OECD	Organization for Economic Co-operation and Development
ORR	Office of Railway and Road
PPM	Public Performance Measure
QFD	Quality Function Development
R&D	Research and Development
RBV	Resource Based View
RD&I	Research Development and Innovation
RDG	Rail Delivery Group
RIA	Rail Industry Association
ROSCOs	Rolling Stock Operating Companies
RSG	Rail Supply Group
RSSB	Rail Safety and Standard Board
RTS	Rail Technical Strategy
SME	Small and Medium-sized Enterprise
SPSS	Statistical Package for the Social Sciences
TLG	Technical Leadership Group
TOC	Train Operating Companies

TRL	Technical Readiness Level
TSAG	The Technical Strategy and Advisory Group
TSLG	Technical Strategy Leadership Group
TTCI	Transport Technology Centre Inc.
UK	United Kingdom
VRIO	Valuable, Rare, Inimitable, Organisational

Copyright statement

Acknowledgments

Undertaking this PhD has been a remarkable experience that has not only contributed to my professional development but has significantly contributed towards my personal growth. Throughout this research I have received guidance and support from several people without which I would have not been able to successfully manage the highs and lows of this journey to accomplish my thesis.

First and foremost, I would like to express my sincere gratitude and great appreciation to my supervisory team, starting with Professor David Bamford, for his unfailing guidance, scholarly inputs, and consistent inspiration encouragement. It was due to his strong faith in my capabilities and mentorship that I was able to overcome the hurdles experienced along the way. Second, I would like to extend my exceptional thanks to Professor Simon Iwnicki for giving me this opportunity in the first place and for consistently supporting and guiding me, to be able to navigate through the complex UK rail industry and develop useful networks for this research. I am also particularly grateful to Professor David Bamford’s Operations Management team for their timely encouragement, wise advice, and funding support.

Furthermore, I would like to thank all the participants who were involved in the data collection phase of this research for their time and for sharing their valuable experiences, knowledge, and contacts, that form the foundations of this research.

Finally, I would like to express my deepest appreciation and gratitude to my husband Amir, for his faith in me and encouragement to work to the best of my ability. Without his undeniable unselfish support and patience, I would not have been able to accomplish this thesis.

1. Introduction

1.1. Introduction

This chapter forms the first of the six chapters of this thesis, and intends to introduce the reader to the research, in terms of what the focus of the research is, why it was conducted, and how it was conducted. This is achieved by providing a research summary as a way of setting the scene, particularly by defining the scope of the study. This chapter also provides a detailed account of the research background and a brief description of the concepts that frame the research foundation, thus positioning the study within the literature context. Subsequently, the research aims and objectives are defined, along with the research questions. This is followed by the methodological approach adopted to best answer the research questions, and the main conclusions of the research that support its incremental contributions (Nicholson *et al.*, 2018) towards the neglected area (Nicholson *et al.*, 2018) of barriers to innovations within the UK rail industry. Finally, the chapter concludes with improving readers ease to navigate through the thesis by summarising the structure of this thesis.

1.2. Research background

This section gives the background to the investigation. In order to understand the rationale of conducting this investigation, it is vital to know about the major events of the past that have set the current course of the UK rail industry. This section starts with a brief account of the privatisation of the UK rail industry from mid to late 1990s, to better understand the current state and structure of the UK rail industry.

In the 1970s the British Rail (BR) displayed a strong culture with an engineering focus on running the railway (Dent, 1991; Wellings, 2014). Despite the strong culture, BR had poor organisation excellence (Wellings, 2014), but the privatisation was avoided by the Thatcher government of the 1980s for being too difficult and politically unacceptable (Shaw, 2000). However, under the pressure of declining share in the transportation market, the BR was restructured into a business-sector structure (Wellings, 2014). BR achieved success under this vertically integrated railway, and as argued by Gourvish *et al.* (2004), with the benefit of a high level of corporate railway morale (Wellings, 2014). This demonstrated that the railway could be split up, as having access to private funding would lessen its dependence on public funds, thus making up for the argument of loss-making entity being not suitable for privatisation

(Wellings, 2014). As such in the 1900s, the Railway Act of 1993 paved the way for privatisation. It was based on a complex structure (Wellings, 2014), vertically and horizontally segregated into over 100 different organisations (Preston, 2018). It intended to introduce competition in the market through open access for freight and some passenger services, and competition for the market by franchising passenger services (Preston, 2018). New mechanisms and public bodies were established to administer and regulate the system (Preston, 2018). The adopted complex structure on one hand unbundled various activities, and on the other hand developed a set of contractual agreements for simultaneous coordination and competition (Yvrande-Billon & Ménard, 2005). Yvrande-Billon and Ménard (2005) simplified and stated the arrangement as: the train operating companies (TOCs) must sign contracts with the infrastructure owner to buy access rights to the infrastructure, and simultaneously sign contracts with the rolling stock leasing companies (ROSCOs) to lease traction and rolling stock (Yvrande-Billon & Ménard, 2005). This network of contracts combined a highly fragmented structure which consists of legally distinct holders of property rights and decision rights, by means of tightly regulated coordinating devices (Yvrande-Billon & Ménard, 2005).

Based on the above account, and for the purpose of this research, the first crucial step for the researcher was to understand the current UK rail industry structure, so as to be able to understand the links and relationships between organisations and to aid navigation through the complex network to gain access to valuable data. As such, the simplified rail structure developed by Stow (2015) was adopted. It is presented below in Figure 1.1 followed by a brief account of the main stakeholders of the UK rail industry.

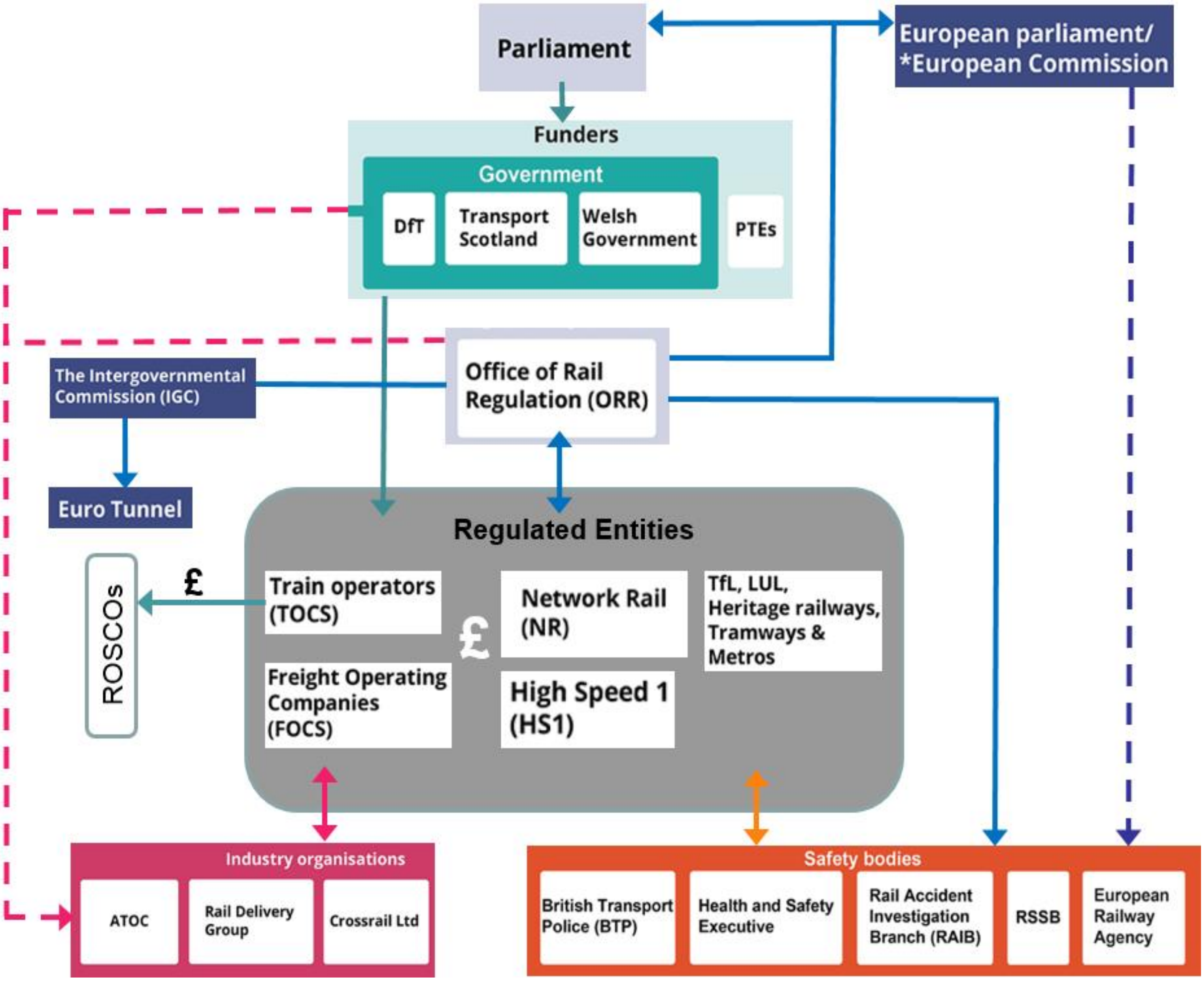


Figure 1.1 - UK rail industry structure

As presented in Figure 1.1, the UK rail industry consists of the Government which is responsible for providing strategic direction and funding, in addition to the European Union, to the railway and procurement of rail franchises and projects (ORR). Office of Rail and Road (ORR), previously known as Office of Rail Regulation, ensures that the network runs smoothly and in case of a problem, it is responsible for remedying it. It regulates Network Rail, the owners of the infrastructure and operator. The ORR also enforces safety regulations and is responsible for the performance of, access to and investment in the network (Butcher, 2012). As mentioned Network Rail is responsible for managing the infrastructure, the Rolling Stock Operating Companies (ROSCOs) (consisting of three companies) are the private owners of rolling stocks (Butcher, 2012), and the Train Operating Companies (TOCs) provide passenger services and consist of franchised train operators, and open access operators, which is obtained by a process of biding for time slots in the railway timetable and consisting of Hull Trains and the Grand Central Railway (ORR). In addition, the safety bodies are responsible for enforcing action in case of health and safety failures. The ORR is an independent health and safety regulator for the rail industry, covering the safety of the travelling public and railway workers (Butcher, 2012). Industry organisations mentioned are the other companies the ORR works with as the safety and economic regulator of Britain's railways (ORR).

Kaewunruen *et al.* (2016) widely advocated the role of transportation in urban development and economic growth of societies, crediting transportation (land, air, marine and pipeline) as the catalyst for building innovation, new capabilities, and efficacy and effectiveness of to their businesses and industries such a s agriculture and tourism. However, Wagner (2008) in his research in innovation management in German transportation industry, highlights the scant knowledge of innovation in logistics research particularly in transportation industry. Further, Huang *et al.* (2017) in their study of transportation systems in China, have also credited innovations for elevating transportation issues around the world. Wiesenthal *et al.* (2015) conducted a cross industry comparison of innovation in the European transport sector by analysing the Research and Development (R&D) investments. The research revealed the high dissimilarity of innovation efforts across different types of transportation. Analysing the European transportation sector in terms of the R&D activities, the study found that despite the high European R&D investments, high intensities for R&D where recorded only in car and airplane. The transport service providers were found to have lower R&D intensities, and service companies and builders of infrastructure were found to have lower incentives to innovate (Wiesenthal *et al.*, 2015). In particular to rail transport Burnewicz (2009) states that main deficiencies in developing rail transportation is due to the national and regional differences in rail technology and closed nature of railway network, compared to air transportation where the developments are hampered mostly by issues arising due to weather conditions, heavy dependence on liquid fuels.

The rail industry reform since privatisation has been widely studied using social cost-benefit analysis. Wellings (2014) argues that post privatisation, heavy regulations inhibited the industry to evolve according to the market processes. The complex and fragmented structure imposed by the government lead to increased transaction costs, while economies of scale and scope were lost (Wellings, 2014). Wellings (2014) further critics that costs and safety experienced a negative impact and the outcomes have been disappointing. Similarly, Jupe and Funnell (2017) used social cost-benefit analysis to study the franchising business, and concluded that privatisation failed to achieve the intended benefits. The study further criticised that the franchising business only appeared profitable through the use of calculative accounting techniques, which depicted the franchised train operators as detached business entities (Jupe & Funnell, 2017). Whereas, the franchised train operators were directly and indirectly supported by continuous government subsidies (Jupe & Funnell, 2017). Bowman (2015) also focused on the appearance created by accounting arrangements, to scrutinise the Network Rail subsidy regime. Bowman (2015) argued that the Network Rail subsidy regime enables train operators to achieve misleading profitability without an increase in the direct support by the state. This in return makes for the claim that the train operators produce net gains for the British tax payers and allows the political backers to avoid criticism and reform (Bowman, 2015). A counter argument is made by M.G and A.S.J (2002), using social cost-benefit analysis to assess the savings in operating costs due to privatisation in rail. The study concluded that the privatised structure, which requires returns to stakeholders, has led to significant improvements in operating costs and the output quality has also not declined (M.G & A.S.J, 2002). However, Köthenbürger *et al.* (2006) argues that the success of train operating companies in raising passenger numbers has led to train overcrowding. Another key criticism to the work of M.G and A.S.J (2002) is that their analysis ends in 2000, and does not include the significant decrease in service reliability and financial collapse of the infrastructure manager that took place after. Further, M.G and A.S.J (2002) states that the rail crashes that took place between 1999 and 2002 at Ladbroke Grove, Hatfield, and Potters Bar, in addition to the continuous delays and train cancellation services damaged the reputation of the privatised rail in UK. Clifton *et al.* (2003) also point out the disapproval of the public where the majority voted against policy of privatisation.

This research does not aim to research the UK rail industry by studying similar effects of privatisation or to analyse whether the intentions of privatisation have been met or not. This research takes a different route to understanding the current state of the UK rail industry. This research takes a snapshot in time to investigate the barriers that inhibit the industry from meeting the challenges of improving railway's competitive position and contribution to the health and wealth of the society (TSLG, 2012). British railways are experiencing an increase in the number of journeys made and the number of passengers travelling (ATOC, 2013). According to Rail Delivery Group (2014) the demand in the UK sector is greater than other European countries, with the passenger numbers growing by 62% between 1997-98 and 2011. The latest statistics issued by ORR (2019) show an increase in the passenger journeys in 2018-2019 Q3 compared to 2017-2018 Q3, by 2.9%, reaching a record high of 451 million. The following graph depicts the increase in passenger at all stations, since 2012.

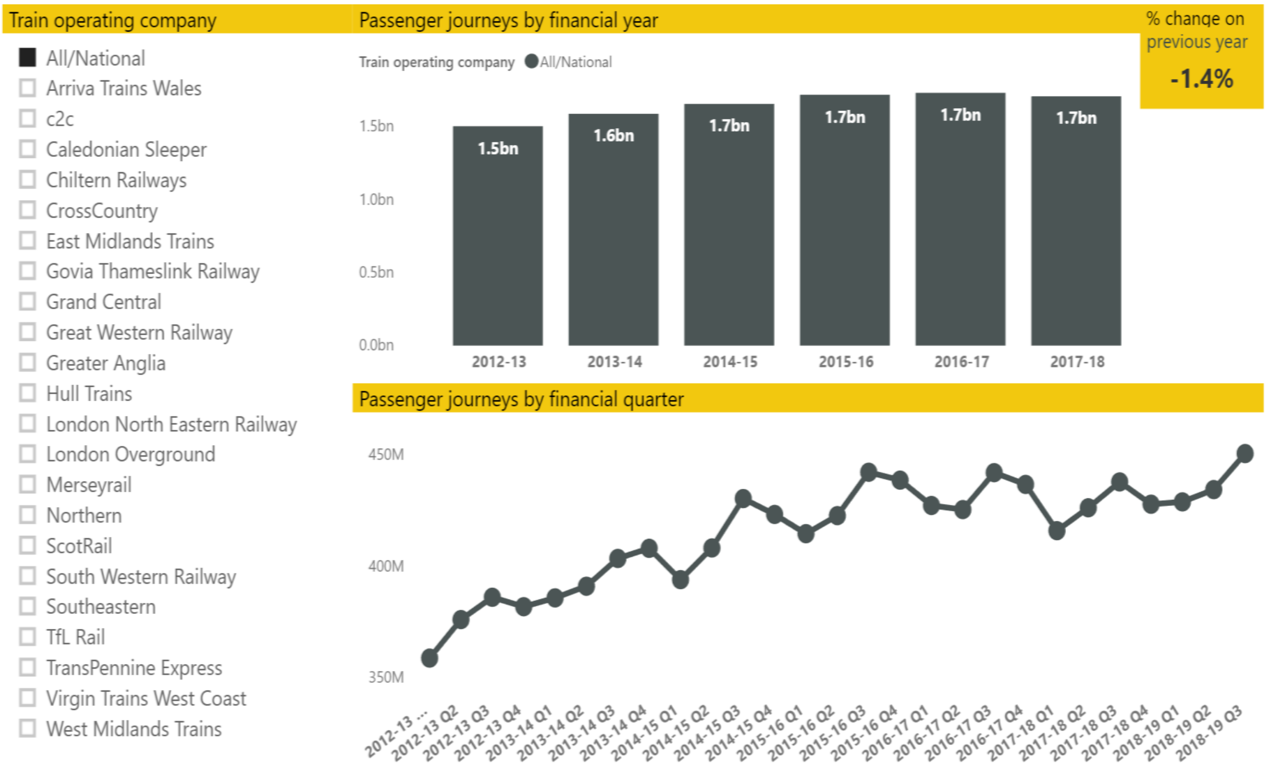


Figure 1.2 - Passenger journeys in UK rail (ORR, 2019)

However, the statistics also reveal that the performance and reliability of the Great Britain Rail services has decreased in 2018-2019 Q3, compared to 2017-2018 Q3. The punctuality of the trains is presented in the below graph:

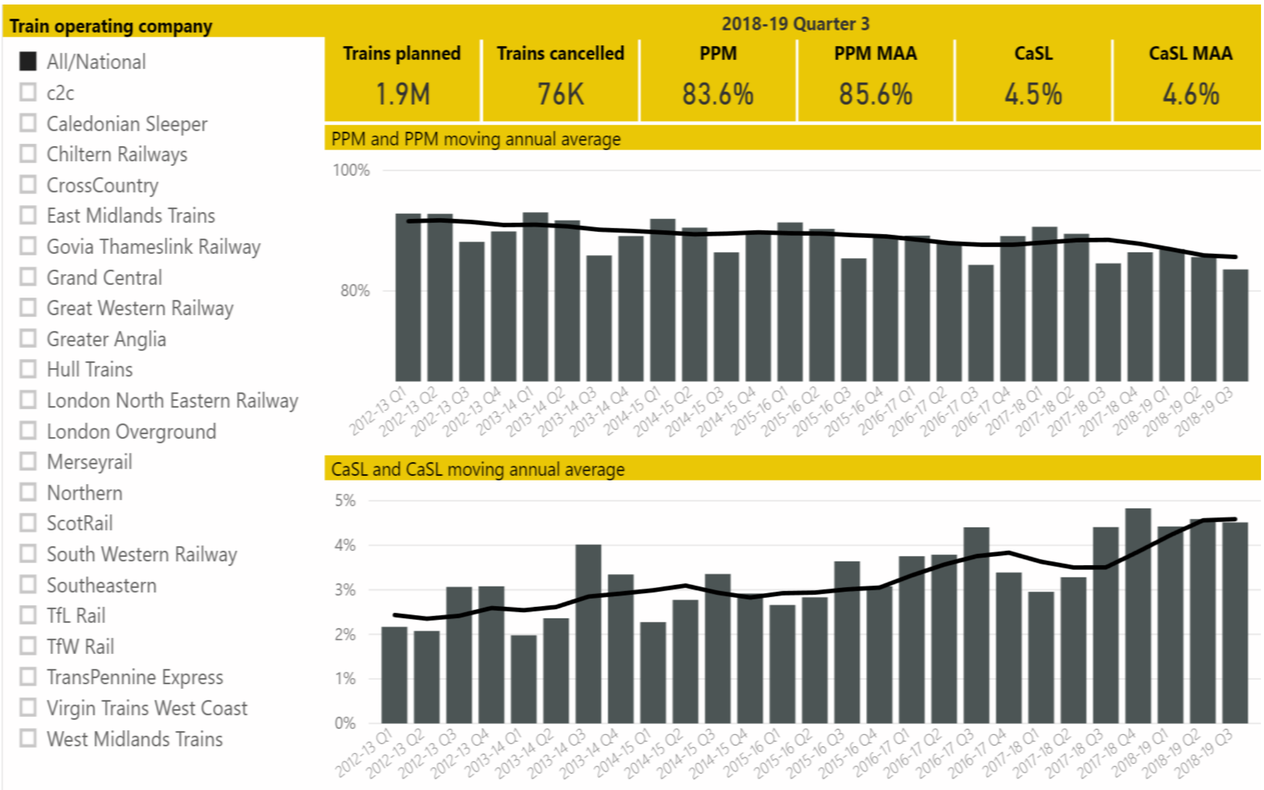


Figure 1.3 - UK rail punctuality (ORR, 2019)

In Figure 1.3 PPM stands for Public Performance Measure, which presents the proportion of trains that arrive on time, and MAA stands for moving annual average that reflects the proportion of trains on time in past 12 months (ORR, 2019). CaSl stands for Cancellations and Significant Lateness, and captures percentage of trains that caused significant disruption to at least some passengers (ORR, 2019). A higher PPM score indicates high performance and a lower CaSl score indicated high performance. But as shown in Figure 1.3, the PPM score in UK rail has declined, and the CaSl score has increased, therefore, indicating poor performance of the UK rail. In addition, complaints related to punctuality/reliability of trains stay as the most common cause of complain, forming 23.2% of overall complaints nationally in 2018-2019 Q3. Second in line with 10% of the overall complaints was the issue of having sufficient room for all passengers to sit/stand (ORR, 2019). Ticketing and refund policy was another issue that recorded the highest increase to 6.4% of all the complaints compared to 4.9% in 208-2017 Q3 (ORR, 2019).

As such, the railway industry is supporting continuous development and improvement of rail technology to satisfy the growing demand (TSLG, 2012). In the Rail Technical Strategy 2012, the government and the rail industry regarded innovations as the key enabler of a beneficial and prosperous rail industry (TSLG, 2012). It focuses on improving the railway performance by targeting improvements in four dominant areas, which are customer satisfaction, capacity increase, cost reduction and carbon reduction, also called the 4Cs. Further, highlighting the role of innovations, Richard Parry-Jones, the ex-Chairman of Network Rail stated, "*We see a future that challenges the limits of our current technical approaches. A future where we must increasingly rely on our ability to exploit a rich stream of innovation*." The Network Rail Technical Strategy also finds innovation at its core to meet its objectives for a future that is driven by innovation in order to improve safety, performance, customer experience, capacity, cost-efficiency, and sustainability (NetworkRail, 2013). European rails sector's shared perception of where the rail sector could be by 2050 was published as Challenge 2050 report by CER *et al.* (2013). The report also credits innovation along with research and development for achieving the visionary elements of the report. The report further stressed that for the Europe rail community to be global leaders in the world markets, while supporting capacity and reliability, it requires funding, inspired leadership and a framework that nurtures innovation to reflect the importance of the rail sector as a pillar of sustainable growth (CER *et al.*, 2013). Though the UK rail industry advocates the useof innovations, the only industry specific report exploring the barriers of innovation in the UK Rail industry was published by HackTrain (2016). The report explored the barriers to innovation among a niche market of low risk, easy to implement innovations. Through an exercise of interviewing the industry stakeholders the original report identified 4 key barriers: franchising, procurement, data and funding. In their update in the subsequent year the report further identified culture as a barrier.

Therefore, this research, in order to investigate the barriers that inhibit the industry from meeting the challenges of improving railway's competitive position and contribution to the health and wealth of the society (TSLG, 2012), focuses particularly on innovation for its significance as a key enabler of achieving the vision of the industry. This research investigates the industry wide barriers to innovation that inhibit the industry from achieving its vision as summarised above.

1.3. Research aim and objectives

Following the above discussion, the particular aim of the research is:

Through engagement of both primary and secondary stakeholders, to identify current barriers to innovation in UK rail sector.

The research therefore, attempts to draw the innovation landscape of the UK rail industry in terms of the barriers it faces from multiple perspectives of the key stakeholders involved in innovation.

In order to achieve the aim of this research, a set of research objectives were developed. These are as follows:

I. To develop a critical review of the extant relevant literature of the key theoretical foundations of this research in order to understand in depth the theoretical underpinnings of innovation to deliver sustainability, competitive advantage and value creation.

II. To breakdown and simplify the complex industry structure and identify the key stakeholders involved in the innovation process in order to identify the key players and the relations/links between them so as to aid navigation within the industry.

III. To identify the barriers to innovation in the UK rail sector.

IV. To compare the identified barriers to the perceived barriers established by the industry in order to identify gaps in industry knowledge and opportunities for improvements.

V. To develop innovation framework and innovation model to support innovation in the UK rail sector, to support a long term vision via stakeholder involvement and to support competitive advantage and value creation in present and in future.

1.4. Research questions and research boundaries

Three overarching research questions were developed to meet the aims and objectives of this research. These are:

RQ1: How do the enveloping external factors impact innovation in the UK rail industry?

RQ2: What elements inhibit the UK rail industry from transforming into an innovative industry?

RQ3: What are the strategic barriers to innovation in the UK rail industry and how do they impact business?

In light of the aim of this research and the research background discussed earlier, three main bodies of literature have been identified to effectively research the phenomena under study and to provide theoretically backing to the research questions. These are: strategy, innovation, and transportation, since the research specific to innovation within the UK rail sector are sparse. The strategy literature provides a broader theoretical background to the research and the relevance of strategic management in order to address the issue in hand. Innovation being the phenomenon under study, enables the justification of the approach to gain the desired outputs of sustainability, competitive advantage and value creation; while transportation is used as the context being assessed. The synthesis of the three fundamental bodies of literature under the lens of strategic management theory of Resource Based View (RBV), sets the scene for this research based upon which the investigation can be carried out and the research questions can be addressed. In addition, theory of Leadership and Change Management has been explored to assist in addressing the scope of this research. The interactions of these three bodies of literature are presented in the following Figure 1.4:

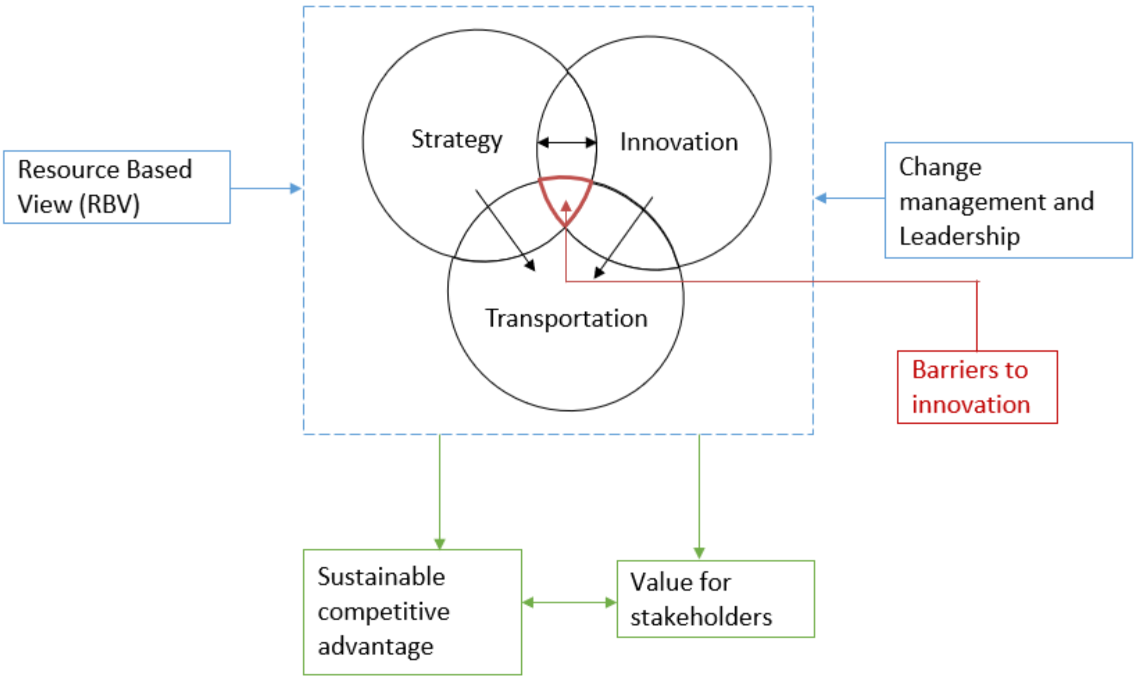


Figure 1.4 - Theoretical boundaries of the research

A series of sub-research question have been developed, to specifically address the innovation issues within the UK rail industry. The sub research questions help structure the focus of the research and provide insights into the interactions between the key elements identified in Figure 1.4 specifically with the UK rail industry. The sub-research questions are as follows:

RQ1: under the first research question, two key externally influencing elements of innovation within the UK rail industry have been addressed. These are:

- *S-RQ 1: Which elements of funding tangibly support innovation?*
- *S-RQ 2: How does government and media influence innovation?*

RQ2: the dominant internal element of people and leadership that comprise of the culture of an organisation are addressed via the second research question. Thus, forming the following sub-research question:

- *S-RQ 3: What specific cultural elements impact innovation in UK rail industry?*

RQ3: further narrowing down the research and targeting it to the very specific elements of the UK rail industry, the third research questions addressed the various key barriers comprising of the strategic barriers to innovation, and how they impact the business. These elements have been addressed via the following sub-research questions:

- *S-RQ 4: What are the barriers to innovation in the UK rail industry in delivering customer specific solutions?*
- *S-RQ 5: How do regulations and specifications create barriers to innovation in the UK rail industry?*
- *S-RQ 6: What are the barriers to innovation in the UK rail industry in the testing and trialling stages?*
- *S-RQ 7: How does communication create barriers to innovation in the UK rail industry?*
- *S-RQ 8: How do structural barriers effect strategy formulation and implementation in the UK rail industry?*
- *S-RQ 9: How do process barriers effect implementation of strategy in the UK rail industry?*

- *S-RQ 10: What is the impact of strategy barriers on business within the rail sector in the UK?*

Figure 1.5 presents the theoretical linkages of the research questions with the main identified bodies of literature, and their corresponding sub-research questions, below:

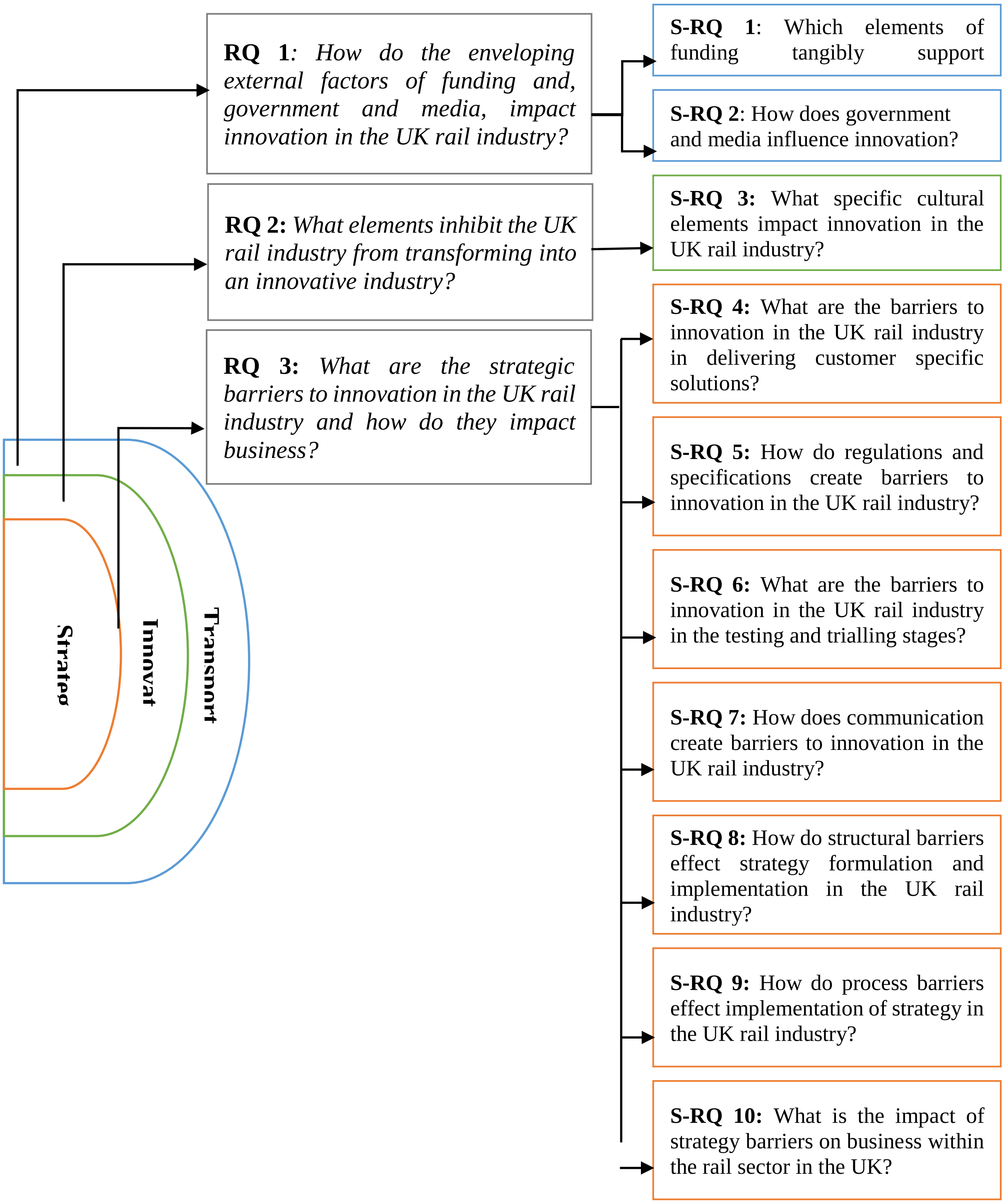


Figure 1.5 - Structure of research questions

1.5. Research scope

This research aims to investigate the barriers to innovation within the UK rail sector. It explores the primary and secondary stakeholder engagements to examine the overall innovation landscape of the industry. The inclusion of multiple stakeholder perspective is deliberate, given the context of the research which highlights the complex structure and interactions of a large number of stakeholders active within the innovation landscape of the UK rail sector. This approach was concluded to be necessary for the lack of progress of the initial research aim. This research originally emerged from the testing and trialling voucher scheme within the UK rail industry to enhance the testing and trialling of innovations. As such the initial aim was to examine the testing and trialling stages in order to identify the barriers to innovation at this particular stage. Subsequently, a year of investigation produced poor results and concrete relations could not be established with the literature to address the issues identified by the industry for gaining sustainability, competitive advantage and profitability. However, the initial investigation, supported by the literature, brought to light the extent of the issue regarding innovations. Adopting a holistic view and investigating the overall innovation scenario, was therefore, considered to better understand the phenomenon under study, and to appropriately address the issues regarding innovations within the UK rail sector.

As such, the research expanded in its original scope, and through the adoption of mixed method approach aimed at investigating the overall innovation landscape of the UK rail industry. The study aims at assisting the UK rail sector to address the challenges of innovation, and also improve the service quality of today while preparing for the future. The research assess strategic management of innovation through the lens of RBV, to establish sustained competitive advantage by transforming a firm's resources by its capabilities (Kostopoulos *et al.*, 2002), in order to positively influence the outcome of the innovation process (Ferlie *et al.*, 2016; Wu & Chiu, 2015). Given the stakeholder involvement in the innovation process in the UK rail industry, the research intends at building upon the strength of stakeholder engagement to improve performance (Parmar *et al.*, 2010). The research assumes and justifies that joining the interest of the stakeholders leads to better firm performance (Freeman *et al.*, 2007). From the RBV perspective, the research explores strategic value of organisations intangible resources (offered by the involved stakeholders) to generate sustainable competitive advantages, which are difficult to imitate by competitions because no two stakeholder relationships are identical (Verbeke & Tung, 2013).

Therefore, the scope of this research can be identified by the clear interactions and interfaces between the three identified key bodies of literature as presented in Figure 1.4. A further development of Figure 1.4, illustrates how these interactions can enable addressing the scope of this research,, which is to identify the barriers to innovation in the UK rail sector, which when addressed and supported by an effective leadership (Gill, 2002) (Hechanova & Cementina-Olpoc, 2013), can lead to value creation for all stakeholders and gain sustainable competitive advantage. This has been presented below in Figure 1.6 :

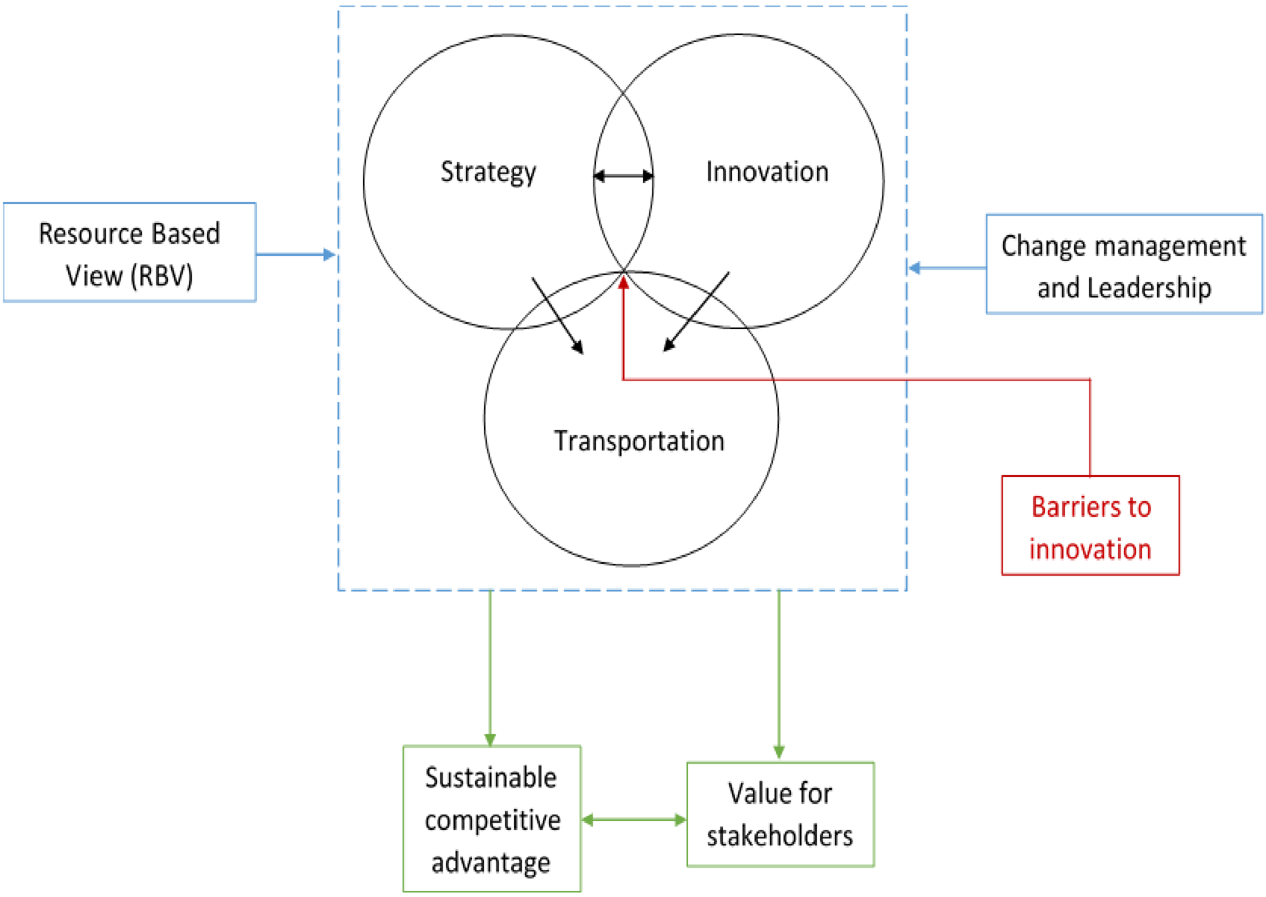


Figure 1.6 - The scope of the research

1.6. *Research methodology employed*

To address the research scope and to the answer the research questions an exploratory research has been designed that adopts a mixed-method approach. The collection of qualitative and quantitative data was considered necessary to gain an overall view of the complex phenomenon under study in a complex industry – the UK rail industry. The multiphase research is conducted under a pragmatic paradigm which takes into account different perspectives, ideas and theories to help gain an understanding of the world (Sekaran & Bougie, 2016). Indeed, the collection of both qualitative and quantitative data enabled the researcher to gain an in-depth multi perceptive knowledge of the innovation landscape within the UK rail industry.

The multiphase research consists of an initial exploratory sequential approach, used to collect primary qualitative data through a combination of unstructured and semi structured interviews with key professionals involved with innovations in the UK rail industry. In total 48 professionals were interviewed. This approach was deployed to explore and understand the lesser known innovation landscape of the UK rail industry and to inform the subsequent parallel convergent approach. Informed by the results of the exploratory sequential design, parallel convergent approach consisted of a quantitative survey to complement the qualitative analysis. The survey response of 57, confirmed, supported and improved the transferability of the qualitative analysis. Simultaneously, a qualitative secondary data analysis as conducted, on the published industry reports, in order to determine the industry perceived barriers to innovation. The parallel convergent approach enabled to find the gaps in industry knowledge, and to suggest recommendations accordingly in combination with the primary findings of this research.

The diversity of the data has enabled to build the validity of this research and to develop innovative solutions that can enable the industry to overcome the barriers to innovation. The methodology chapter will further detail the research strategy, philosophies and methodologies adopted for this research along with the rationale of adopting the said approaches.

1.7. *Main conclusions of this research*

The research makes incremental contribution to knowledge as justified by Nicholson *et al.* (2018), in the neglected (Nicholson *et al.*, 2018) area of innovations within the UK rail sector. The analysis of the collected data, demonstrates and confirms the barriers to innovation arising from poor strategic intend, and multiple stakeholder interactions. The research identifies external, internal and strategic barriers to innovation, while taking into account the various stages of the innovation process and the corresponding barriers. With a robust strategy the stakeholder’s engagements can be effectively managed under a strategic intend to improve innovations with the UK rail sector. This will enable value creation for all stakeholders, while continuously learning to improve, and replenishing the resources and capabilities of the sector to address the future challenges while gaining a sustained competitive advantage. The research, identifies six main barriers to innovation, and draws contrasts with the industry perceived barriers, highlighting gaps in knowledge and opportunities for improvement.

The research concludes with two main outputs to support innovation and to enable the industry to overcome the barriers to innovation. Firstly, an Innovation Framework, developed in this research, combines the strengths of the main enablers of innovation, and provides a road map for successful integration and exploitation of the key elements of innovation, such that the barriers to innovation can be addressed, and value created for all stakeholders while gaining sustainable competitive advantage. Secondly, an Innovation Model, presents the current innovation scenario in the UK rail industry, along with the short and long-term measures to guide the industry to achieve the desired ideal innovation led state. These have been presented further in the conclusion chapter.

1.8. Structure of the thesis

This section presents the structure of the thesis, which is divided into six chapters, outlined below. Each chapter consists of relevant conceptual models developed along the study.

Chapter One: Introduction

The first chapter introduces the research study, while providing the research background, boundaries and scope. In addition, it presents the research aims, objectives, and the research question that structure the thesis. It briefly describes the employed methodology to answer the research questions. Finally, the chapter outline the main conclusion and outcomes of this research.

Chapter Two: Literature review

The second reviews significant literature that make the theoretical foundations of this research. The three identified bodies of literature are reviewed to gain knowledge about the research topic in terms of wider research done by other researchers till date. It includes the wider over governing bodies of knowledge, relevant theories, and literature related specifically to the research topic. As demonstrated in Figure 1.4, strategy, innovation and transportation literature is synthesised under the lens of RBV, to identify the how innovation can be used as means of strategic advantage, to create value for all stakeholders and to sustain competitive advantage. Theory of leadership and change has also been examined to support innovations.

Chapter Three: Methodology

The third chapter presents the research philosophies, paradigms, methodology and the tools and techniques adopted to address the research aims and objectives, and to answer the research questions. It also provides the rationale for the adopted mixed method approach under a pragmatic paradigm, in addition to the developed research design to effectively carry out the research study.

Chapter Four: Findings

The fourth chapter presents a detailed account of the findings of the results, as a result of the analysis of the rich data collected. The chapter presents the primary results of the qualitative data analysis, supported by the results of the quantitative data analysis. Subsequently, the chapter provides the results of qualitative secondary data analysis, which when compared to the primary data analysis, expose the gaps in industry knowledge pertaining the barriers to innovation.

Chapter Five: Discussions

The fifth chapter synthesis the relevant literature with the research findings, to answer the specific research questions of this study. It thoroughly discusses the research outputs, which when evaluated by the use of relevant literature, enabled the development of conceptual models to overcome the identified barriers and suggest how the barriers can be overcome to help the UK industry achieve its vision and goals.

Chapter Six: Conclusion

The final chapter, provides a synopsis of the thesis. Specifically, it presents the Innovation Framework and the Innovation Model, which presents the main contributions of this research. In addition the chapter provides the research limitations and recommendations for potential future research.

1.9. Conclusion

The first chapter of this thesis introduced the research background and provided a brief description of the research boundaries and scope. In particular, the research aims and objectives were introduced, along with the research questions and sub-research question that outline the structure of this research. The research methodology employed to address the research questions was briefly introduced. Figure 1.7 presents the discussed structure of this thesis. The following chapter will present a detailed critical review of the relevant literature in order to frame the context of this research.

Chapter 1: Introduction	**Chapter 2: Literature Review**	**Chapter 3: Methodology**	**Chapter 4: Findings**	**Chapter 5: Discussion**	**Chapter 6: Conclusion**
Research background	Business strategy and strategic management	Philosophical assumption	Primary data findings	Literature summary	Review of the research aims and objectives
Research aims and objectives	Resource Based View	Research paradigm - pragmatism	Qualitative data findings -Thematic analysis	Findings summary	Summary of three main research questions
Research questions and research boundaries	Aspects of innovation	Research strategy – mixed methods	Quantitative data findings – descriptive statistical analysis	Research questions and sub-research questions discussed	Main research contributions – Innovation Framework and Innovation Model
Research scope	Strategic management of innovation	Research approach – Exploratory research	Secondary data findings – qualitative findings	Research recommendations	Research contributions and recommendations
Outline of main research conclusions	Sustainable competitive advantage via innovation	Research tools and techniques – Interviews/survey/secondary data			Research limitations
	Challenges of innovation strategy in transportation	Data analysis			Opportunities for future research
	Innovation activities in transportation and value creation				
	Barriers to innovation, and change management				

Figure 1.7 - Thesis Structure

2. Literature review

2.1. Introduction

This chapter reviews the relevant literature pertaining to this research. Reviewing significant literature is a key part of the research process. It helps gain knowledge about the research topic in terms of wider research done by other researchers till date. It includes the wider over governing bodies of knowledge, relevant theories, and literature related specifically to the research topic. Reviewing existing literature, thus helps in identifying a direction for further research and gaps in knowledge. This chapter links the existing literature to the research topic by investigating in depth innovation in order to understand the source, need, relevancy and outcomes of innovation.

To structure this chapter, ‘funnel and lens’ approach has been used. As such, the chapter is structured so as to first review innovation in a wider perspective, understanding where it comes from, the need for innovation, and subsequently narrowing it down to the relevant research sector - the UK rail industry, investigating the barriers to innovation and its outcomes; whilst throughout applying the lens of ‘resource-based view’ (RBV).

In view of the approach mentioned above, this chapter consists of three main sections: strategy theme, innovation theme, and innovation in transportation. The chapter first reviews the vast literature of strategy to establish its relevance, and the concepts of strategic management. It then narrows down strategy to the research area, that is, innovation, to review its advantages. This is followed by further narrowing down innovation to the relevant sector of research, that is, transportation and rail, to review innovation strategy in transportation, innovation activities and the need to innovate. The three sub sections of this chapter, in turn also use the funnel approach to narrow down to the relevant literature areas of this research. The chapter structure is illustrated below in Figure 2.1:

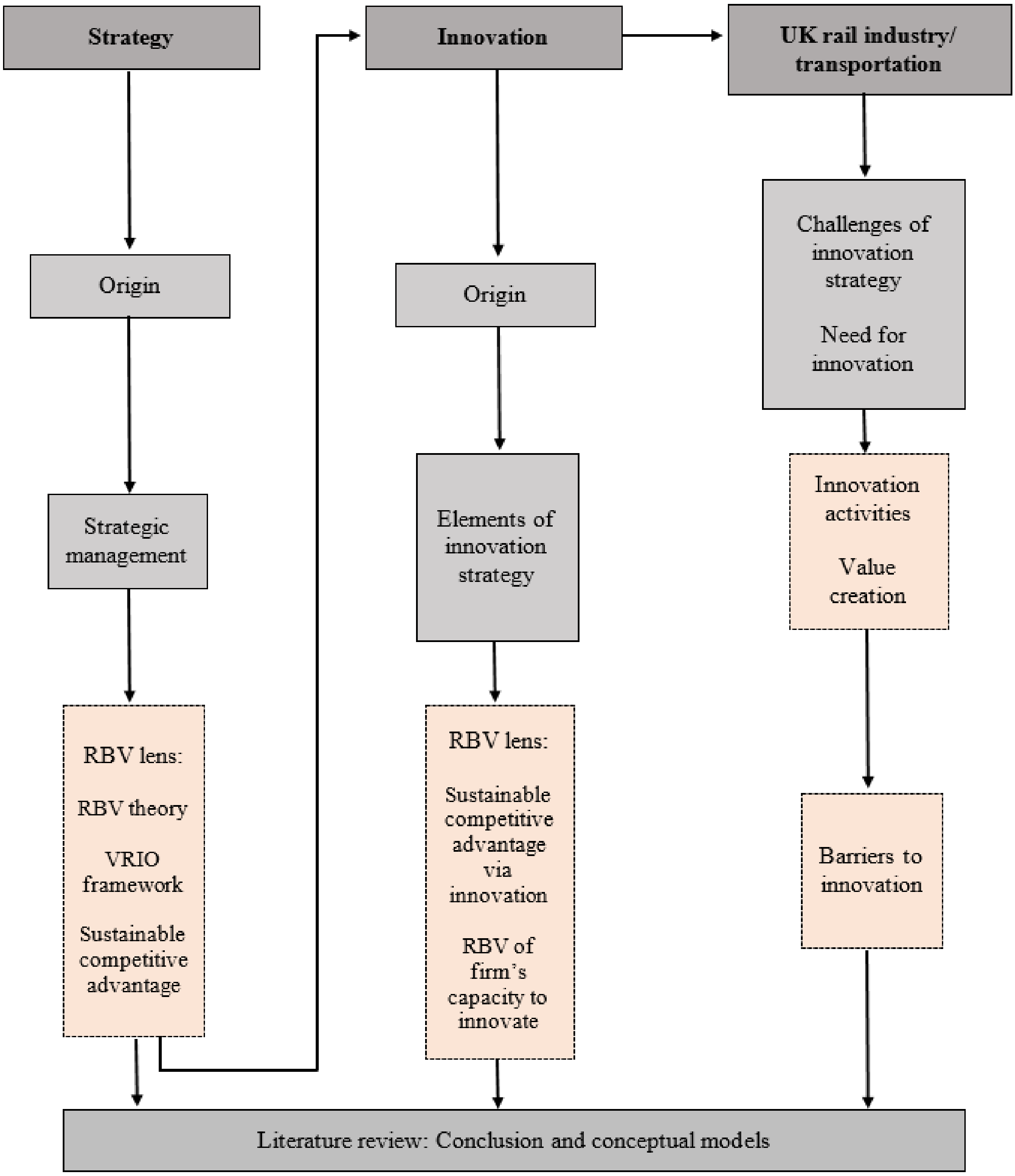


Figure 2.1 - Structure of literature review

2.2. *Strategy theme*

2.2.1 Business strategy

The aim of this section is to build a foundation of the underlying field of study that forms the basis of this research. The concepts of strategy, and in particular the concept of strategic management to gain competitive advantage have been taken into account as they form the building blocks of this research. In addition, the theory of Resource-Based View (RBV), also forms an integral part of the literature review, as its role in achieving the scope of this research has been investigated.

2.2.1.1 What is strategy and why is it important?

The first written study of strategy, was produced by the Chinese, in the period of 400-200 B.C. Strategy originated in the army where there was a need to defeat the enemy. These Chinese works, which includes the critically acclaimed book written in 400 B.C by *Sun Tzu*, called '*The Art of War*', were written in the form of poems and prose. The work that followed from these accounts is however, written in a theoretical form (Horwath, 2006). As recognised by the scholars in the field of strategy management, strategy began to emerge as an academic field of research in the early 1960's (Ronda-Pupo & Guerras-Martin, 2012).

The term strategy has its origin in the Greek word 'strategos', which means 'general in command'. *Von Neumann and Morgenstern* were the first modern authors to relate the concept of strategy to business, in their book 'Theory of Games and Economic Behaviour' (Ronda-Pupo & Guerras-Martin, 2012). (Homkes, 2016)

The definition of strategy, as given by Drucker (1954) in his book 'The Practise of Management' (Drucker, 1954) can be considered the first as it defined strategy of an organisation based on its business and what it should be in future. It is the clarifying of corporate objectives, and making strategic decisions via a careful, deliberate and systematic approach, whilst checking progress towards the defined objective (Omalaja & Eruola, 2011). Since then, many authors have argued definitions of strategy based on various conceptual elements, for example goals, actions, environment, performance etc. (Ronda-Pupo & Guerras-Martin, 2012). Some authors highlight the selection of long-term goals and the plans to achieve them as crucial elements of the strategy concept (Ronda-Pupo & Guerras-Martin, 2012). For example, according to Ansoff (1968), strategy is a broad concept of a firm's business, which provides guidelines for the firm to search and achieve the most attractive opportunities

(Omalaja & Eruola, 2011). While others, stress on defining actions, plans and programmes required to achieve certain goals (Ronda-Pupo & Guerras-Martin, 2012). Chandler (1990), is of the opinion that a corporate strategy is the determination of basic long term goals of an organisation, and adaption of route of action and deployment of resources required to achieve the goals (Chandler, 1990). Other key ideas argued in definitions of strategy are competitive advantage and company performance (Ronda-Pupo & Guerras-Martin, 2012). D. C. Rogers captures these elements in defining strategy as a plan of action for appropriation of scarce resources in order to gain competitive advantage, achieve an objective, and to profit from an opportunity at an acceptable level of risk. Again, James Brian Quinn defines strategy as the overall future activities of a business, a plan that defines how an organisation can achieve its goals in light of opposing pressures from competition and limited resources (Omalaja & Eruola, 2011).

Additionally, Mintzberg (2007) recognised strategy as 'a pattern in a stream of decisions'. Using the word pattern recognises the dynamic element of strategy as it takes a less certain view of strategy, suggesting that strategies may not always take a certain deliberately chosen path, and can emerge over time (Johnson *et al.*, 2017). While Porter (1996) emphasised on the uniqueness of chosen activities and the mix of value it delivers.

By the chain of definitions capturing multiple views, it could be realized that strategy is a long term direction of an organisation (Johnson *et al.*, 2017), pattern of decisions, that conclude and review its purpose, goals, objectives, formulate its policies and plans for achieving these goals and defines the businesses the company is going to pursue and the kind of human and economic organisation it is or intends to be, and the kind of economic and non-economic value it intends to create for its stakeholders (Omalaja & Eruola, 2011). Johnson *et al.* (2017) argue the advantage of defining strategy as long term in two ways: 1) it allows the inclusion of both deliberate, logical strategy, and more incremental and emergent patterns of strategy and 2) it can include strategies for difference and competition, along with strategies that recognise the role of cooperation and imitation (Johnson *et al.*, 2017).

The definition and role of business strategy have been introduced in this section. It highlights the benefits of developing and deploying a strategy. The strategy enables the alignment of overall business activities with the corporate vision and mission. In order for strategy to bear results, it must be effectively formulated, implemented and outputs measured. Strategic choices must be made for the generation, evaluation and selection of strategic options.

As such, the following section details the role of strategic management and in view of this research, one of its most relevant theory – resource-based theory, which forms the underpinning theory of this research.

2.2.1.2 Strategic management and competitive advantage

Strategy and its execution are interdependent. A good strategy bears results when properly executed, however, failure to execute is always partly due to the way in which a strategy was formulated. The most challenging task for executives is the execution of strategy. Executives highly focus on designing a good strategy, but often pay less attention on how it should be executed (Sull *et al.*, 2018). For complex organisations, real challenges arise when there is a lack of coordination among various departments, functions and units (Homkes, 2016). As such, even though describing a strategy might favour complexity, its execution demands simplicity (Sull *et al.*, 2018).

Omalaja and Eruola (2011) view strategic management as the management of the integrated components of the three stages of the strategy process, which are, strategy development, strategy implementation, and strategy evaluation. According to Ansoff and McDonnell (1990), strategic management is the systematic approach to the management of change, which include, positioning of the organisation by means of strategy and planning, managing problems by real time strategic responses, and systematic management of resistance during strategy implementation (Mainardes *et al.*, 2014). On the other hand, Edward *et al.* (2001) focus strategic management on the creation and sustainability of competitive advantage. Furthermore, Dess *et al.* (2003), emphasise organisational analysis, decisions, and actions in strategic management, for creating and sustaining competitive advantage. Building on the dynamic nature of strategy, Stead and Stead (2008) define strategic management as an ongoing process. It builds on the efforts of strategic managers to adjust the organisation to the environment it operates in, while developing competitive advantage. The competitive advantages enable an organisation to seize opportunities and minimise environmental threats (Mainardes *et al.*, 2014).

Bao (2015) advocates that in the extant definitions of strategic management, even though scholars might use different vocabularies to define strategic management, such as objectives, overall long-term direction, decisions, planning, emergent initiatives, resources allocation etc. (Nag *et al.*, 2007a; Ronda-Pupo & Guerras-Martin, 2012), almost all definitions concentrate on organisational integrity and futurity (Bao, 2015). Along the development of strategic management as a field of research and practise, its focus has moved from initial financial budgeting in the 50's to the concept of competitive advantage in the 80's and since the concept has been further broadened to include issues related to technology and innovation changes, and globalisation (Jofre, 2011). Grant (1991) argues that at the business strategy level, '*explorations of the relationships between resources, competition, and profitability include the analysis of competitive imitation, the appropriability of returns to innovations, the role of imperfect information in creating profitability differences between competing firms, and the means by which the process of resource accumulation can sustain competitive advantage*'. This amounts to the 'resource-based view' of the firm (Grant, 1991), which forms the underpinning theory of this research. Figure 2.2 below presents a framework for resource-based approach to strategy analysis. Its includes analysing the firms resource base, appraising the firms capabilities, analysing the profit-earning potential of firm's resources and capabilities, selecting a strategy, and extending and upgrading a firms pool of resources (Grant, 1991).

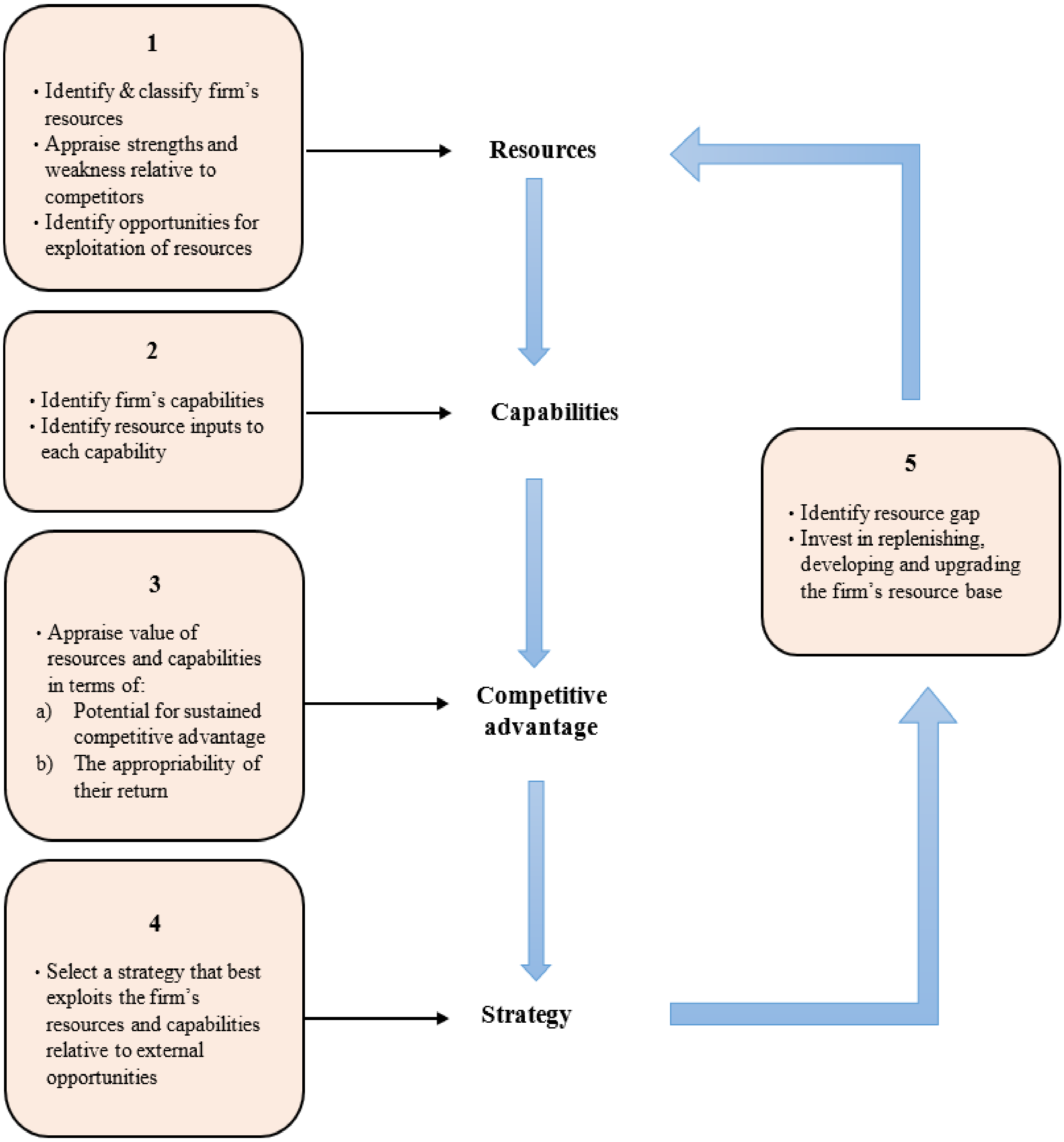


Figure 2.2 - Resource-based approach to strategy analysis (As adapted from (Grant, 1991))

The concept of strategic management to gain competitive advantage has been explored in this section, with the introduction of 'resource-based view' of the firm. Building up on the argument presented, the following section explores 'resource-based view' in depth and how it can enable a firm to gain sustainable competitive advantage. First the concept of sustainability has been introduced.

2.2.1.3 Sustaining competitive advantage – VRIO framework

The resource-based discourse is mostly focused on specific firm resources and capabilities for yielding some degree of competitive advantage. This notion is grounded in Barney (1991) VRIO framework for sustained competitive advantage.

Barney (1991) introduced the value, rarity, imitability, organisation (VRIO) framework, which is used by firms to analyse their resources and capabilities, to determine whether it has a competitive advantage. According to the VRIO framework a valuable resource/capability enables a firm to implement strategies that allows the firm to exploit opportunities, improve effectiveness and efficiency, and to mitigate external risks (Brem *et al.*, 2016). A resource/capability is considered rare if the number of firms possessing it is less than the number of firms required to generate perfect competition dynamics. The inimitability of the resources/capability is created by unique historic conditions, social complexity in a company, and/or casual ambiguity (Brem *et al.*, 2016). And finally, the organisation aspect suggests that the organisation should be sufficiently organised to take full advantage of their resource/capability and implemented strategies in order to achieve its full economic potential (Chatzoglou *et al.*, 2018). This is illustrated below in Figure 2.3, representing Barney (1991) VIRO framework (Seo *et al.*, 2016):

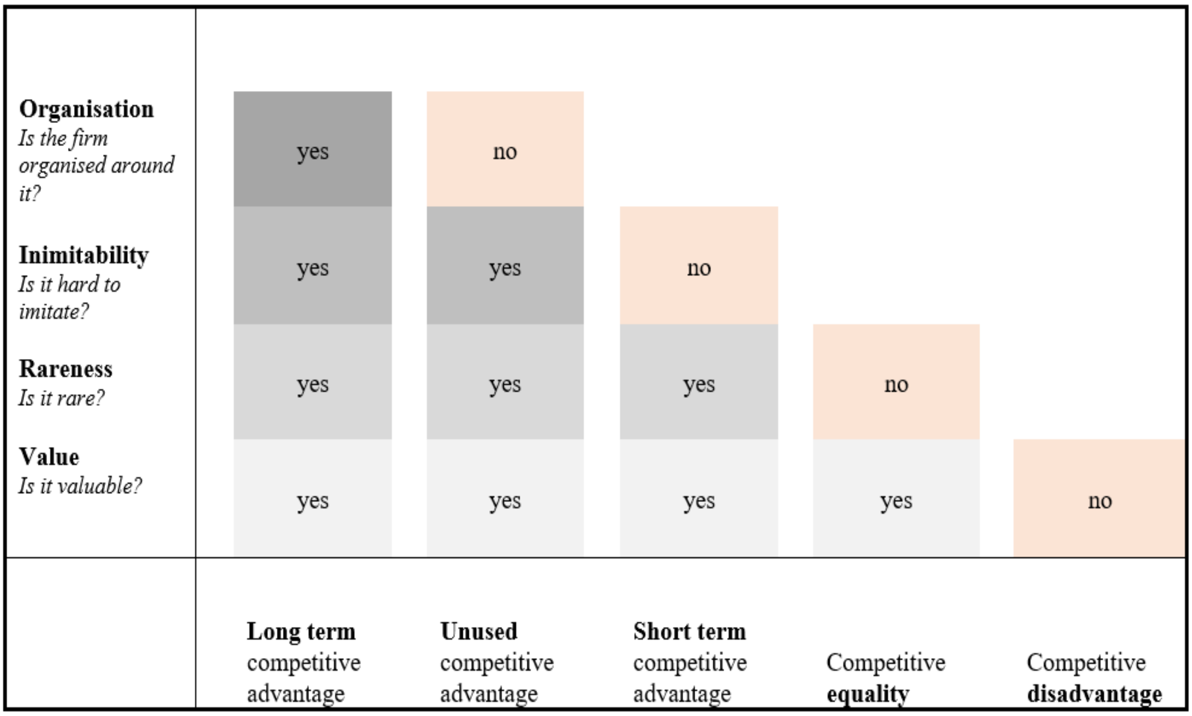


Figure 2.3 - VRIO framework (As adapted from (Barney, 1991))

The pursuit of competitive advantage is at the core of most of the strategic management literature (Omalaja & Eruola, 2011). Having set the basis of sustained competitive advantage and understanding the characteristics of the sources required to gain competitive advantage in this section, the following section explores the theory that argues that the source of an organisation's competitive advantage is based on its resources (Perunović *et al.*, 2012), called the 'resource-based view'.

2.2.2 *Resources Based View – theoretical background*

The strategic literature indicates the importance of resource-based view (RBV), as a strategic management theory and its rapid diffusion throughout it (Grant, 1991; Hesterly & Barney, 2008; Hitt, 2011; McWilliams & Siegel, 2011; Omalaja & Eruola, 2011). The main argument of RBV addresses the elementary question of why firms are different and how firms achieve and sustain competitive advantage by deploying their resources (Kostopoulos *et al.*, 2002). Irwin *et al.* (1998) argue that the resources of a firm are the determinants of its competitive advantage and financial performance.

Wernerfelt (1984) in his path-breaking article recognised resources as a new direction in strategic management. The resource-based view imposes that in strategic management the paramount sources and drivers of a firm's competitive advantage are mainly associated with the characteristics of their resources and capabilities, which are valuable and costly-to-copy (Omalaja & Eruola, 2011). Hesterly and Barney (2008) argue that for a firm to outperform other firms, even if competing in the same industry, its resources and capabilities must display heterogeneity and immobility. Penrose (1959) one of the earliest major contributors of RBV (Bakar & Ahmad, 2010), also argued that it is the heterogeneity and not the homogeneity of the resources of a firm that give it its unique character (Kostopoulos *et al.*, 2002). Building upon the firm's resources, Barney (1991) presented a more concrete and comprehensive framework to identify the needed characterises of a firm's resources required for generating a sustainable competitive advantage. The framework as presented in Figure 2.3, describes the resources as valuable (in the sense that they exploit opportunities and/or neutralize threats in a firm's environment), rare among a firm's current and potential competitors, inimitable, and non-substitutable (Kostopoulos *et al.*, 2002)

Barney and Arikan (2001) defined competitive advantage as the exploitation of performance differences between firms. A firm is described as the collection of profitable resources that are deployed over time by administrative decisions (Zubac *et al.*, 2010). Resources are the remarkable blend of assets and capabilities of a firm that enable it to create and execute strategies to better its performance (Zubac *et al.*, 2010). These resources include both tangible and intangible assets of a firm (Wu & Chiu, 2015). Irwin *et al.* (1998), defined resources as 'all assets, capabilities, information, knowledge etc. controlled by a firm that enable a firm to develop and implement strategies to improve its efficiency and effectiveness' (Irwin *et al.*, 1998). When these resources are strategically valuable and difficult for competitors to duplicate, they become sources of sustained competitive performance (Wu & Chiu, 2015).

Kostopoulos *et al.* (2002) identified the emphasis in strategy literature on resources internal to the firm as a fundamental driver of firm profitability and strategic advantage, due to various reasons. Firstly, new technology, new products, and shifts in customer preferences are changing at a drastic rate. In such a scenario, strategies cannot be formulated for an increasingly dynamic environment based on traditional methods of taking a static snapshot of a moving industry (Kostopoulos *et al.*, 2002). Secondly, traditional boundaries of industry are blurring as there is an increased overlap among industries, especially the information-technological industries (Bettis & Hitt, 1995; Kostopoulos *et al.*, 2002). Lastly, the increasing rate of change demands that the firms react quickly as time is often seen as a source of competitive advantage (Kostopoulos *et al.*, 2002). As such, firms should look inwardly for strategic opportunities, and in addition should reconceptualise how they look at industries and define competitors (Kostopoulos *et al.*, 2002).

2.2.2.1 Elements of Resource based view for gaining sustainable competitive advantage

The core of the resource-based research is the heterogeneity of the strategic resources owned and controlled by a firm (Kostopoulos *et al.*, 2002). As such, each firm can be viewed as a unique bundle of tangible and intangible resources and capabilities (Wernerfelt, 1984).

Resources: are the assets that are tied semi-permanently to the firm. It includes financial, commercial, technological, physical, human, and organisational assets used by the firm in order to develop, manufacture, and deliver products and services to its customers. These can be further classified as tangible such as, financial and/or physical, and intangible, such as, experiences and skills, employee's knowledge, firm's reputation, brand name and organisational procedures. (Kostopoulos *et al.*, 2002)

Capabilities: refer to a firm's capacity to deploy and coordinate a firm's resources using organisational processes to deliver the desired. Capabilities are specific to a firm, having been developed over time through complex interactions of a firm's resources. They can be regarded as the intermediate goods, developed by a firm to enhance the productivity of its resources, and the strategic flexibility and protection for its end product/service. (Kostopoulos *et al.*, 2002)

Amit and Schoemaker (1993) well summarised the difference between resources and capabilities. According to Amit and Schoemaker (1993) capabilities are embedded in the organisation and its processes, and as such are firm specific. This implies that if an organisation is dissolved, its capabilities will also be lost, whereas, the resources will be transferred to the new owner. In addition, the primary purpose of capabilities is to enhance effectiveness and productivity of the resources in order to achieve its targets and goals. (Amit & Schoemaker, 1993)

Wernerfelt and Montgomery (1988) identify the impact of changing environment in which a firm operates, and suggest that firms must continuously acquire, develop and upgrade their resources and capabilities to maintain competitiveness and growth (Wernerfelt & Montgomery, 1988). Various arguments exist in the literature about the traceability and creation of resources and capabilities. However in a nut shell, resources and capabilities can be attributed to a history of strategic choices and resource commitments made by the firm in order to gain effectiveness and profitability as guided by economic rationality (Kostopoulos *et al.*, 2002). The development, selection and deployment of resources is influenced by a firm's strategic choices, in relation to industry and market determined factors (Amit & Schoemaker, 1993; Kostopoulos *et al.*, 2002).

In conclusion, from a resource-based perspective, the sustainable competitive advantage of a firm is a result of resource selection, accumulation, and deployment by means of organisational capabilities and is based on a firm's resource heterogeneity (Kostopoulos *et al.*, 2002). Figure 2.3 below summarises the above discussion of gaining sustainable competitive edge from a resource based view of the firm:

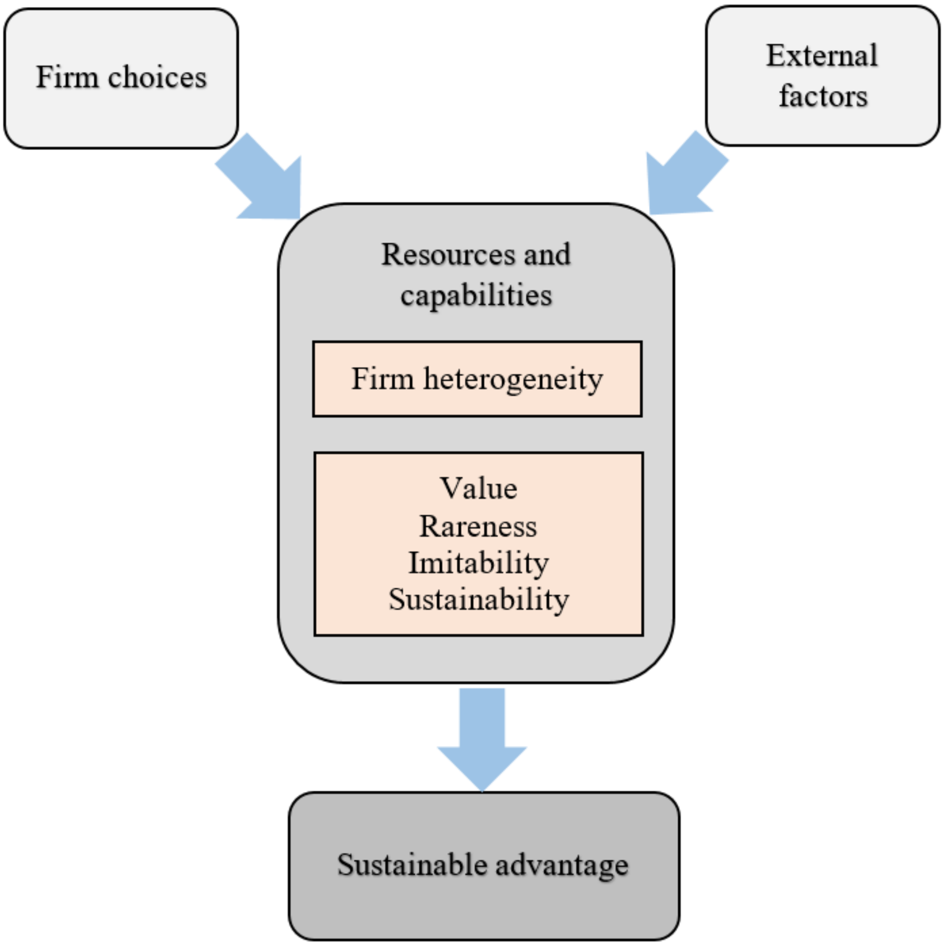


Figure 2.4 - Sustainable advantage and RBV (As adapted from (Kostopoulos *et al.*, 2002))

2.2.3 *Strategic theme conclusion*

In conclusion, the strategy theme section presented above, reviewed the strategy literature through the lens of gaining competitive advantage. The strategic theory of resource-based view was also reviewed in light of sustainable competitive advantage, setting the building blocks of this research. The literature reviewed suggests that a robust business strategy identifies, exploits, builds and replenishes strategic resources and capabilities of a firm to gain sustained competitive advantage. Strategically managing the strategy development and delivery process, transforms it into results by achieving its objects and goals and creating value for its stakeholders. Figure 2.5 below presents a conceptual model of the strategic theme of the literature review:

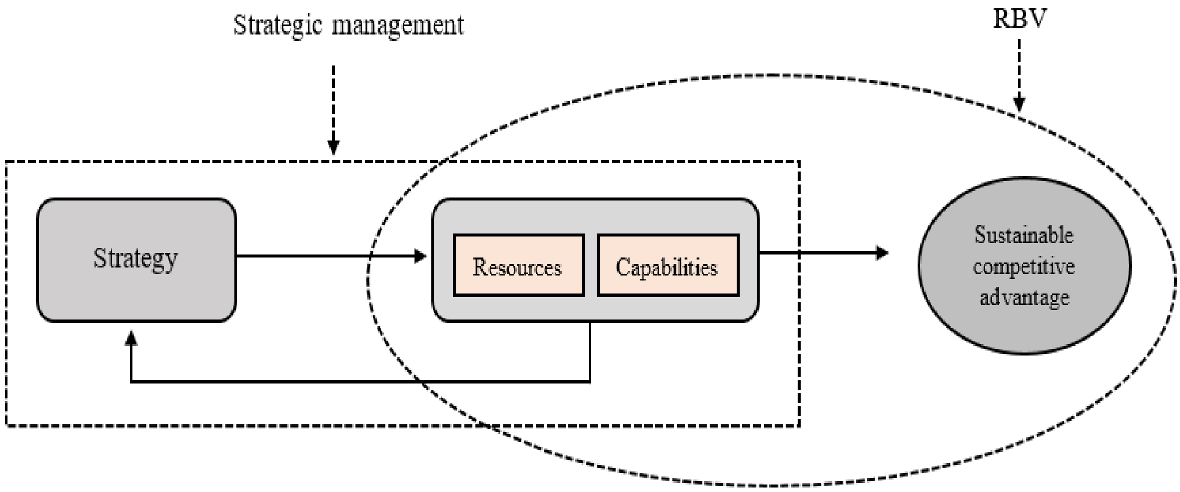


Figure 2.5 - Conceptual model of strategy theme

Having deployed the funnel approach, the following section narrows down the literature reviewed to the second theme of innovation. The following section will build upon the understanding and knowledge gained in this section and explore innovation as a strategic source of competitive advantage.

2.3. Innovation theme

The aim of this section is to build upon the reviewed literature of the previous section and extend it to the theme of innovation. Using the funnel approach, this section narrows down the wider literature of the previous section to the more particular theme of this research - innovation. The same approach (funnel and lens approach) will be deployed in this section to explore first the wider themes of innovation strategy, elements of innovation, to subsequently narrowing it down to gaining sustained competitive advantage via innovation through the lens of RBV. It then further narrows down the literature to review the innovation scenario in rail/transportation.

2.3.1 Strategic approach towards innovation

In the current dynamic markets, ongoing success typically requires innovation and change (Sull *et al.*, 2018). As established by the OECD, the innovation capacity of a nation determines its growth (Lundvall, 2010), as the living standards are determined by the competitiveness of the firms and also provide social stability (Sabir & Sabir, 2010). Competitiveness as described by The Centre for Process Excellence and Innovation, involves the capability to innovate and develop novel solutions; and to deliver these products and solutions by efficient operational processes (Sabir & Sabir, 2010). In a study within the healthcare sector Matthias and Brown (2016), highlight the importance of operations strategy to define and implement operations management initiatives in order to enhance services and performance. Same can be applied to the transportation sector, which is also characterised by customers that are increasingly experience-aware and demand better value for money (Matthias & Brown, 2016).

Improvements in performance depend widely on innovation, and an effective innovation requires a strategic approach. However, implementation of technological strategies is very difficult and only few companies have been successful in consistently developing innovation in a strategic manner (Dodgson *et al.*, 2008).

2.3.1.1 What is innovation strategy and why is it important?

Dodgson *et al.* (2015) characterise an effective innovation strategy by its systematic way of decision making and efforts in order to improve innovation within and across organisations. Pisano (2015) argues, that without an innovation strategy, innovation improvement efforts can become a mere collation of best practises. As such, according to Cooper and Edgett (2009), an innovation strategy must have clearly defined goals and objectives and defined strategic areas of focus which tie into broader business goals. Again, Dodgson *et al.* (2015) argue that such strategies enable an organisation to choose the type and level of innovation that best support its organisational aims, while establishing guidelines on the use of resources to deliver best value to customers. This in turn allows an organisation to build its adaptive capacity, helping it to react in unforeseen events (Dodgson *et al.*, 2015).

Defining in the context of product lifecycle, such as in railways where vehicles and other infrastructure has a life span of 40 years or more, Cooper and Edgett (2010) define innovation strategy as a long-term commitment. Davies *et al.* (2014) argue that learning, evidence from external environment, assessment of internal capabilities, resources and processes, are the fuel to build, support and formulate an organisation's knowledge and innovation capabilities in changing environment, suggesting that innovative strategy is a continuous dynamic process. In addition, a successful strategy requires a tolerant, supportive environment that encourages learning and failure (Dodgson *et al.*, 2008).

In a large industry such as railways, innovation is searched beyond the boundaries of an individual firm, which when combined with internal ideas helps create value (Chesbrough, 2003). As described by Chu (2007) in the study of Taiwan's Industrial Evolution, a successful innovation requires skilled manpower, information, research, venture capital and entrepreneurship (Chu, 2007), which is very well facilitated by the combined efforts of more than one organisation. In today's rapidly changing environment, an innovation strategy must enable an organisation to learn from other industries, influenced by internal resources and external capabilities of suppliers, universities, individuals and organisations, to achieve its corporate goals (Davies *et al.*, 2014). Summarising this perception, Dodgson *et al.* (2015) states that the basic principle of innovation strategy is its collaborative process which involves internal ideas, people with diverse expertise, and external inputs from customers, suppliers, research institutes etc. accomplished by the combined efforts of inter-related organisations forming an industry (Dodgson *et al.*, 2015)

In addition, the formulation of an innovation strategy also requires a wider analysis of the market, technologies, and industry trends (Dodgson *et al.*, 2008). Dodgson *et al.* (2008) argue the significance of external analysis being crafted alongside a firm's understanding of its internal resources and capabilities, as Dodgson *et al.* (2008) believe that it enables the effective deployment of firm's internal resources and capabilities in delivering a firm's value proposition. Internal to the firm, Cooper and Edgett (2010) argue that key influencing factor of successful strategy is the strategic leadership (Busse & Wallenburg, 2011) and a strategic vision of the business (Cooper & Edgett, 2010). Alegre-Vidal *et al.* (2004) argue that a key feature of product innovating companies is the relationship between operations strategy and new product development. These links have been explored by Matthias and Brown (2016) who define operations strategy as the means to providing a broader concept of value and service delivery, whilst creating organisational knowledge and enable planning to harmonise market demands and resources.

In conclusion, an innovation strategy enables and guides decisions on the use and deployment of resources to meet a firm's innovation objectives (Pisano, 2015), thereby delivering value and building competitive advantage (Dodgson *et al.*, 2008). Pisano (2015) further adds, that an effective innovation strategy should address how innovation can create value for customers and how the organisation can capture a share of value generated by the innovation. In order to create and capture value, an innovation strategy should identify the best suited types of innovations and the resources that should be developed and exploited for each innovation type (Pisano, 2015). It is supported by the innovative capabilities of a firm that direct the configuration and reconfiguration of a firm's resources and aids the selection of appropriate innovation processes for the firm's circumstance and ambitions (Dodgson *et al.*, 2008). Figure 2.6 below presents a simple model of innovation strategy:

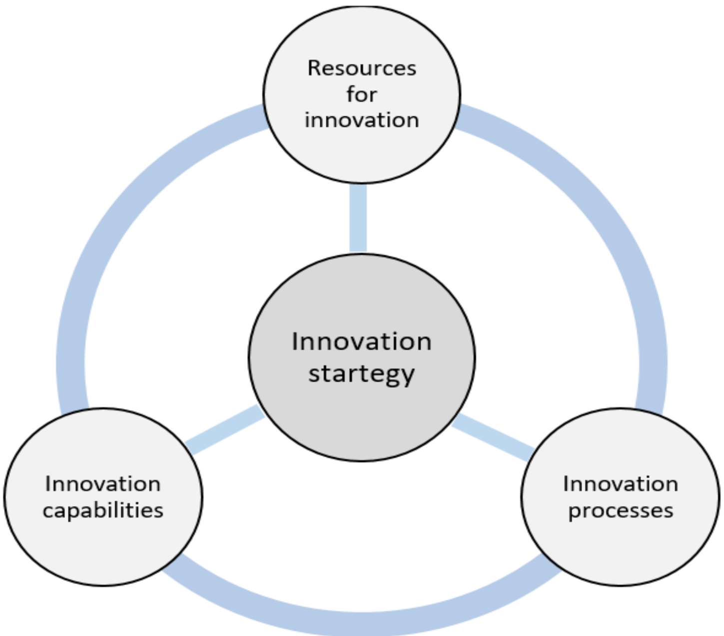


Figure 2.6 - Innovation strategy model (As adapted from (Dodgson *et al.*, 2008))

These key interrelated elements presented in Figure 2.6 are discussed in detail in the following section.

2.3.1.2 Elements of innovation strategy

Innovation strategy, as defined above, should fit with the overall strategy of the company, recognise the existing innovation efforts, and should be fit for the market it is operating in. It should identify the right technologies and market to create and deliver best value for the firm (Dodgson *et al.*, 2008). The resources and capabilities then determine what resources are best suited to gain competitive advantage and the capabilities ensure their best exploitation. Innovation processes, as described by Dodgson *et al.* (2008), is the combination of management and organisation around Research and Development, new product and service development, operations, and commercialisation and synthesis of the inputs (innovation strategy, resources and capabilities) to produce results.

As discussed in the above section, innovation strategy focuses attention on how resources and capabilities and processes can be best developed and deployed to meet corporate objectives. These three key elements are further defined as follows:

Resources: innovation strategy resources include financial, human, technological, marketing, organisational, and network resources. Figure 2.7 presents a model of resources of innovation.

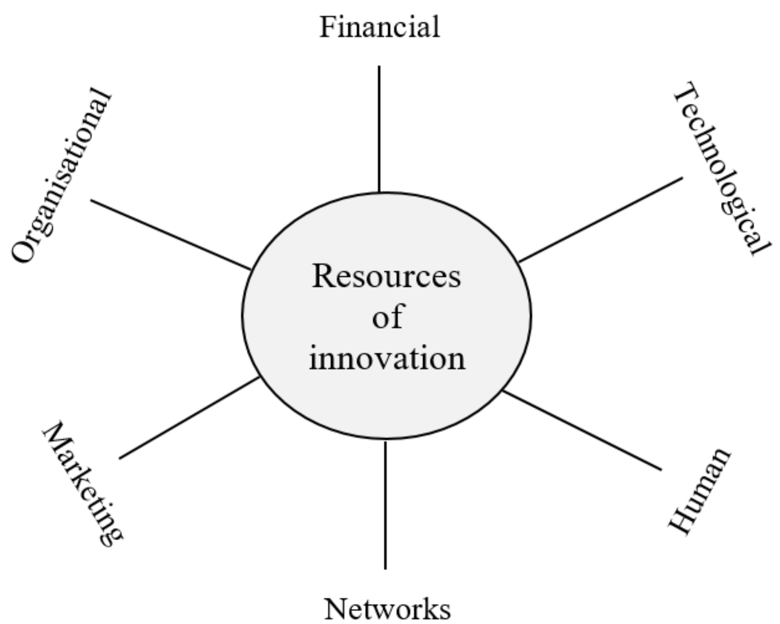


Figure 2.7 – Innovation resources

Financial resources determine the speed of development of innovation (Archibugi *et al.*, 2013) and help build an appetite and tolerance for risk (Dodgson *et al.*, 2015). Technological innovation provides an impetus for innovation as a whole which includes new products, processes, management systems and better profitability from old products and processes (Sabir & Sabir, 2010). Implementation of processes and strategy is vastly influenced by the human resources and their capacities for innovation (Dodgson *et al.*, 2008). Market resources include the market knowledge, market penetration, and access to lead customers. Various key processes are developed via organisation resources which include routines, procedures, policies of the firm, and practises. And finally, network resource referrers to the adhesiveness between the partners, suppliers, customers, communities within which the firm operates (Dodgson *et al.*, 2008).

Capabilities: innovation capabilities are defined as the stocks of skills used by a firm to develop and implement an innovation strategy, which involves the creating, extension, and modification of innovation resources (Helfat & Peteraf, 2009). Figure 2.8 presents a model of innovation capabilities.

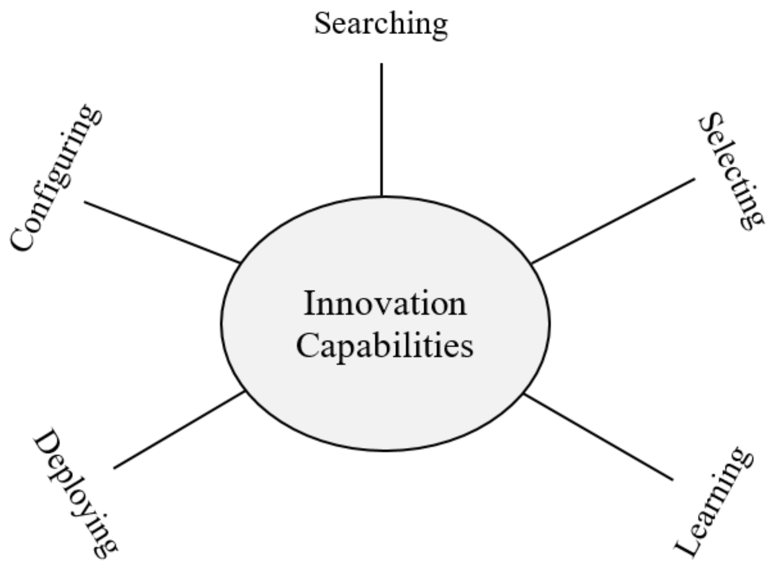


Figure 2.8 - Innovation Capabilities

In innovation strategy, Dodgson *et al.* (2015) identified searching, selecting, configuring, deploying and learning as the key capabilities. Seeking refers to the forward-thinking characteristic of an organisation that is always seeking and assessing market technological opportunities. Selection involves choosing the best technologies and other resources based on an evaluation of available resources, and market and opportunities, in order to create value for the firm (Dodgson *et al.*, 2015). Configuring and deploying refers to the coordination and integration of activities involved in the innovation process, and delivering them on time and to budget. In order to maximise the effectiveness of an innovation process, the performance of the innovation process must be continuously improved through experimentation and experience. This also includes the creation, development and adaption of knowledge in order to improve efficiency in times of change. It also enables the organisations to improve on existing processes and effectively learn new things (Dodgson *et al.*, 2015).

Processes: innovation process includes technological collaborations, Research & Development, creation of new products and services, operations and generation of economic returns through commercialisation (Dodgson *et al.*, 2008). Dodgson *et al.* (2008) emphasised the importance of innovation processes as: '*An innovation strategy helps firms decide on the right things to do; their innovation processes help them do things in the right ways*'.

An example of the interrelations of the elements of innovation strategy discussed above can be found in Slater *et al.* (2014) study of radical innovations, where organisational culture, senior leadership, and organisational characteristics were found to have strong interrelation with innovation capability processes to improve firm performance in dynamic market conditions.

This section reviewed the key strategic elements of innovation strategy, that is, resources and capabilities, as the foundations of a robust innovation strategy. The following section thus, explores how innovation can enable a firm to gain sustained competitive advantage.

2.3.2 Sustaining competitive advantage via innovation

Innovation activities of an organisation significantly influence competition, which is based on inimitable resources and capabilities. These resources have been defined as productive assets of the firm through which activities are accomplished (Bakar & Ahmad, 2010). These have also been defined by other scholars as factors owned and controlled by a firm, (which include knowledge, physical assets, human capital, and other tangible and intangible) which are then converted into products and services effectively and efficiently (Bakar & Ahmad, 2010; Capron & Hulland, 1999). Limitation of these resources, as observed by Day and Wensley (1988) in small and medium enterprises, argues that these should not always prove to be a disadvantage as when unique and well positioned compared to the competitors can enable the creation of value products for consumers and also provide the greatest potential for wealth creation and redistribution (Bakar & Ahmad, 2010).

Gaining higher competitiveness by means of innovation means producing higher quality goods and services at lower costs as compared to the competitors (Urbancová, 2013). Developing successful technological innovation is fundamental to creating and sustaining an organisation’s competitive advantage (Martín-de Castro *et al.*, 2013). Zemplinerová (2010) argues that the expenditure on research, development and introduction of innovation are the determining factors of gaining a dominant market share (Urbancová, 2013). Autant-Bernard (2001) conducted a survey which supports the view by showing the importance of regional innovations and argue that an organisation should have original strategies and support knowledge flows from and to the organisation.

Organisations that are not able to introduce innovations on an ongoing basis risk lagging behind as the initiatives might be taken by other entities (Urbancová, 2013). Schumpeter in Tidd *et al.* (2007) showed that entrepreneurs use technological innovations such as a new product or service, or a new process in their course of production to gain strategic competitive advantage. This might not necessarily effect the profit margins or outputs of the existing organisations, but their essence and their existence (Urbancová, 2013).

For the purpose of this research it is vital to consider large organisations that engage in innovation as they have the capability to extend beyond their internal threshold of innovation and influence external environment. Urbancová (2013) in her research found that the concept of innovation in large organisations not only influences inspection and change in internal environment, but also in the external environment. The internal environment of an organisation requires a suitable pre-set innovation culture (which is often characterised by the inconstant organisational structures), utilisation of specialists and temporary teams, the flexibility and speed to respond to new opportunities, in order to increase its innovation potential (Molina-Morales *et al.*, 2014). The characteristic features of such organisations thus include flexibility, openness to change, inclusion of information and resources in the external environment, anticipation, creativity, and experimentation and informal communication (Urbancová, 2013). Organisations with such a culture were also found to create loyalty arising from employee engagement to fulfil the organisations goals and performance (Urbancová, 2013). However, irrespective of the size of the organisation, changes in external environment due to the rapidly progressing technology and the multi-technology nature of products and processes pose constraints to developing and mastering internal capabilities required for innovation (Filiou, 2005). This leads to the systematic use of capabilities, as they are increasingly distributed among industrial and non-industrial actors (Filiou, 2005). As a result firms are motivated to cooperate to further exploit their knowledge beyond the boundaries, in diverse contexts (Filiou, 2005).

In addition to technological innovations, Bakar and Ahmad (2010) in their research on assessing relationship between firm resources and product innovation performance, found that intangible resources are important determinants of a firm’s success. The research classified a firm’s resources as: physical, reputational, organisational, financial, human intellectual, and technological (Bakar & Ahmad, 2010; Puente & Rabbino, 2003). Runyan *et al.* (2006) define resources as tangible and intangible. Tangible resources include capital, access to capital and location such as location of the buildings, warehouse and other facilities, and intangible resources include knowledge, skills and reputation and entrepreneurial orientation such as pro-activeness, innovativeness and risk-seeking ability (Bakar & Ahmad, 2010). Even though the tangible resources (physical and concrete assets in ore concrete form) are much easier to protect than intangible resources where many factors can make them flow out of the organisation. Bakar and Ahmad (2010) in their research state that intangible assets are found to contribute more than tangible assets in creating value. Intangible resources are therefore equally important to be taken into account in this research as they support a greater level and breadth of activity (Bakar & Ahmad, 2010).

Having explored the means of gaining sustainable competitive advance via innovation, the following section applies the lens of RBV, to review a firm’s capacity to innovate and gain sustainable competitive advantage.

2.3.2.1 A Resource Based View of the firm’s capacity to innovate

Traditionally innovation activities have been studies in terms of organisational structure and/or industry characteristics (Kostopoulos *et al.*, 2002). However a growing body of literature that embraces resource-based view of the firm advocate that the presence of different organisational resources and capabilities positively influence the outcome of the innovation process (Ferlie *et al.*, 2016; Wu & Chiu, 2015). According to Kostopoulos *et al.* (2002), the basic fundamental of resources based research of innovation is that a firm’s resources and capabilities are the underlying determining factors of a firm’s capacity to innovate. As such, a firm's resources are transformed by its capabilities to produce innovative forms of competitive advantage (Kostopoulos *et al.*, 2002).

Kostopoulos *et al.* (2002) identified various critical resources to innovation. These are presented below in Figure 2.9:

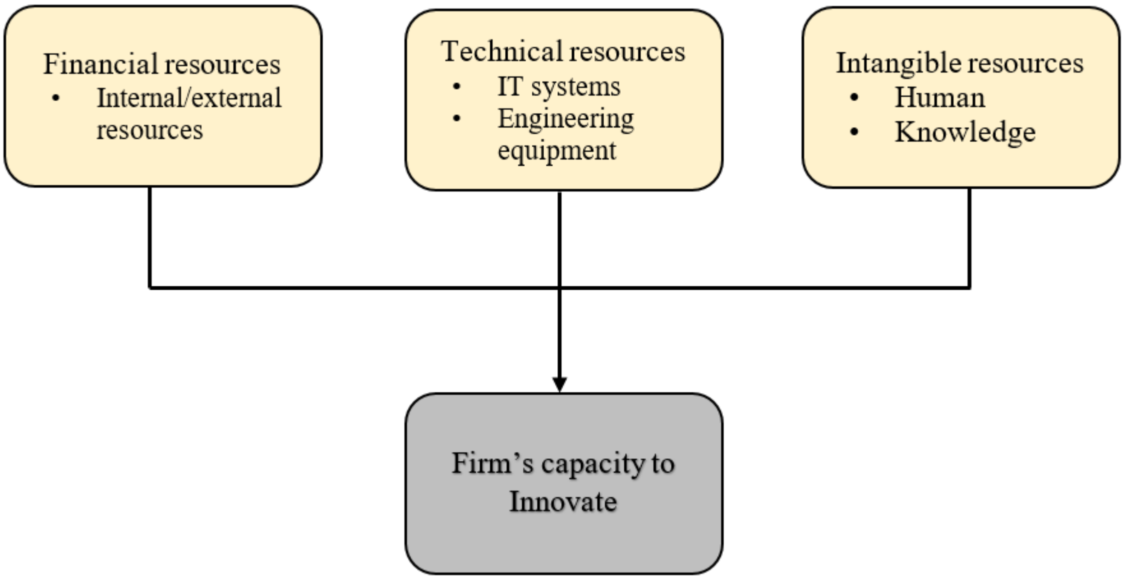


Figure 2.9 - Resources of innovation (As adapted from (Kostopoulos *et al.*, 2002))

Elaborating on Figure 2.9, the financial resources of a firm are found to support its innovation activities (Davenport, 2013), whereas the lack of it can limit the level of innovation of a firm (Archibugi *et al.*, 2013). Transaction-costs Economics and Agency literature, reports that a firm's internally generated funds are more favourable to a firm's Research and Development (R&D) activities and investments than external funds. Kostopoulos *et al.* (2002), identified that this is because there is a risk of competitors gaining information on R&D projects and the firm losing control over their innovation due to the information asymmetries that exist between firm and the external capital market (Kostopoulos *et al.*, 2002).

Technical resources such as engineering and production equipment, manufacturing facilities, IT systems have been found to positively affect innovation (Bloom *et al.*, 2016). Innovation activities in many cases requires a prior investment in highly sophisticated technical equipment which raises the possibility of producing unique, diverse and high quality products, which results in an increased value for the firm (Kostopoulos *et al.*, 2002). For example, technical equipment and software are essential for testing and trialling a product. According to Tahera *et al.* (2012), testing is an essential part of both the technology development process and the product development process (Tahera *et al.*, 2012). Testing at an early stage determines the feasibility of the concept. (Lévárdy *et al.*, 2004). Using upfront analysis at the concept stage can help reduce the Product Development cycle time (Tahera *et al.*, 2012; Wilkinson, 2007). For example, tools such as, QFD (quality function development) are used to translate customer needs to engineering details. These details form the inputs for the FMEA (failure mode and affects analysis). Along with data of previous products, the FMEA helps identify potential failures (Tahera *et al.*, 2012). At the later stages, focus is on reliability, product performance, and requirements verification. By this stage there are more physical objects and virtual models are detailed (Tahera *et al.*, 2012). Engineers believe that at this stage since both virtual and physical testing is an option, intelligent integration of the two is required for high fidelity testing and to save time and costs. Virtual testing drives physical testing at these later stages (Tahera *et al.*, 2012) . Tahera *et al.* (2012) believe that it makes the physical testing more focused as the boundaries are set by virtual testing (Tahera *et al.*, 2012). Technology also plays a vital role in incremental changes. Yassine *et al.* (2008) define incremental changes as the technical changes done to an existing design due to customer needs or legislation. Such change might be easier to incorporate in virtual domain but might prove challenging physically (Yassine *et al.*, 2008). This can then reduce the number of prototypes and save time and costs. (Tahera *et al.*, 2012; Thomas *et al.*, 2006; Wilkinson, 2007). Further late in testing stage, as discussed in RSSB (2014), highly sophisticates testing laboratories and in some cases depending on the type of technology being tested, full scale rigs are required. Testing at this stage ensures that the requirements defined in the early lifecycle stages have been delivered. Testing in the later stages of product development lifecycle, is a crucial part of the acceptance process. It enables to demonstrate compliance with legislation and requirements set by the client in the contract (RSSB, 2014).

Intangible resources are found to remarkably influence the success of an innovation (Barney, 1991; Drucker, 2014), so much so that Kostopoulos *et al.* (2002) stated that intangible assets may be more important from strategic point of view as they more often produce the necessary attributes for sustainable advantage (that is, to be valuable, rare, and difficult to imitate and replace by competitors). The effectiveness of innovation activities is greatly influenced by the qualification and technical skills of the human capital involved in the production process (Drucker, 2014). Knowledge is another influencing factor extensively identified in literature. Leonard-Barton (1995) argued the need for organisations to be able to create knowledge within their boundaries, while simultaneously adapting innovative ideas from external market in order to determine their competitive success (Leonard-Barton, 1995). Knowledge sharing between employees, across and within teams contributes to knowledge application and innovative activities, and has a positive impact upon production costs, new product and service development and team performance (Abualqumboz *et al.*, 2017).

Therefore, from the above discussion it can be concluded that a firm's resources (tangible and intangible) when worked upon using firm's capabilities, have the ability to transform into competitive advantage for the firm. Figure 2.10 below presents the essential capabilities identified in literature for innovative transformation.

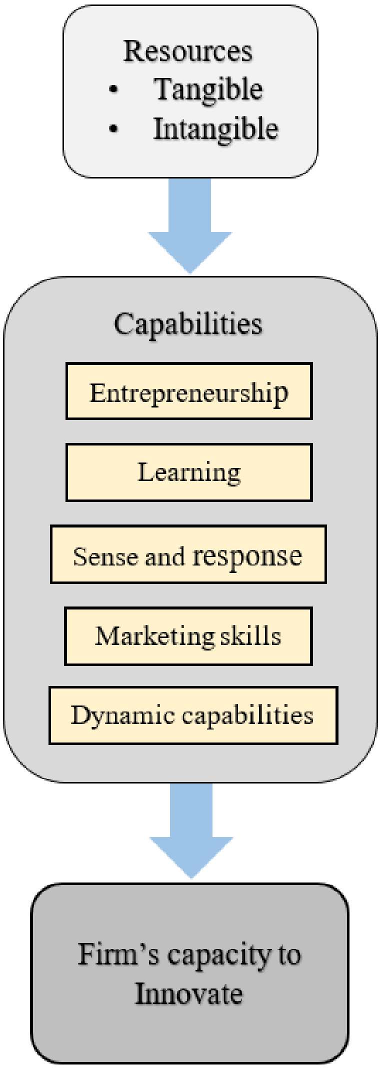


Figure 2.10 - Capabilities of innovation (As adapted from (Kostopoulos *et al.*, 2002))

Elaborating on Figure 2.10, entrepreneurship is the capability of comprehending a long-term vision for a firm, aiming at higher growth and profit maximisation, through the introduction of innovative products and technologies (Kostopoulos *et al.*, 2002). Lumpkin and

Dess (1996) also argued that the key dimension of entrepreneurship is the emphasis on innovation. Various other studies have also recognised the strong links between entrepreneurship and innovation (Eshima & Anderson, 2017; Kostopoulos *et al.*, 2002).

The literature evidences the positive effects of organisational learnings on innovation. Learning enables an organisation to generate new knowledge, recombine existing knowledge and skills, and adapt to changing market conditions (Kostopoulos *et al.*, 2002). Leaning also forms a key enabler of organisational transformation and change (Newman, 2000).

Organisational capability of 'sense and response' has also been found to have a positive impact on innovation. 'Sense and response' refer to the ability of a firm to rapidly sense changes in the environment and develop an appropriate response and reconfigure resources accordingly (Kostopoulos *et al.*, 2002). Other researches such as Quinn (2000) and Souder and Jenssen (1999) also advocate the importance of 'sense and response' for continuous innovation.

For the implementation and exploitation of innovation, Kostopoulos *et al.* (2002) recognises the importance of marketing skills. For successful innovation outputs, the interaction and integration between marketing and innovation activities plays a crucial role, as it enables the exchange of required knowledge and information (Drucker, 2014).

Drucker (2014) and Souder and Jenssen (1999) exemplified that the integration and interaction between marketing and R&D functions is critical in order to exchange the required knowledge and information within and in between departments, accelerating innovation process and achieving successful innovation outputs. Hultink *et al.* (2000) in the study of new product success also recognise the important association between innovation and marketing competences.

Finally, innovation requires the integration, building, and recognising internal and external competences of a firm, in order to address the rapidly changing environments. These are brought about by the dynamic capabilities of a firm (Teece *et al.*, 1997). These dynamic capabilities of coordination and integration, learning, and transformation serve as the mechanisms of combining and transforming available resources into new and innovative forms of competitive advantage (Kostopoulos *et al.*, 2002; Teece *et al.*, 1997).

In conclusion, from the Resource-based View perspective, managing the available stocks of resource and core competences of an organisation, can lead to successful innovation activities.

RBV also exploits the heterogeneity of the firm's resources which provides opportunity to increase the future value. Thus, RBV enables the production of innovation outputs of increased value and by implementing innovations, enables a firm to establish new 'stocks' of assets that the competitors will find difficult to replicate quickly (Kostopoulos *et al.*, 2002).

For the purpose of this research, and for the ease of connecting the third theme of literature review with the innovation theme, it is found significant to define innovation and its key elements. The following section thus, forms the last section of the innovation theme, assembling all the required building blocks for the third theme of this chapter.

2.3.3 Innovation

Innovation has been the main impetus of humanity since its origin. However, it was only after the last half of the last century, that it came to be connected to having the capacity to stage value resulting in a better economy and society (Teixeira *et al.*, 2013). Today innovation is known a social procedure where individuals make strategic choices for economic transactions and to generate, monitor and transmit knowledge. Innovation is associated with identifying, generating and implying knowledge effectively, and as appropriate throughout organizations (Edwards *et al.*, 2005; Teixeira *et al.*, 2013)

Freel (2000) emphasises on innovation as a key condition of economic progress and recognises its role in the competitive struggle of enterprises and nation states (Freel, 2000). Innovation is broadly perceived as a key variable in the competitiveness of countries and firm. Innovation is essential for economic growth and for firm to remain competitive. Due to increased global competition, reduced product lifecycles, increased technological capabilities of firms, and rapidly changing consumer demands, the need for innovation has increased (Galia & Legros, 2004; Madrid-Guijarro *et al.*, 2009).

2.3.3.1 What is innovation?

The Department for Business, Innovation and Skills defines innovation as the successful exploitation of ideas (Conway & Steward, 2009). Unlike invention, innovation is the summation of all the activities, from discovery and invention, through to development and commercialisation (Conway & Steward, 2009). Urbancová (2013) defined innovation by dividing it into inventive, which is the generation of the original idea or concept and, innovative which is the implementation and marketing of the invention (Urbancová, 2013). Dodgson *et al.* (2008) further expanded the definition of innovation by not restricting it to the realm of technology, and includes the decisions made on strategy as a part of innovation. (Dodgson *et al.*, 2008).

Literature suggests that an invention does not become innovation until it has gone through production and marketing tasks and has been dispersed into the market (Freeman, 1989; Layton, 1977). Again, Garcia and Calantone (2002) argue that innovation, in addition to basic and applied research, includes the product development, manufacturing, marketing, distribution, servicing, and later product adaption and upgrading (Garcia & Calantone, 2002). Differentiating invention from innovation, Garcia and Calantone (2002) state that the main difference between an innovation and invention is that an innovation is diffused into marketplace and is of economic value (Garcia & Calantone, 2002). Roberts (2007) also defines and innovation as the process that includes commercialisation and application of new ideas in a particular environment (Wagner, 2008)

Concluding from the extant literature and in view of the purpose of this research, innovation as defined by OECD (2018) '*is a new or improved product or process (or combination thereof) that differs significantly from the units previous products or processes and that has been made available to potential users (products) or brought into use by the unit (process)*'. These innovations can include one or more types of innovation (e.g. marketing methods, workplace organisation, organisational methods in business practices, external relations) for instant product and process innovations (OECD, 2005).

2.3.3.2 Elements of innovation

As the OECD (2018) definition states, the innovation process involves both the product innovation and process innovation. Successful companies overcome the traditional understanding that a trade-off exits between customer value creation (via product innovation) and cost control (via process innovation). It has been recognised that organisations need to be aware of both of these innovations and invest in different innovation activities simultaneously, in order to improve the current services and reduce the costs of delivering these services (Wagner, 2008). Expanding further on the role of innovation, Porter (1983) argued that for an organisation to be competitive, its strategy must drive technological development (Ortega Jiménez *et al.*, 2011). However, Benda (2015) in the study to enhance aviation security, argues that undoubtedly technology plays a significant role in improving the firm's ability in relation to security systems it offered, process changes could vastly improve the firm's output, staff utilization rates and effectiveness (Benda, 2015). This statement is supported by Utterback

(1994) which states that in order to cope with the challenges from complex and integrated markets, firms must be able to shift from strategy focused on product/service innovation to strategies focused on process innovation (Utterback, 1994). Utterback (1994) stated the above with regards to meeting customer service demands via product innovation and delivering these services at reduced costs via process innovation.

Technology is traditionally associated with machines and hardware; however, it is more than that. As stated by Li-Hua and Lu (2013) it is '*theoretical and practical knowledge, skills and artefacts that can be used to develop products and services as well as production and delivery systems*'. Kumar *et al.* (1999) also define technology as a combination of physical components such as products, tools, processes, and informational components such as production, managerial skills and know-how, reliability and skilled labour. Technology has been recognised as a key element of business and competitive advantage by the strategic management scholars since 1980's (Li-Hua & Lu, 2013). Porter (1983) considers technology as a crucial element of gaining competitive advantage and is believed to be an effective character to business definition by Abell (1980). In addition, technology can determine the quality of service characteristics as Windrum *et al.* (2009) in their study of relationship between technical and service characteristics, concluded that technical components underpin large sets of service attributes valued by the customers.

Innovation is increasingly becoming the centre of competitiveness due to the advancements in technology and increased global competition (Lawson & Samson, 2001). Lawson and Samson (2001) identified that as innovation increasingly became the focus of all companies, the barriers to performance have also increased significantly to achieve success (Lawson & Samson, 2001). The current competitive environment demands organisations to have multiplicative levels of improvement in business performance. According to Davenport (2013), a business should be viewed in terms of its key processes and innovative technologies and organisational resources should be employed to improve them. Process innovation, therefore brings together the process view of the business and the application of innovation to key processes. (Davenport, 2013). An excellent example to demonstrate the impact of process innovation is the success of Japanese firms. Davenport (2013) in his research found that the Japanese implemented process management long before their competitors and since have gained significant competitive advantage over their rivals. The development of efficient processes in key areas as product development, logistics, and sales and marketing, was found to be a competitive resource as they were highly refined and logical, balanced, and streamlined (Davenport, 2013).

Dervitsiotis (2010) in the study of assessing a firm's innovation excellence, defined the key components of the innovation system as the inputs, which include new ideas and investments; the innovation process which includes the various stages of the innovation process,idea generation, project selection, innovation development, and taking to market; and outputs which can be in the form of new products/services, processes and/or business models.

In addition, innovation can also be classified as radical, that is, innovation that is a new technology resulting in the creation of a new market (O'Connor, 1998), addresses the unrecognised demand (Garcia & Calantone, 2002), and is characterized by long term developments and huge investments, promising large returns (Teixeira *et al.*, 2013). On the other hand if the innovation involves substantial changes either in the technology or the established business model it is called semi-radical innovation (Teixeira *et al.*, 2013). Although Teixeira *et al.* (2013) also highlight that usually changes in both do not occur as the businesses might struggle to keep up with the changes in both the areas. However changes in one does influence the other. Song and Montoya-Weiss (1998)classify improved products that provide new features and benefits over existing products as incremental innovations. According to Garcia and Calantone (2002) incremental innovations act as competitive weapon in the market and alert organisations to technological shifts. It is the iterative nature of innovation that gives rise to incremental innovations. However, if an organisation launches a product but is not the first to complete their R&D, it is called imitative innovation, and is new to the firm but not to the market (Garcia & Calantone, 2002). This type of innovation is classified by lower levels of innovativeness, but an imitator with more resources and larger market share has the benefit of being more competitive and changing the market (Garcia & Calantone, 2002).

Another form of innovations that are being increasingly acknowledged are service innovations (Stauss *et al.*, 2010). Service innovations can be defined as new developments in activities to deliver core service products for a variety of reasons, for example to make core service products more attractive to customers (Oke, 2007). Product and service firms are increasingly advancing their service offerings to retain customers and build competitive advantage (Bettencourt *et al.*, 2013). As such, service innovation forms a key factor in a firm's competitive strategy (McDonough *et al.*, 2008). Service innovation priorities must be consistent with the capabilities and technology know-how of a firm which can be achieved by understanding what the customers are trying to achieve, what are their expected outcomes, and which of those outcomes are opportunities for creating service innovations (Bettencourt *et al.*, 2013). Maglio and Spohrer (2008) further emphasise that advances in service innovation are only possible when a firm possesses information about the capabilities and the need of the clients, its competitors, and itself. Building on the earlier contributions of service innovation research, Stauss *et al.* (2010) summarised the possible dimensions of service innovation into following dimensions: new service concept, new customer interaction, new business partners, new revenue models, new delivery systems – personal organisation, culture, and technological. These dimensions are realised by the firms innovation capabilities and resources (Stauss *et al.*, 2010). As stated by Ordanini and Parasuraman (2011) service innovation depends on the collaborative competences of a firm, dynamic capability of customer orientation, and knowledge interfaces, which in turn determines innovation outcomes and firm performance.

2.3.3.3 Strategic management of innovation

In terms of economic activities, greatest levels of growth and dynamism has been achieved in the past years due to innovations in services (Brentani, 2001). The strategic management of innovation is a crucial part of firm’s strategy, and is a major contributing factor to a firm’s competitive advantage (Keupp *et al.*, 2011; Porter, 1985). Keupp *et al.* (2011) combine Damanpour (1991) definition of innovation and Nag *et al.* (2007b) definition of strategic management, and suggests that the strategic management of innovation is the boosting of firm’s growth and performance through innovation activities by using appropriate strategic management techniques and measures (Keupp *et al.*, 2011). As such, Ojasalo (2008) argues that innovation management is the management of entire innovation process from idea generation through to development and commercialisation, including strategic and operational issues (Ojasalo, 2008). A good summarisation of the activities involved in innovation management is given by Drejer (2002). These are: technical integration, the process of innovation, strategic technology planning, organisational change, and business development (Ojasalo, 2008). Technical integration refers to the integration of the technologies and market in order to deliver what the customer needs, satisfactorily. Upfront market research, knowledge about competitors and use of superior techniques to address customer needs has a positive influence on the success of new product (Tomala & Sénéchal, 2004). According to Ojasalo (2008) innovation process is the cross functional activities that take place among the various departments of the firm to create innovation. Strategic technology planning involves the planning of technologies with the aim of maintaining or gaining competitive edge and safeguard other investments. Innovation and organisational change is an interlinked process; as new or advanced outputs cannot be achieved without change/ or from traditional methods. And for business development, innovation can drive as well as be driven by business development. (Ojasalo, 2008).

In the innovation process, the management play an important role in determining the success or failure of the process. McCosh *et al.* (1998) suggest that for successful management, the company in which the innovation is taking place must be very supportive of innovation in their actions, words and examples that they set. Maintaining a close relation with the customers can enable a firm to determine the future needs and best solutions for the customers (McCosh *et al.*, 1998; Ojasalo, 2008). Defining innovation as a continuous process, Ojasalo (2008) stresses that through internal procedures all innovations must be under continuous reconsideration to work simultaneously on all fronts in an adaptable cohesive manner. Another key factor identified in innovation management is the innovation culture. It involves appreciable freedom of action, resources to educate the employees about new technologies, and using teams of highly skilled employees (McCosh *et al.*, 1998; Ojasalo, 2008). Rewards for innovative employees is also suggested as a mechanism for sustaining and reinforcing the innovation culture.

The above can be summarised using innovation eco-systems, which is defined as structural approach to innovation, embodying technology and information flow between actors to turn ideas into processes, products or services (Bulc, 2011). As discussed above, these actors refer to material resources such as funds, equipment etc, and the human capital such as industry representatives, that make up the organisational entities such as universities, policy makers, business firms etc. that make up the ecosystem (Jackson, 2011) The effective management of an innovation eco-system is determined by the focus on customer value creation, quick responses to address market changes, quick transition from research to production, and adaptiveness to change (Bulc, 2011).

2.3.3.4 Creating value through innovation

Innovation enables to transform existing products and services, enhancing their value (in tangible and intangible form). It enables generation of new solutions by harbouring new ideas. Innovation enables a firm to gain competitive edge as it has the potential to generate unique, difficult to imitate organisational capabilities and competencies (Hall & Martin, 2005). For the emergence of new collective behaviour, it is essential to have cultural innovation. This has the compelling impact on maximising value created, due to the similar behaviours and attitudes deep rooted within a group setting (Moleiro Martins & Teles Fernandes, 2015). The accumulation and combining of resources through technical processes, that have value creating features is not sufficient. It is critical to have a network of stakeholders as resource providers that help the firms achieve a unique competitive position in the industry (Verbeke & Tung, 2013).

Interactions with the key stakeholders enhances innovativeness and adds to the success of the new launched product/service (Smirnova *et al.*, 2009). Collaborating with stakeholders provides a unique opportunity of enhancing firm's know-how, technological competencies and new product development. Involvement of internal and external stakeholders can compensate for weaker institution environment to make up for poor financial support and difficulty in developing competitive offerings (Smirnova *et al.*, 2009). Analysis shows a positive effect on financial performance of a firm where stakeholder issues are integrated in management decisions (Driessen & Hillebrand, 2013). Through strategic and operational changes, innovation can positively affect stakeholder cohesion (Minoja *et al.*, 2010). Stakeholder cohesion provides a firm with higher degree of freedom in defining its strategy and enables it to avoid costs and inefficiencies from conflict and negotiations, by providing better access to resources (Minoja *et al.*, 2010).

This view is further strengthened by resource based view which acknowledges the understanding of resources beyond goods and money and emphasizes the strategic value of organisations intangible resources to generate sustainable competitive advantages. These intangible resources are in the form of distinctive knowledge, skills and competencies. (Mele *et al.*, 2010). Such intangible resources provide a stronger competitive advantage as these are difficult to imitate by competitions and because no two stakeholder relationships are identical (Verbeke & Tung, 2013). In transportation, innovations that bring workers and firms together can lead to production cost savings and/or technological advantages, thereby lowering input costs, improving communications between firms, reduce labour market frictions and improving work efficiency (Gibbons & Machin, 2005).

As previously mentioned, the aim of successful business is to create value for its stakeholders. By offering innovative solutions to customer problems, a firm earns their loyalty, purchase intent, positive attitude and minimised scepticism regarding the quality and ethical issues related to the product/service (Verbeke & Tung, 2013). Employees are a valuable resource to a firm for gaining sustained competitive advantage, and are always open to opportunities from competitive forms in order to improve their overall wellbeing (Verbeke & Tung, 2013). As such firms should make a conscious effort to deliver ethically appropriate benefit packages to employees (Hosmer & Kiewitz, 2005) as reward to recognise and encourage the innovation culture in a firm.

Another critical stakeholder in the innovation process is the supplier. Developing and strengthening buyer-supplier relationship enhances the sense of mutual reliability and confidence that one party will not exploit vulnerabilities of the other party. This results in reduced costs and increase in return to both parties. This sense of security among the suppliers provides an opportunity to the firm to jointly prepare for future challenges (Verbeke & Tung, 2013). Political powers, irrespective of having a financial stake in an organisation, have a power to influence events that can have an impact on an organisation. Innovation supports the main role of the government in helping to co-create a society that improves the life of its citizens and create markets for business to compete and prosper (Verbeke & Tung, 2013). Innovation in transportation enables greater mobility by reducing commuting costs and thus, changes the distribution of job types and wages accessible to people (Gibbons & Machin, 2005).

Therefore, it can be concluded that a firm's performance greatly depends on its innovation capability (Odeh *et al.*, 2014). Innovation enables higher value creation for the stakeholders of firm, which are the main drivers of a firm's business.

Error! Reference source not found. below summarises the above discussion in terms of the type of value innovation creates for the stakeholders involved.

Table 1 - Creating value through innovation (As adopted from (Harrison & Wicks, 2013))

Stakeholders	***What type of value can it be?***
Employees	Elements of employment contract: pay, benefits Perceived fairness of decision-making processes Perceived treatment: respect, inclusiveness Promotion policies/upward mobility Firm's position/performance on other societal issues
Customers	Product/service features Perceived treatment during transactions: respect, fairness Perceived authenticity Firm's environmental performance Firm's position/performance on other societal issues Objective measures such as repeat business
Suppliers	Perceived treatment during transactions: respect, fairness Firm's environmental performance Firm's position/performance on other societal issues Nature of payments: size speed Also, objective measures such as longevity Availability of supplies
Shareholders	Financial returns Perceived riskiness of investment Governance structure and policies Disclosure of pertinent information/transparency Firm's environmental performance Firm's position/performance on other societal issues Also, objective data on returns and risk
Community	Perceived impact on community/environment (per community leaders or general perceptions) Perception of integrity of firm Also, objective data on number of positive/ negative encounters, community service, charitable and infrastructure contributions

As summarised above in Table 1 innovation creates both tangible and intangible value for its employees, customers, suppliers, shareholders and the community. As discussed above, this in turn strengthens the resources and capabilities of the firm improving and sustaining its competitive advantage. In order to gain competitiveness, all business develop their offering by adding services, while attempting to strengthen their capabilities and competencies via interactions that help improve the value creation process (Polese *et al.*, 2009).

2.3.4 Innovation theme conclusion

In conclusion, the innovation theme expands the knowledge gained from strategic theme section to innovation. Applying the funnel and lens approach within this sub section, vast literature on innovation, its building blocks of innovation strategy, were reviewed, and through the lens of RBV, the concept of gaining sustainable competitive advantage through innovation was explored. The literature reviewed in this section strongly suggest that innovation can enable a firm to gain competitive advantage, when managed strategically, and aligned with the overall business strategy. In light of this research, having applied the lens of RBV, innovation resources and capabilities were brought forward and their applicability and importance to gain sustainable competitive advantage was established. Figure 2.11 below, presents a conceptual model of the innovation theme of the literature review:

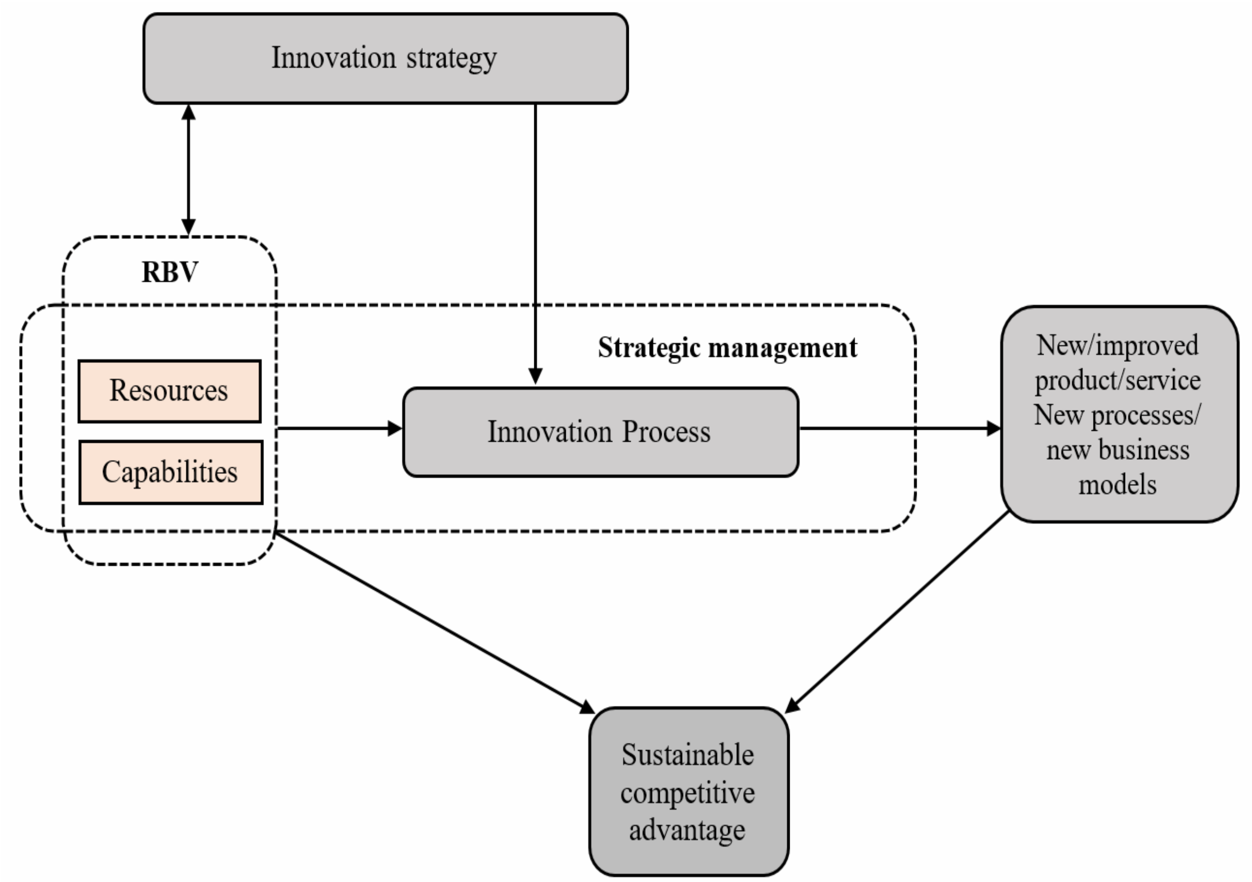


Figure 2.11 - Conceptual model of innovation theme

Having channelled the flow of innovation literature from the overall business strategy literature, the following section further narrows down the literature to the more specific area of this research, that is, the UK rail industry.

2.4. Transportation theme

Following the lead from the strategy theme and innovation theme this section explores the innovation strategy and innovation activities of a funnelled down area directly linked to the research, that is, transportation. Having reviewed strategy and innovation through the lens of RBV in the previous sections, this section explores transportation along the same themes, and the output of innovation in terms of value creation. Lastly, the barriers to innovation have been reviewed towards the end of this section.

2.4.1 Innovation scenario in transportation

2.4.1.1 Need for innovation in rail transportation

Chapman *et al.* (2003); (Nagarajan & White, 2007) state that there has been a rapid growth in the service-sector enterprise and their increased economic importance, due to the economic growth, higher disposable incomes, and technological advances. Irrespective of the offered products and services, the global market place is compelling every industry to transform itself into a customer-oriented and service-focused business (Chapman *et al.*, 2003). Chapman *et al.* (2003) further argue that it is the service element of a business that offers the best chance of gaining sustainable competitive advantage.

Busse and Wallenburg (2011) identified three trends that appear to have increased the need for innovation in logistics service providers. These trends are, firstly, the need to deliver sophisticated services which require more innovation; secondly globalisation and consolidation increases competition and the pressure to innovate and; thirdly deregulation which increases possibility and pressure to innovate by increases competition for cost and quality (Busse & Wallenburg, 2011). Some of these trends could be true for rail transportation as the need to deliver better services to customers and address the increasing demand, might put pressure on Train Operating Companies (TOCs) to innovate. The new regulation of innovation fund, which is a part of the contract of TOC can further strengthen the need and pressure to innovate. In terms of deregulation, the privatisation of the rail industry in UK can provide excellent competitive environment for the various rail entities to innovate. However, this can be argued to not hold true due to various other factors such as franchise system and contracts and poor business structure of the industry among others, which will be discussed further in later stages of the research based on its findings. Other factors that can influence the need for innovation are the growing demand for increased capacity (Wagner, 2008) and the demand for industry specific solutions, which according to Flint *et al.* (2008) can help develop customer focused solutions (Flint *et al.*, 2008).

Innovation is based on two critical factors, the willingness and the capability of the organisation to innovate (Garcia & Calantone, 2002), and the knowledge of a novelty that could be adopted (Busse & Wallenburg, 2011). Busse and Wallenburg (2011) stress that innovation projects need to be strategically management as they enable the delivery of successful innovation by forming strategic linkages, addressing resources conflicts, and managing organisational cultural impact (Busse & Wallenburg, 2011). As distinguished by Damanpour and Wischnevsky (2006), innovation can be separated into innovation creation which includes the "fuzzy front end" and innovation adoption which is seem more as a problem solving process (Damanpour & Wischnevsky, 2006). Owing to the lack of specific research in this areas among logistics service Busse and Wallenburg (2011) defined the same for the purpose of ease as adoption and generation (Busse & Wallenburg, 2011). One can thus, build an argument that in an industry such as the railways, there is the need and space for both these types of innovations. The innovation generation can be in the form of radical innovations to drastically change on a larger scale and improve one's position on global competitive level. The innovation adoption can form a part of the incremental changes required to do things in a new, more effective and innovative way to sustain and improve the quality, efficiency and as mentioned by Wagner (2008) the competitiveness of the firm in the transportation industry.

EuropeanCommission (2011) has stated transportation as a key enabler of economic growth and job creation. It recognises that the transportation faces new challenges while the old challenges remain. Issues including, providing better services to the customers to meet their growing desire to travel, transporting goods while preparing for resources and environmental constraints are highlighted in the report with an aim of fully uniting eastern and western parts of Europe, reflecting the needs of almost the whole continent (EuropeanCommission, 2011). In preparing for the future, the EuropeanCommission (2011) also recognises that there is a possibility of scarcer oil resources in the future, and with the goal of limiting climate change, there is a need for drastic reduction of greenhouse gases. The statistics presented in the report confirm that even though transport has become more energy efficient and cleaner, the EU transport still depends on oil and oil products for 96% of its energy needs, and the increase in volume of transportation leads to the increase in noise and local air pollution (EuropeanCommission, 2011). EuropeanCommission (2011) presents a vision and strategy for a competitive and sustainable transport system. It identifies new technologies as key to lower transport emission; continuous development and investment in infrastructure, logistics, traffic management systems and manufacturing transport equipment to maintain its global competitive position and; investments in infrastructure for positive economic growth, wealth creation and jobs, enhancing trade, geographic accessibility and mobility of people (EuropeanCommission, 2011). Lastly, the EuropeanCommission (2011) also states that the current transport system is not sustainable and continuing the business as usual will hamper the development along the same path, 40 years ahead.

2.4.1.2 *Innovation activities in transportation*

Service firms rely on a wide range of innovation sources simultaneously. Sirilli and Evangelista (1998) found that among the mix of innovation activities, acquisition and development of software, purchase of machinery and equipment, and the training of the employees are the most cited. Further expanding on these results, the innovation process can be classified into 5 activities, as described by Wagner (2008) in his conceptual framework for innovation management in the German transport industry:

1. Internal R&D
2. External R&D
3. Investment in infrastructure and capital goods
4. Acquisition of knowledge
5. Training and further education

(Wagner, 2008)

In the UK rail industry most of the R&D is conducted externally via various organisations. These organisations can include private industrial firms, universities or other research facilities (Wagner, 2008). RSSB invests about £9 million each year towards R&D. But as Bowdler (2002) suggests in his study on freight logistics in Australia, internal and external R&D is not fully developed in transportation industry because the innovations are often incremental in nature and the adopters of the innovation tend to confine the application and adaption of existing technologies to their own needs (Bowdler, 2002). In terms of knowledge acquisition, Macdonald (1995) argues that it is crucial to collaborate with the customers, to in-cooperate customer's understanding of challenges, success factors etc. (Macdonald, 1995). Björklund and Forslund (2018) also identified vast literature stressing the significance of acquiring knowledge and information sharing on innovation development capabilities. While creating strategic linkages, Gkypali *et al.* (2017) highlight the need for a balance while exploring external linkages to acquire additional knowledge to boost innovation performance. Gkypali *et al.* (2017) in their study of R&D collaborations in Greek innovation systems, found that internal efforts owing to the internal dynamic capabilities of a firm, have a positive impact on innovation while the diversity in the external R&D collaborations was found to negatively impact innovation performance of a firm, as diversity demands considerable resources to manage and monitor in coming knowledge flow. Tidd and Pavitt (2011) also found that the presence of many actors increases complexity and challenges. But at the same time Macdonald (1995) points out that since the customer is not always completely knowledgeable of the latest market trends and technological advances, one needs to utilise knowledge through expertise (Bowdler, 2002) as well. Therefore, as Wagner (2008) stated, '*transportation industry demands the acquisition of industry expertise and the implementation of this knowledge to other customers in the same sector*' (Wagner, 2008). Training and further education has been recognised as early as 1986 by Gellman (1986) in his work on barriers to innovation in railroad industry. As mentioned by Gellman (1986), innovation process requires highly intelligent and skilled labour, and as such relevant measures should be taken in career development. Isaksson (2014) stressed upon the critical activity of employee learning in his study of sustained logistics development. Learning also includes reflecting upon all the phases of the innovation process and reviewing successes and failures. Chapman *et al.* (2003) regards reflection important in order to better manage the process, accumulate process knowledge and increase the process efficiency. Tidd and Pavitt (2011) however state that even if researchers and practitioners recognise the role of learning, it can be challenging to do so in a structured way (Björklund & Forslund, 2018).

2.4.1.3 Challenges of innovation strategy in transportation

Most of the challenges reported in transportation related to the poor interactions between the actors of innovation ecosystem discussed earlier. A study conducted in 2005 on the innovation strategy in Cross rail (Dodgson *et al.*, 2015), highlights the challenges faced in implementing innovation strategies in large transportation projects. Van Marrewijk *et al.* (2008) stated that megaprojects such as railways are associated with risk and uncertainty that lead to avoidance of innovation (Van Marrewijk *et al.*, 2008). Clients and contractors in such projects were found to be very reluctant to introduce innovations and often stick to tried and tested techniques to avoid risks (Flyvbjerg *et al.*, 2003; Merrow, 2011). Innovation is further hindered by preferences for lowest price bids and not changing management practices with changing circumstances. There are no examples in literature of mega projects as reviewed by Davies *et al.* (2014), of organisations, contractors, clients or sponsors developing deliberate strategies and processes to design and implement innovation. However, the situation may be changing in UK with the greater emphasis on innovation in government reports (Dodgson *et al.*, 2015). Defining strategy as a top down approach, Dodgson *et al.* (2015) identified that it reflects the leadership of an organisation. In order to implement a strategy successfully it is crucial to equip the organisation and supply chain with the necessary knowledge, processes and incentives to generate innovation and encourage collaboration. Thus, building the innovative capacity, equips the organisation to deal with changing times and unforeseen circumstances (Dodgson *et al.*, 2015).

However, the strategies need to be continuously analysed and developed in order to stimulate economic growth and stability. In megaprojects such as transportation one of the key challenges identified by Dodgson *et al.* (2015), was to make contractors collaborate which otherwise are in competition. An innovation strategy also brings changes internal to organisation such as putting a team together. This is identified as crucial process as the integration and management of innovation is in the hands of the innovation coordinators. The right mix of strategic and operational expertise which is open to new ideas determines the successful implementation of innovation strategy (Dodgson *et al.*, 2015). F.R.David (2011) argued that another key task is the assessing of successes and failures to feed back into the system for learning purposes, not only from own projects but other projects and other sectors. F.R.David (2011) suggested that an analysis can be performed to identify the competition and industry performance, to enable pairing of suitable strategies with the industry structure (F.R.David, 2011). It may also help to prepare for unforeseen circumstances by bringing to light appropriate and cost effective measures that can be taken in such times (Porter, 1980). Emphasising the role of strategy in innovation ecosystems Adner (2006) stated that while competing in innovation ecosystems an innovation strategy enables mitigating risks that arise from changes in the external environment beyond firm's control. This in turn can help creative and perhaps more importantly maintain competitive advantage (F.R.David, 2011). As established by Porter (1985), gaining a sustainable competitive advantage is the only way of achieving superior performance.

Having reviewed the innovation scenario in transportation, the following section funnels down the literature to assess the success of innovation in terms of the value it creates for its stakeholders.

2.4.2 Barriers to innovation

The management of innovation systems is not restricted to the management of single innovation processes. Busse and Marcus Wallenburg (2011) stated various reasons for this which include challenges, such as resource conflict, the need for strategy linkages and for structural anchorages, because of innovation portfolio aspects, and as a result of the impact of organizational culture (Busse & Wallenburg, 2011). In a study of process improvements, Reid *et al.* (2015) researched the impact of external intervention to enhance the internal capabilities of a firm when they reach saturation. In order to improve an organisation's business processes, the study revealed that the main barriers to successful interventions were financial constraints and change in market; closely followed by ownership changes and pressure from customers and suppliers (Reid *et al.,* 2015). A number of studies shown that the barriers to innovation are mostly related to costs, human resources, government policies, organisational structure and flow of information (Madrid-Guijarro *et al.,* 2009). Freel (2000) argues that radical or major innovations take place in large firms or large public laboratories, but it is the small firms that are mostly responsible for near to market developments and initial market diffusion (Freel, 2000). Small firms face barriers in terms of lack of technically qualified labour, lack of funding, poor utilization of external information, risk management, high costs of gaining compliance, and management (Freel, 2000). This view is supported by Hewitt-Dundas (2006), who used resource based view to show that small firms are particularly restricted by innovation barriers due to their limited resource base. According to Dougherty (1992) in large firms, collaboration is necessary for technology market linkage to enhance product design and improve the development process In addition, Dougherty (1992) also found that the organisational culture is a major barrier to innovation. The study stated that the disconnect between departments and separate organisational routines further creates a barrier to innovation.

Since the UK rail industry consists of a number of organisations varying in purpose and size, it was found apt to review literature pertaining to barriers to innovation without any strict classification, although special stress has been given to literature related to transportation. The various barriers identified are reviewed below:

2.4.2.1 Identified barriers to innovation

Ross *et al.* (2012) conducted research on the grassroots innovations in small enterprises with a headcount ranging from 1- a sole innovator to less than 50, in UK transport and found that the innovators faced various barriers to innovation. These included barriers to *networking* in terms of finding the appropriate audience for their innovation, especially when the resources were limited. Similarly, the findings of Freel (2000) on small scale industries based in West Midlands region of England, with regards to contacts and collaborations with other firms were found to be very disappointing. Most of the firms under study, made contacts which did not necessitate the undertaking of formal projects or commitment of resources. Another barrier recorded by Ross *et al.* (2012) was the *need to establish a proof of concept* which gave rise to more barriers in terms of the costs associated, requiring of securing a *funding* especially in case of a radical change (Ross *et al.*, 2012). The research found that the innovators lacked business skills and knowledge to start and run a company. Madrid-Guijarro *et al.* (2009) also highlighted the popularity of poor management skills, especially poor marketing skills among small firms. These *management deficiencies* result in poor planning and financial assessment or product development and marketing, lack of support and expertise, discontinuity of management staff and insufficient marketing endeavours (Freel, 2000; Nooteboom, 1994). *Government policies* further hindered innovation as gaining access to transport data was found to be prohibitively expensive, and in cases where support had been secured within local or national government, frustrations surfaced by the constant move of the individual to other departments (Ross *et al.*, 2012). Data plays a key role in supporting innovations as volumes of reliable and timely information can aids decision making thereby, allowing an organisation to transform its operational capabilities by means of harnessing internally and externally generated data (Matthias *et al.*, 2017). *Lack of government support* was also recorded as a barrier to innovation in Spanish manufacturing SMEs by (Madrid-Guijarro *et al.*, 2009).

The California Department of Transport studied three innovations (Orcutt & AlKadri, 2009b) to identify the roadblocks to innovation. The first innovation faced barriers due to the lack of *funding* limiting the exploration of new concepts and lack of *functional requirements and specifications* which resulted in additional testing adding time and costs, which was further hindered by the *difficulty of collecting and evaluating data* (Orcutt & AlKadri, 2009b). In addition, barriers occurred due to *sole sourcing contracts* and the *resistance to change* and *risk aversion nature* of the organisation (Orcutt & AlKadri, 2009b). The second innovation also experienced barriers due to *risk aversion nature* and the *resistance to change*. In addition, barriers arose due to the *lack of profit motive*, *poor marketing* and *difficulty in sharing innovations* with other states (Orcutt & AlKadri, 2009b). The second and third innovation both experienced barriers due to the *lack of product evaluation approval process*. Other barriers identified in the third innovation was the *unfamiliarity* of the customers *with the innovation product*, the *high capital costs*, uncertainty in evaluating the *market value* of the product, and *restricted competitiveness* bidding due to the *patent issues* (Orcutt & AlKadri, 2009b).Similar barriers were recorded in a pilot survey of transport professionals by (Orcutt & AlKadri, 2009a)which revealed that the most common barrier to innovation was the *resistance to change*, lack of an *executive sponsorship*, inadequate *funding*, stiff *legal requirements* and lack of *implementation requirements*. Other less common barriers recorded by the study were *risk* *averse culture*, lack of *performance criteria*, *not enough time* for innovation, *poor business case* for the product and *contractual* issues (Orcutt & AlKadri, 2009a).

In a study of innovations in UK logistic services, Mena *et al.* (2007) used the PESTLE analysis to assess and break down the barriers to change into *political*, *economic*, *social*, *technological*, *legal* and *environmental* factors (Mena *et al.*, 2007). The study found that the transport and communication infrastructure sets limits to logistics activities and innovation is hampered by land use issues. Mena *et al.* (2007) conclude that due to the economic growth the logistics chains are growing longer and more complex, decreasing visibility and increasing risks. The fragmentation and competitive markets were found to lead to falling margins (Mena *et al.*, 2007). On the social front, the study states that high employment rates in certain area led to difficulty in finding sufficient staff. Congestion on transport networks and accidents were found to have a negative social impact (Mena *et al.*, 2007). Legal and environmental factors that create barriers to innovations were the increased taxation, and the unsustainability of oil and gas (Mena *et al.*, 2007).

Naor *et al.* (2015) in their study of a failed electric vehicle infrastructure firm classified barriers from the consumer point of view into functional barriers and psychological barriers. The functional barriers were identified in terms of *usage*, *risk* and *value*. Shumaker *et al.* (2013) in their survey of transport professionals across United States, to identify the barriers to implementation of unconventional intersection designs also state that the biggest barriers experienced were *lack of public support* widely in terms of its potential for driver confusion and *cost* concerns (Shumaker *et al.*, 2013). In terms of the psychological barriers Naor *et al.* (2015) state that *image* and *tradition* were the main barriers of using electric vehicles.

Ward recognized 30 years ago that transportation technology is an important part of the overall technical advances to make a better society (Ward, 1984). For industries such as railways, when compared to its growing stage, the *slow growth* and *minimal product change* increases competition for market share (Levitt, 1965), which generally lacks innovation (Porter, 1985). Govindarajan (2012) argues that organisations in such industries tend to have a *dominant logic* with attained success in the past and helps the organisation to maintain its current path, it however, limits their growth (Govindarajan, 2012). In an industry which is *safety critical* such as railways, firms tend to stick to tried and tested strategies and often lose opportunities to create value and overcome stagnation in the mature phase (Prahalad, 2004). Ward (1984) views on importance and barriers to innovation in transportation are still applicable. In systematically integrating innovation in development, construction and operations, large transportation systems hold a poor record. (Dodgson *et al.*, 2015). Ward, recognised it and argued that innovation was often feared and resisted, and due to the *complex nature* of large transportation systems, interaction between various systems required high levels of compatibility and interdependent evolution which further added to the complexity of innovating (Ward, 1984). He also observed that the *tolerance for the risk and failure* that is inherent in the innovation process, is very low in publicly funded projects (Dodgson *et al.*, 2015). Similarly, highlighting the barriers due to regulations, Benson (2015) argued that regulations can cause market failures as they represent interests of specific groups, and often result in monopoly situation, by preventing entry, setting prices and limiting competition (Benson, 2015).

In another study of system engineering ideas in rail sector Elliott *et al.* (2012) identified three main barriers; *nature of rail sector*, *nature of the system engineering* and the *cultural differences* between the two domains. Elliott *et al.* (2012) argued that the rail projects are best known for incremental changes to existing systems, and applying new process to existing systems, which may not been well documented, is challenging. In the absence of precise agreements, system engineering was found to remain underexploited due to the lack of knowledge of its relevance, for effective implementation. Lastly, the cultural barriers were found to result in work duplication, unnecessary disruption, and conflict, while creating resistance for the lack of understanding of something that was new and relevant (Elliott *et al.*, 2012).

Other barriers identified in literature, regarding innovation in public sector were *bureaucracy*, *capacity constraints*, innovation as *value*, innovation as *skill*, *blameability*, and need for *guidance* (Zolnik & Sutter, 2010). Zolnik and Sutter (2010) argue that management infrastructure is changing to allow public servants in transportation organisations to be more innovative by less specifying the jobs, flattening out hierarchies, promoting teamwork across departments and less strict rules for using human and financial resources. The managers are found to be doing more with less as stated in the public management reform, however, Zolnik and Sutter (2010) state it is due the capacity constraints rather than the reform. The *middle management* is found to great influence the value of innovation, as the perspective of public servants of innovation value is found to be greatly influenced by the perspective of middle management towards innovation (Zolnik & Sutter, 2010). Another key element identified by

Zolnik and Sutter (2010) is the innovativeness of the *senior management*, as they argue that a department is highly unlikely to be innovative if the senior management lack the expertise and training in innovative institutions.

Having reviewed in depth the relevant barriers to innovation in the literature in the above section, two aspects stand out. First, the barriers arising due to the change taking place via innovation and the support from leadership in carrying out the change and vision for innovation. As an enabler of innovation, while change must be well managed, it also requires effective leadership to be successfully introduced and sustained. Therefore, the following section reviews change and leadership in view of the critical analysis of the barriers to innovation.

2.4.2.2 Change and leadership

Gill (2002) argues that while change must be well managed, it requires effective leadership for its successful introduction and sustainability. Globalisation has put enormous pressure on business organisations to change (Hechanova *et al.*, 2018), with technology being the key factor of revolutionising the way organisations are run for greater efficiency, systems streamlining, processes and structures (Hechanova & Cementina-Olpoc, 2013). Literature suggests two core modes of change, planned and emergent (Bamford, 2006). In planned changes, pre-planned steps guide an organisation to move from one fixed state to another (Bamford, 2006). Bamford and Forrester (2003) however argue that the theory of emergent change is better able to understand problems of managing change in complex environments. Dawson (2014) identifies that change is complex and thus, reducing organisational change to a list of sequential steps, does not take into account the unplanned, unforeseen, and the unexpected occurrences, and is likely to generate only short-results and increase instability (Bamford & Forrester, 2003). He further emphasis that change must be linked to the developments in market, systems of management control, work organisation, and shifting nature of organisational boundaries and relationships (Bamford & Forrester, 2003). Therefore, for the advocates of emergent change, it is the uncertainty of the environment that makes emergent change more appropriate than planned change (Bamford & Daniel, 2005). Given the strategic nature of change, Appelbaum *et al.* (2015) highlighted that transformational change is generally a top down approach, however, a major development of emergent change is its emphasis on bottom-up approach (Bamford & Forrester, 2003). Research demonstrates that top management is often unaware of the implementation challenges of change, whereas low-level employees engaged in daily operations are more likely to be knowledgeable of these obstacles (Appelbaum *et al.*, 2015). Bamford (2006) giving the rationale behind this, stated that due to the rapid and complex nature of change, it is impossible for senior management to identify, plan and implement every action required. The responsibility becomes more devolved and as a result greater change occurs in the roles of senior management, as their roles shifts from that of a controller to a facilitator (Bamford, 2006) (Bamford & Forrester, 2003).

Change programmes often fail due to poor management such as poor planning, monitoring and control (Gill, 2002). According to the American Management Association survey (Gill, 2002) the keys to successful change are first and foremost leadership, followed by corporate values and communication (Gill, 2002). Describing change as a process of taking an organisation from its current state to a desired future state while managing all the problems that arise along, Gill (2002) believes than in such a case change is about leadership. Hechanova and Cementina-Olpoc (2013) while considering organisations to be human systems, argues that the success of any transformational change lies in the hands of the people who are tasked to implement change. Change is orchestrated by the leader of the organisation or the change agents authorised to facilitate the change (Quinn *et al.*, 2006). Aarons *et al.* (2015) also considered leadership as critical in implementing innovation in organisation, which when congruent with organisational strategies increases the tendency of an organisation to implement and sustain change. As stated by Hechanova and Cementina-Olpoc (2013), leadership defines how the future should look like, aligns people to that vision, and inspires them to make change happen despite the obstacles that may surface. According to Dervitsiotis (2010) this further requires periodic assessment of both innovation outputs and inputs via a balanced set of innovation metrics. (Matthias & Brown, 2016). One of the most popular tool that enables organizations to make clear their vision and strategy and turn it into action is the balanced scorecard method (Hakkak & Ghodsi, 2015). It is a customer based planning and process improvement tool which focuses on driving organisational change process by identifying and evaluating its performance indicators (Chan, 2004). Chan (2004) further emphasised the use of this method to identify the firm's mission, strategy formulation and process execution, with great stress on translating strategy by means of financial and on-financial measures, as discussed in the previous sections of this chapter. Al-Ali *et al.* (2017) argue that in addition to leadership or change agents, change is not possible without the organisational culture and the commitment of those involved in the change process. Emergent change relies more on the participation of the employees, as the management may initiate emergent changes, but does not formulate detailed action of change. High quality of change information, and high degree of participation are both positively related to the acceptance and supporters of change by employees (Kuipers & Groeneveld, 2016). Due to the increasing organisational complexity, the role of middle management as change agents is increasing (Appelbaum *et al.,* 2015). Appelbaum *et al.* (2015) argue that middle management play a critical role in linking frontline resources and top management. This linkage role is effective for strategy formulation and implementation as the top management communication is distant from frontline employees and cannot interact directly with them (Appelbaum *et al.*, 2015). One of the greater challenges reported in literature to change is the mind-set and reluctance of employees to change (Hechanova *et al.*, 2018). Huy (2002) argues that the middle management owing to its close work proximity with frontline employees, has the ability to balance unpleasant/high-activation emotions that can be generated in frontline employees during the turmoil of radical change, with pleasant/low-activation emotions. Al-Ali *et al.* (2017) argue that leadership plays a strategic role in managing the resistant to change by employing elements of organisational culture to motivate employee participation in change process. Transformational leadership is characterised by its ability to inspire a shared vision (Hechanova & Cementina-Olpoc, 2013). As such, for successful change management initiatives, the leader should act as a role model and demonstrate commitment and positive attitude towards the strategic initiates taken to facilitate change (Al-Ali *et al.*, 2017). Organisations in which goals are achieved, the change leaders exhibit task behaviours and also adopt behaviours that make employees more comfortable and receptive of change. These transactional and transformational leadership styles ensure productivity and effective change management, thus, enabling the leaders to act both as supports of organisational change and as change-agents (Al-Ali *et al.*, 2017). In addition, transformational leaders stimulate their employees to think outside the box and find innovate solutions in their work by addressing old problems in new ways (Kuipers & Groeneveld, 2016).

2.4.3 Transportation theme conclusion

In conclusion, the literature highlights that there is a need for innovation in transportation for it to be sustainable in the coming years and to help boost economy. In light of the innovation activities and challenges of implementing strategies in transportation, the literature critically reviewed the barriers to innovation in logistic service providers. The outputs of innovation in terms of the value it creates for the stakeholders has been successfully established, supported by the theory of change and leadership as an enabler of innovation. Figure 2.12 below presents a conceptual model of the transportation theme of literature review.

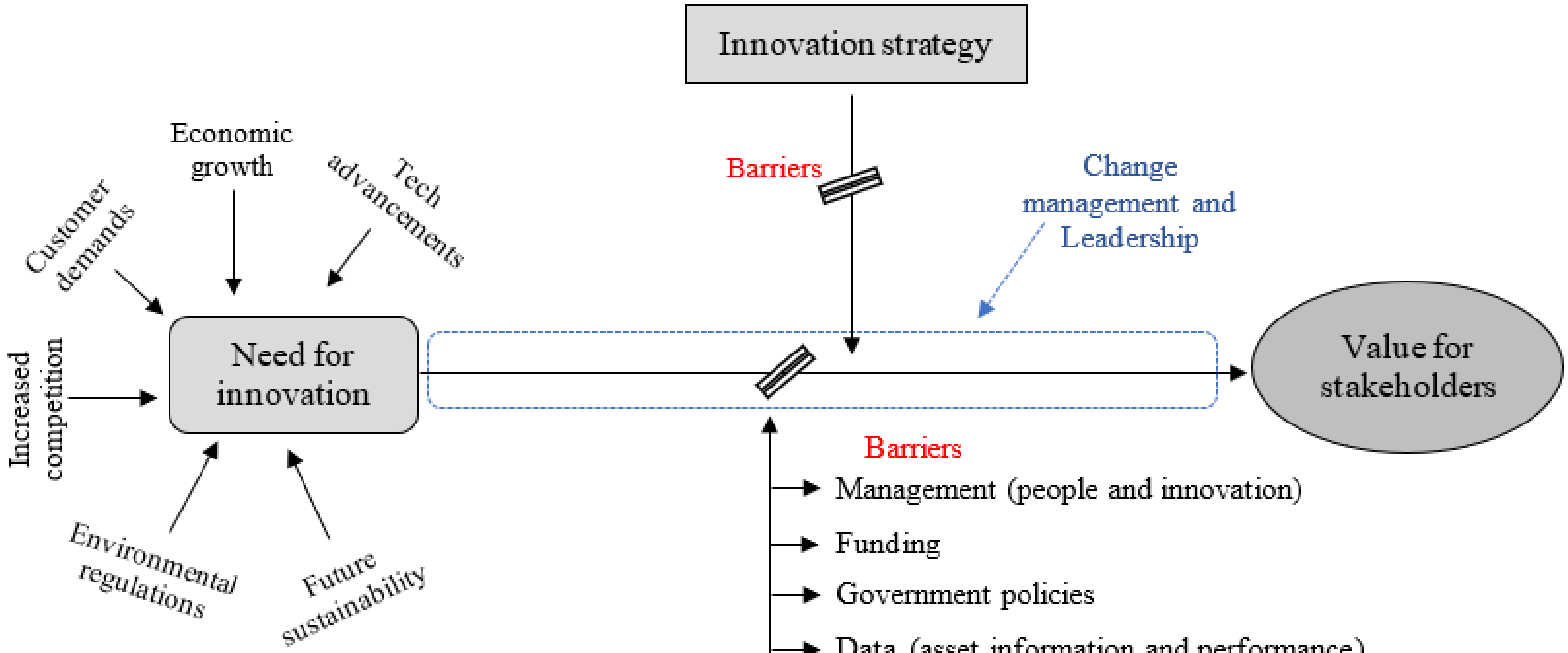


Figure 2.12 - Conceptual model of transportation theme

2.5. *Conclusion of literature review*

This chapter presented and critically analysed the key literature themes underpinning this research. The literature review started with exploring broader aspect of strategy and the role of strategic management. Narrowing down the breadth of literature to the more particular aspects of this research, the significance of innovation and innovation management were reviewed. As innovation is the core theme of this research, aspects of innovation, and in particular relation to transportation, the innovation activities were analysed. The final focus of the chapter was review of innovation outputs in terms of the value it creates for its stakeholders. The chapter concludes by boiling down the literature to review the barriers to implementation of innovation strategy and the barriers to innovation in logistic service providers.

The management theory used to facilitate the logical understanding of innovation in a complex industry such as railways, was RBV. Throughout the chapter, the literature was reviewed through the lens of RBV to determine the role of innovation in gaining sustainable competitive advantage by focusing on organisational resources and capabilities. This is directly related to the research area as it determines the benefit of addressing the barriers to innovation. Another key theory explored in literature review to facilitate innovation is change and leadership. With RBV as a fuel for innovation (Kostopoulos *et al.*, 2002), facilitated with the understanding of change and the role of leadership, can thus, help manage innovation in relation to the identified barriers in the literature.

The conceptual model of literature review, presented in Figure 2.13, presents the innovation process from its formulation to producing desirable outputs. It builds upon the conceptual models presented in Figure 2.5, Figure 2.11 and Figure 2.12, to illustrate the key enablers of gaining sustainable competitive advantage and value creation for the stakeholders involved. This could be achieved my implementing innovation. However, as the literature identified the barriers to innovation, Figure 2.13 illustrates the deployment and interaction of various management theories identified in the literature.

Having presented the extant literature, the following chapter will present and analyse the methodology adapted by the researcher to best capture and analyse the data pertaining to the research subject.

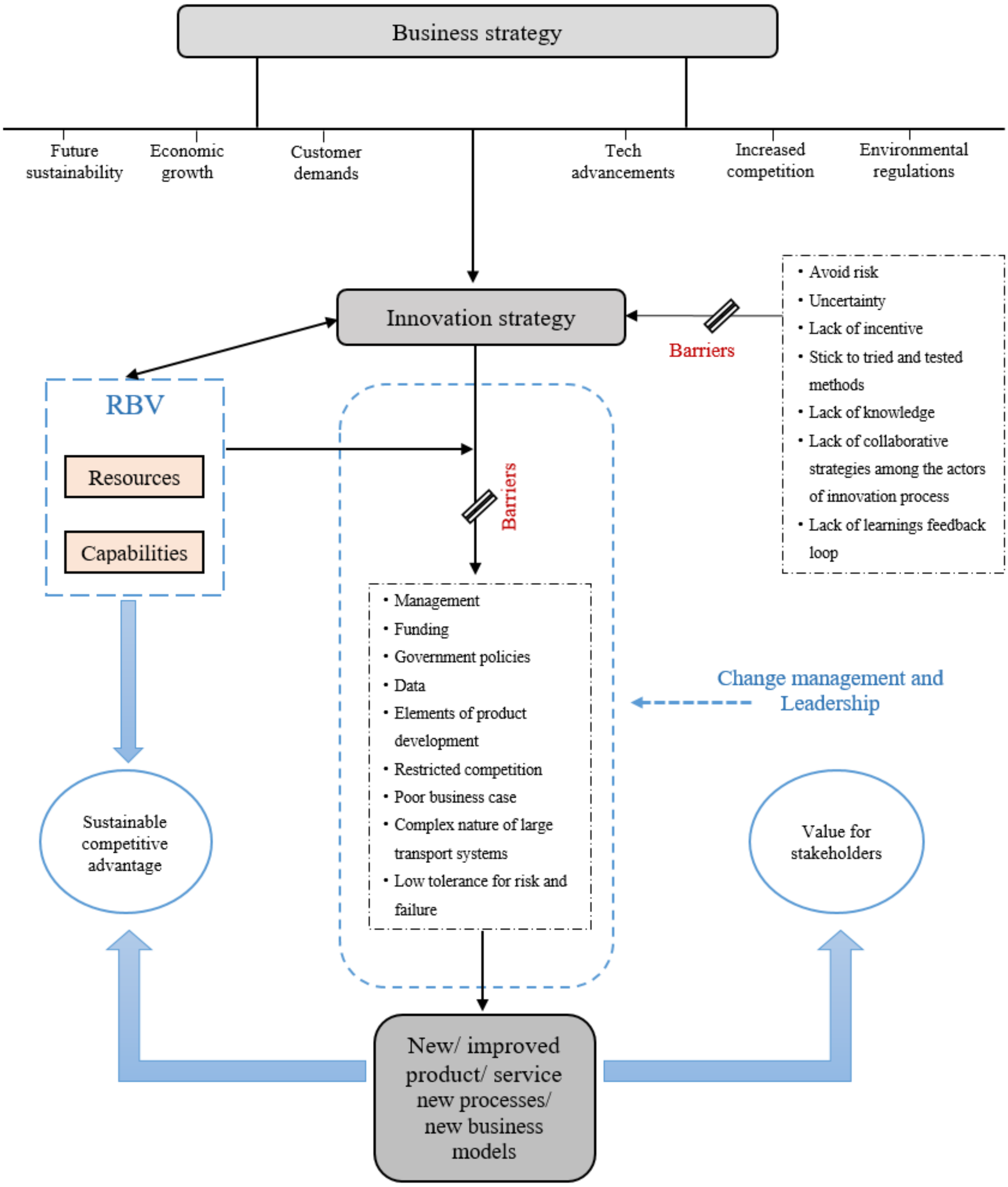


Figure 2.13 - Conceptual model of literature review

3. Methodology

3.1. Introduction

In this chapter, the research aims and objectives are linked with the research methodology. In the first section research philosophies are discussed along with the various assumptions included. Based on the adopted assumptions, methodological assumptions are discussed to choose and employ the most appropriate methods and techniques for addressing the research questions of this thesis. The chapter in particular, discusses the paradigms in research and the rationale for the chosen paradigm. Data collection and analysis is further discussed in detail.

Bryman (2016) argues that in order to understand and conduct research effectively, researchers need to engage with the research philosophies. The relation between particular methods and the research philosophies has been long debated (Mkansi, 2012). However Johnson and Onwuegbuzie (2004) argue that these arguments should not exploitations of the research methods. They further stressed that the differences in philosophical assumptions and logic of justifications should not dictate the methods for data collection and analysis. In addition, Mkansi (2012) revealed the incoherencies in the classifications of the research philosophies. For the purpose of this research, the philosophies and their relations have been considered based on David (2015) explanation of research methods and their links with more abstract matters such as world-views. Bell *et al.* (2018) stress researchers to think about the ontological, epistemological, and methodological assumptions to conduct their research, in order to generate valuable knowledge. The research philosophies form the first art of the research design. They determine what reality is and how knowledge of that reality can be gained, followed by research methodology which is concerned with how to do research. It further includes the tools and techniques of data collection and analysis. These have been illustrated below in Figure 3.1:

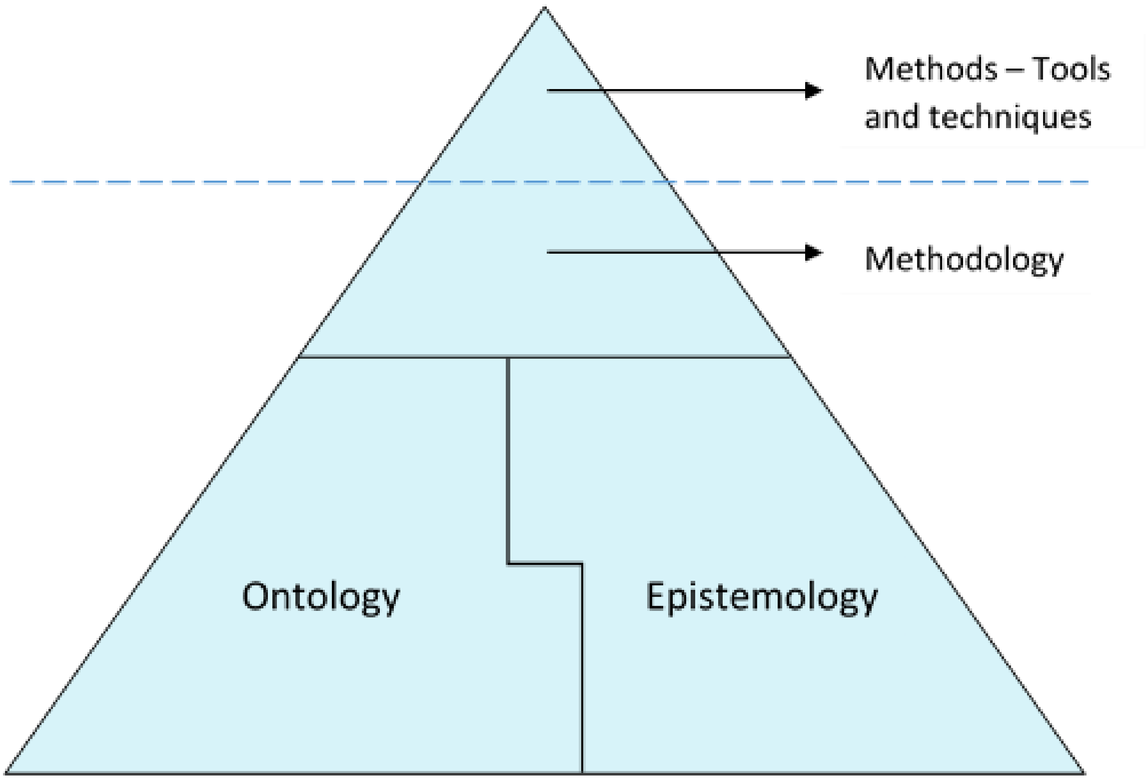


Figure 3.1 - Research philosophies (Adapted from (David, 2015))

David (2015) described research philosophies by means of comparing it to an iceberg, where the visible tip is only a small part of the whole system. This visible tip is referred to as the tools and techniques employed by the researcher such as surveys and interviews. Just below the surface lies the methodological assumptions which are concerned with the discussions and arguments about the qualitative, quantitative and mixed method approaches. Further below, the not so apparent part, yet the foundations consists of the ontological and epistemological assumptions. These have been further discussed in detail in the following sections of this chapter, along with the rational for the chosen paradigms.

Before evaluating the research philosophies, the aims and objectives of this research are revisited in order to justify the chosen paradigm that best address them.

3.1.1 Research context

As mentioned in the previous chapter, the increased globalisation, and deregulation increase competition and pressure to innovation in order to deliver sophisticated services to meet the growing customer needs (Busse & Wallenburg, 2011). In the UK, the rail passenger journeys in 2018-2019 Q3 (October to December 2018) increased by 2.9% that is, by £13 million, compared to 2017-2018 Q3, reaching a record high of £451 million (ORR, 2019). The total number of journeys recorded in the 12 months of 2018 till the end of December 2018 was 1.74 billion, with a passenger kilometre increase to 17.1 billion in 2018-2019 Q3, which was a 2.0% increase compared to the same quarter the previous year (ORR, 2019). EuropeanCommission (2011) has stated transportation as a key enabler of economic growth and job creation. It is evident by the statistics of the total passenger revenue in 2017-2018 Q3, which increased by £5.9% that is by £147 million, to £2.261 million compared to 2017-2018 Q3 (ORR, 2019). However, complaints related to punctuality/reliability of trains stays as the most common cause of complain, forming 23.2% of overall complaints nationally in 2018-2019 Q3. Second in line with 10% of the overall complaints was the issue of having sufficient room for all passengers to sit/stand (ORR, 2019). Ticketing and refund policy was another issue that recorded the highest increase to 6.4% of all the complaints compared to 4.9% in 208-2017 Q3 (ORR, 2019).

As mentioned earlier, Richard Parry-Jones, the ex-Chairman of Network Rail stated, "*We see a future that challenges the limits of our current technical approaches. A future where we must increasingly rely on our ability to exploit a rich stream of innovation*". EuropeanCommission (2011) recognises that the transportation faces new challenges while the old challenges remain, such as, providing better services to the customers to meet their growing desire to travel, transporting goods while preparing for resources and environmental constraints. In preparing for the future it also recognises that there is a possibility of scarcer oil resources in the future, and with the goal of limiting climate change, there is a need for drastic reduction of greenhouse gases, as the EU transport still depends on oil and oil products for 96% of its energy needs, and the increase in volume of transportation leads to the increase in noise and local air pollution (EuropeanCommission, 2011). Wagner and Busse (2008) argues that in transportation industry, adoption of innovation can enable the improvement and sustainability of the quality, efficiency and the competitiveness of the firm. However, a number of studies have shown that the barriers to innovation are mostly related to costs, human resources, government policies, organisational structure and flow of information (Madrid-Guijarro *et al.*, 2009).

Ward recognized 30 years ago that transportation technology is an important part of the overall technical advances to make a better society (Ward, 1984). In light of the need to meet the growing customer demand and to maintain the railway as a sustainable industry for the future, this research was designed to study the complex UK rail industry in order to identify the barriers to innovation. A multi stakeholder perspective was considered suitable to gain an in-depth understanding of the phenomena under study, in order to draw a comprehensive picture of the innovation landscape in the UK rail Industry.

3.1.2 *Research aims and research questions*

The understanding of the defined problems, discussed in the previous section, and the extensive review of the literature, led to the defining of a specific research aim, which is:

Through engagement of both primary and secondary stakeholders, to identify current barriers to innovation in the UK rail sector.

Owing to the complex nature of the industry

In order to address the broad and challenging research aim, three overarching research questions were identified:

RQ 1: How do the enveloping external factors of funding and, government and media, impact innovation in the UK rail industry?

RQ1 discusses the influence of the peripheral factors that impact innovation.

RQ2: What elements inhibit the UK rail industry from transforming into an innovative industry?

RQ2 discusses the factors that influence innovation at a semi-peripheral level.

RQ3: What are the strategic barriers to innovation in the UK rail industry and how do they impact business?

RQ3 discusses the factors that lie at the core of the innovation scenario in the UK rail industry.

Owing to the multiple actors contributing to innovation in the UK rail industry, these research questions were further broken down to sub-research questions to fully answer and satisfy the overarching research questions. These are:

RQ1:

S-RQ 1: Which elements of funding tangibly support innovation?

S-RQ 2: How does government and media influence innovation?

RQ2:

S-RQ 3: What specific cultural elements impact innovation in UK rail industry?

RQ3:

S-RQ 4: What are the barriers to innovation in the UK rail industry in delivering customer specific solutions?

S-RQ 5: How do regulations and specifications create barriers to innovation in the UK rail industry?

S-RQ 6: What are the barriers to innovation in the UK rail industry in the testing and trialling stages?

S-RQ 7: How does communication create barriers to innovation in the UK rail industry?

S-RQ 8: How do structural barriers effect strategy formulation and implementation in the UK rail industry?

S-RQ 9: How do process barriers effect implementation of strategy in the UK rail industry?

S-RQ 10: What is the impact of strategy barriers on business within the rail sector in the UK

Having re-established the foundation of this research, the next section discusses the research strategy employed to answer the research questions.

3.1.3 Research strategy

Research strategy refers to the overall approach taken by the researcher in the reproach project (Bell *et al.*, 2018). It is influenced by the phenomena under study, and the philosophical assumptions linked to constituting elements of the research paradigm – ontology, epistemology, and axiology. These philosophical assumptions inform the research design and the choice of research questions, and methods employed to answer them (Bell *et al.*, 2018).

Bell *et al.* (2018) and Saunders *et al.* (2012) argue that even though the concept of philosophies might seem abstract in the context of practical research, these philosophies enable researchers to examine the underlying assumptions of reality, which enables a researcher to clearly articulate what is known about business and decide how to go about studying it (Bell *et al.*, 2018).

The following sections thus, analyse these philosophies, in order to determine the best suited research paradigm adopted for this research and the justification for its selection. In addition the following sections later discuss the methodology employed, and the tools and techniques used to inform the research questions, according to the chosen research design.

3.2. Research philosophy

Saunders *et al.* (2009) described research philosophy as a "*system of beliefs and assumptions about the development of knowledge*". While developing the research proposal, researchers make decisions regarding the methodologies and methods to be used, and how to justify the choices made (Crotty, 1998). These justifications are drawn from a number of assumptions, including assumptions about human knowledge (epistemological assumptions), about the realities encountered during research (ontological assumptions), and how the researcher's values influence the research process (axiological assumptions) (Saunders *et al.*, 2009). This belief system consisting of ontological, epistemological and methodological assumptions is called the paradigm (Guba, 1990). Bell *et al.* (2018) argue that in order to generate valuable knowledge, ontological, epistemological and methodological assumptions need to be consistent with each other and with the chosen methods and design. As such, the following sections present these assumptions, to state and justify the chosen paradigm of this research.

3.2.1 Ontological assumptions

Ontological assumption is concerned with the essence of reality (Collis & Hussey, 2013). According to Bell *et al.* (2018), it is the assumptions of "*what it means for something to exist*" that is, in a research these assumptions determine how researchers view and study their research objectives (Saunders *et al.*, 2009). As such, the ontological assumptions enable researchers to understand what they seek to understand from their research (Bell *et al.*, 2018). Further, assumptions related to reality, inform the assumptions related to how reality is to be researched (epistemology) (Bell *et al.*, 2018). Importance of ontology (Bell *et al.*, 2018) is given by its ability to produce valid knowledge (Saunders *et al.*, 2012), highlighted by the two ontological positions: objectivism and subjectivism.

Objectivism

Objectivism is an ontological position (Bell *et al.*, 2018), that portrays that in reality, social entities and social actors exist independently of each other. Saunders *et al.* (2012) defined it as social entities existing in reality external to social actors. This position can be better understood by applying it to an organisation. Organisations function in a set manner, having hierarchies, processes and procedures that dictate day to day work, values and mission statements that the employees are required to adhere to. One can argue that these functions vary from organisation to organisation (Saunders *et al.*, 2012), and as such, it points to the view that organisations have a reality that is external to the residing actors (Bell *et al.*, 2018) (Bryman, 2016). Organisation as presented here can therefore be said to have the characteristics of an object (Bell *et al.*, 2018) as it represents a social order where organisations exert force on individuals to conform to certain organisational requirements (Bryman, 2016).

Subjectivism

An alternative ontological position is offered by *subjectivism*, according to which "*social phenomena are created from the perceptions and subsequent actions of the social actors*" (Saunders *et al.*, 2012). As such, through the process of social interactions, these social phenomena keep continuously evolving (Saunders *et al.*, 2012). Remenyi (1998) stressed upon the study of situation to better understand the reality (Saunders *et al.*, 2012). According to Saunders *et al.* (2012) this is often referred to as constructionism. This position argues that through the actions and understandings of the social actors, social entities are made real (Bell *et al.*, 2018). As such constructionism lays stress upon exploring the subjective meanings behind the motivations of the actors, in order to better understand the actions (Saunders *et al.*, 2012). For example, in the study of customers, a subjective view would be to understand the motives, actions, and intentions of customers, in order to understand their perception of a situations that determines their social interactions (Saunders *et al.*, 2012). As such, from a subjective view, customer service is constantly changing as it is produced by the constant interaction of the service provider and the customer (Saunders *et al.*, 2012).

Figure 3.2 below presents the ontological assumptions of research:

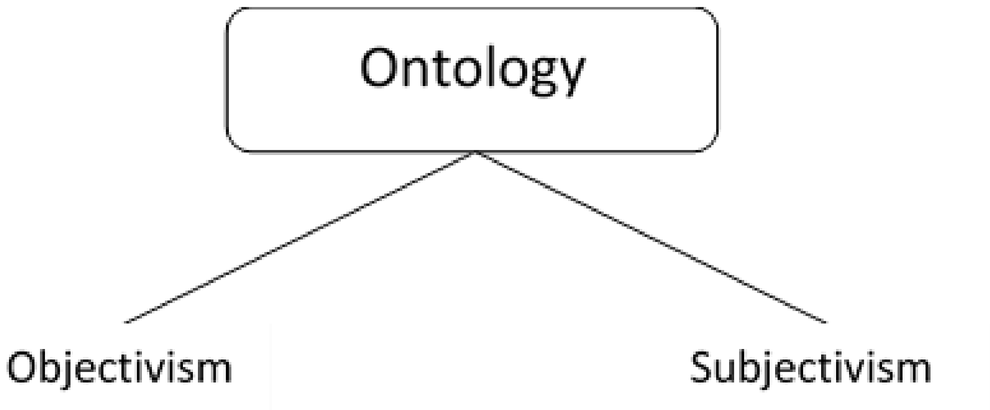


Figure 3.2 - Ontological assumptions

Having discussed the two positions of ontological assumptions, a subjectivism view best suits the objectives of this research to identify the barriers to innovation. This is because the innovation landscape in the UK rail industry consists of a large number of stakeholders with diverse perceptions and types and levels of engagements in the innovation process. It is therefore vital to understand their motivations, actions, and intentions in order to identify the barriers and their solutions.

3.2.2 Epistemological assumptions

Epistemological assumptions are concerned with what is accepted as valid knowledge (Saunders *et al.*, 2012) (Collis & Hussey, 2013). The epistemological position, that is, the understanding of knowledge can be gained, is implied by the ontological position, that is, what reality is (Bell *et al.*, 2018). As such, it includes the examination of the relationship between the researcher and what is being researched (Collis & Hussey, 2013). Bell *et al.* (2018) stated that epistemological assumptions are crucial in business research, as it determines how to conduct the research. In order to understand the business related phenomena, a researcher gathers and analyses data. The design of the study, and the techniques and tools employed by the researcher allow knowledge generation. This knowledge lays foundation for claim about the business world and informs policy and practice (Bell *et al.*, 2018). Epistemological assumptions provide the means to ensure that the knowledge created is robust (Bell *et al.*, 2018). Saunders *et al.* (2012) considered an example of a manufacturing process to explain the two positions of epistemological assumptions – positivism and interpretivism. Saunders *et al.* (2012) stated that in the study of manufacturing process, a researcher can be concerned about the resources such as computers and machines, and as such it can be argued that the data collected will be less open to bias and objective in nature. This is a positivist position. However, in the study of the same process a researcher can be concerned about the feelings and attitudes of the workers involved towards their managers. This is an interpretivist perspective (Saunders *et al.*, 2012). Positivism and interpretivism stand at the two extreme ends of the philosophical continuum (Collis & Hussey, 2013).

Positivism

Positivism, as stated above, is therefore associated with the objectivist ontological position (Bell *et al.*, 2018). It maintains that since reality exists externally and is objective in nature, the best fitting way is to observe phenomena directly or to measure those using surveys or other instruments (Bell *et al.*, 2018). Positivism reflects the principles of a natural scientist (Saunders *et al.*, 2012). As such, under the positivist approach research is conducted in value-free way (Saunders *et al.*, 2012), that is objectively (Bell *et al.*, 2018). Given the nature of this position, it is frequently argued that a highly structured methodology is used a positivist researcher, and emphasis is laid on quantifiable observations that can be statistically analysed (Saunders *et al.*, 2012).

Interpretivism

Interpretivism provides a contrast to positivism (Bell *et al.*, 2018). Interpretivist argue that critical knowledge is lost when complex systems are reduced entirely to law-like generalisations (Saunders *et al.*, 2012). An interpretivist position is underpinned by social constructionism (Bell *et al.*, 2018) which advocates the importance of understanding the distinctiveness of humans rather than objects (Saunders *et al.*, 2012). (Bell *et al.*, 2018) further added, that interpretivism is associated with 'how' and 'why' of social actions including the processes by which things happen. The researcher is a critical social actor in this position as Saunders *et al.* (2012) argues that the researcher enters the social world of the research subjects and tries to see the world from their perspective. As such, in such a position the researcher adopts a synesthetic stance (Saunders *et al.*, 2012). Owing to the complexity of the business situations, scholars argue that this position is highly appropriate in the field such as organisational behaviour and marketing. And due to the human element involved, less stress is given on generalisation as the situation is subjected to continuous change (Saunders *et al.*, 2012).

Pragmatism

Having discussed the two extreme positions on the philosophical continuum, researchers have long had disagreements about the both epistemological and ontological assumptions (Sekaran & Bougie, 2016) (Saunders *et al.*, 2012). Some scholars argue that the research question determines the research philosophy and that methods from more than one paradigm can be used in a study (Collis & Hussey, 2013). This view is advocated by what is known as *pragmatism*. According to Sekaran and Bougie (2016) pragmatists consider both objective, observable phenomena and subjective meanings can produce valuable knowledge, depending on the research questions. Pragmatism argues, that researchers should not be bound by single paradigms, rather should be free to mix methods from different paradigms, to best address their research questions (Collis & Hussey, 2013). As advocated by Johnson and Onwuegbuzie (2004) in their paper, pragmatic position helps advance knowledge by improving the communication among researchers from different paradigms. As such pragmatism highlights how research approaches can be mixed successfully (Hoshmand, 2003). Saunders *et al.* (2012) also advocates that prgamstist approach is best suited for mixed methods approach. According to Tashakkori and Teddlie (2010) a pragmatist approach takes a more continuum approach towards research philosophies rather than taking opposite positions. They further stress upon a researchers studying what appeals to them and creates value in whatever ways is appropriate to best address the research question (Saunders *et al.*, 2012).

The epistemological assumptions have been presented below in Figure 3.3:

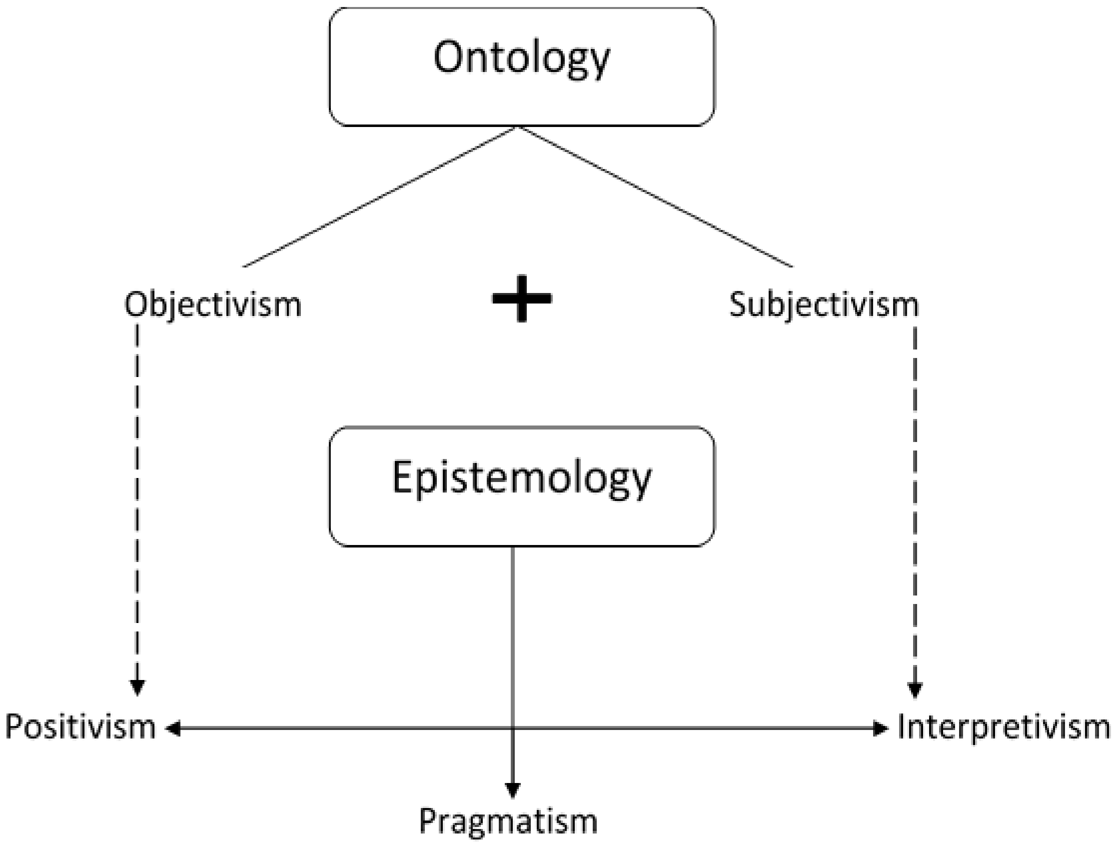


Figure 3.3 - Epistemological assumptions

3.2.3 Adopted paradigm for this research

In view of the aims and objectives of this research, a pragmatism approach was adopted, where the researcher explored the social reality based on the collected data on barriers to innovation in the UK rail industry. This approach was mainly chosen considering the issue at hand and the complex nature of the industry, which is operated by a large number of stakeholders. In order to effectively study the phenomena under question, relative information was deduced to be more useful for an in-depth understanding. This is supported by the pragmatist approach which takes into account different perspectives, ideas and theories to help gain an understanding of the world (Sekaran & Bougie, 2016). Another reason for adopting a pragmatist approach was the use of mixed methods. In the current study, it was vital to collect a cross dimensional view of the industry. It was mainly done via qualitative means however, the use of quantitative data was regarded necessary for gaining a wider industry view, and to complement the qualitative approach, by helping remove bias if any. In addition, in order to understand the industry's perspective of its innovation landscape, mixed methods were again used to compare the primary and secondary findings. This is supported by the pragmatist approach which advocates that one approach may be better than other for addressing a particular issue and that it is perfectly possible to work with both the philosophies (Saunders *et al.*, 2012). These elements are further discussed in the following sections.

The three main paradigms of positivism, interpretivism, and pragmatism were discussed to highlight their appropriability and implications in research. The adopted view of pragmatism was discussed along with its appropriability with this research. Having pinned down the ontological and epistemological assumptions of this research, the next section deals with the methodological assumptions, the research design and the tools and techniques used to collect and analyse the data of this research.

3.2.4 Methodological assumptions

For the progression of management research, it is vital for the researcher to assess the employed chosen methods (Scandura & Williams, 2000). Mackenzie and Knipe (2006) summarised the extant literature on methodology and methods, and defined methodology as the overall approach to research linked to the theoretical framework, and method as the systematic modes, procedures or tool used for data collection and analysis (Mackenzie & Knipe, 2006). According to Saunders *et al.* (2012) research can be defined in three ways based on the research purpose: 1) exploratory research used to familiarise with a phenomenon or to gain new insight into it (Kothari, 2004), or to assess it in new light (Robson, 2002); 2) descriptive research used to accurately portray characteristics of a situation (Kothari, 2004); and 3) explanatory research used to establish casual relationships between variables (Saunders *et al.*, 2012).

Based on Saunders *et al.* (2012) and Kothari (2004)'s theoretical research classification, and based on the purpose of this research, which is to explore the barriers to innovation in the UK rail industry and gaining new insights into the innovation landscape of the industry, this research comprises of exploratory research. Explanatory research is flexible and adaptable to change (Saunders *et al.*, 2012). Schvaneveldt and Adams (1991) argue that flexibility in exploratory researcher does not mean lack of direction. It means that the initial focus is broad and as the research progresses, the focus becomes narrower. These traits of exploratory research further reinforce its suitability to this thesis. Since very little was known about the research topic at the beginning of the research, the researcher's aim was to find new insights and narrow down the issues to specific elements of the innovation landscape. In addition the identified themes of barriers to innovation from literature, the exploratory research approach enabled to accommodation of new emerging themes particular to the UK rail industry. In order to conduct this exploratory research two core types of research methods (Saunders *et al.*, 2012) are used – qualitative and quantitative (Kothari, 2004).

3.2.4.1 Qualitative methods

Research concerned with subjective assessment of attitudes, opinions and behaviour use qualitative approach to research (Kothari, 2004). Qualitative approach merits when a concept or phenomenon needs to be understood because of little research done on it (Creswell, 2003). Creswell (2003) further argued that this type of research may be needed because the topic is new, or the topic has never been addressed with a certain sample or group of people, as is the case in this research. Silverman (2015) summarized the characteristics of qualitative research as describing phenomena in context, seeking understanding, interprets meanings, and uses theoretically based concepts. As stated by Merriam (2002), the main interest of qualitative researchers is to understand these interpretations at a particular time and in particular context. This research aims at learning the experiences of the sample population and how they interact within the given context - *interpretive qualitative approach*, and how the social and political aspects of the situation shape the reality - *critical qualitative approach* (Merriam, 2002).

Tracy (2012) defined qualitative methods as an umbrella phrase for the collection, analysis and interpretation of interviews, participant observation, and document analysis, to understand and describe meanings, relationships and patterns. The primary intention of researchers deploying these methods is to develop themes from the collected open-ended emerging data (Creswell, 2003). Creswell and Poth (2017) studied the characteristics found in qualitative research in major books, and deduced that, 1) qualitative research involves data collecting in a natural setting, that is from the participant where they experience issues under study; 2) instruments of research or questionnaires are not adopted from other researchers, rather research specific questionnaires are developed by the researcher, 3) multiple forms of data might be gathered such as interviews, observations and documents; 4) inductive-deductive logic process is used to derive comprehensive set of themes from the data. The inductive process involves the continuous back and forth between emergent themes and data and use deductive thinking to constantly check the themes against the data; 5) focus is on the meanings of the issue as held by the participants, amounting to multiple perspectives on a topic while remaining unaffected by the researcher's own perspectives; 6) the research is set within the context of the participants; 7) the research process is emergent, that is the initial research plan can change as the data progresses; 8) researchers position themselves within the study to justify their interpretation of the information and what they gain from the study; and 9) complex picture of the problem is derived, reporting multiple perspectives, identifying the many factors involved in the situation, and describing their complex interactions (Creswell & Poth, 2017). These characteristics are further displayed in the results of the data analysis presented in Chapter Four – findings.

3.2.4.2 Quantitative methods

Quantitative is chiefly used for any data collection technique and procedure that generate or use numerical data (Saunders *et al.*, 2012). Creswell (2003) argues that quantitative approach is best suited for problems that aim at finding factors that influence an outcome, recognising the best predictors of outcome, or the appropriateness of interventions. Creswell (2003) further added that quantitative data uses predetermined instrument-based questions, to retrieve performance data which is statistically analysed. Therefore, quantitative research is the collection of numerical data, which when analysed using statistics, explain the phenomenon under study (Muijs, 2011). As opposed to qualitative research that focuses on depth of the situation, quantitative research focuses on breadth of the situation (Muijs, 2011).

One of the common quantitative methods, and as used in this research is surveys. It is a data collection method, using highly structured and very detailed questionnaire, to gather information from a sample population that is representative of a larger population (Berger, 2019). Quantitative methods are not limited by data that does not appear naturally in quantitative form. Research instruments can be designed in order to rate the responses in order to convert such phenomenon into quantitative data (Muijs, 2011). A non-experimental approach to qualitative research has been taken in this research. That is, the variables (the data collected from the identified sample population) were used as they appeared in practice and external influences were not controlled (Muijs, 2011).

3.2.4.3 Mixed methods

When both qualitative and quantitative data collection techniques and data analysis methods are used in a research, it is called mixed methods (Saunders *et al.*, 2012). Mixed methods approach has enabled the researchers to expand the scope of their studies and to gain in-depth insight of the issue in hand (Sandelowski, 2000). Ivankova *et al.* (2006) argue when qualitative and quantitative methods are mixed, they compliments each other and the combination of the strengths of both the methods results in a more robust analysis. According to Hesse-Biber

(2010), mixed methods is mainly used to either converge data collected by all methods to enhance the credibility of the research findings, or in a complementarity form which enables the researcher to gain a fuller understanding of the research problem or to clarify the research results. A prominent example of the usefulness of complementarity is found in Yauch and Steudel (2003) study that examined the organisational culture of two small manufacturers (Hesse-Biber, 2010). The study gathered a narrative information by employee interviewees, and used the qualitative findings to create a survey to collect numerical data. *Triangulation* of the two methods enriched the conclusions and increased the validity of their research making it appealing to both qualitative and quantitative advocates (Hesse-Biber, 2010). Golafshani (2003) strongly advocates the use of triangulation method to establish the reliability and validity of qualitative data, as it strengthens the study by combining methods, and establishes the generalisability of the research. In addition the *complementarity* resulted in the production of a thorough comprehension of the organisational cultures under study (Hesse-Biber, 2010). Hesse-Biber (2010) further argues that mixed methods approach supports the development of the research project, as the collaborative effect of the study, enables the *development* of one methods informed by the results of the other. A similar approach of using mixed methods has been used in this thesis. The motivation for using mixed methods was to demonstrate the validity of the results associated with one particular method, as the aim is to derive same conclusions from two different studies (Morgan, 1998), where results of one method guided the development of the other. This enabled to establish the trustworthiness, rigor and quality of the research (Golafshani, 2003), thus advocating its validity and reliability. In addition mixed methods can be used when the results of one methods raises questions or contradictions that *initiates* the use of other method to provide clarifications, and to *expand* the breadth and range of inquiry (Hesse-Biber, 2010). All these reasons as argued by Hesse-Biber (2010) provide a strong argument for the use of mixed methods. Mixed methods approach combines the strengths of both qualitative and quantitative approach, and removes the bias that may exist in any single method (Creswell, 2003).

The methodological assumptions are presented below in Figure 3.4:

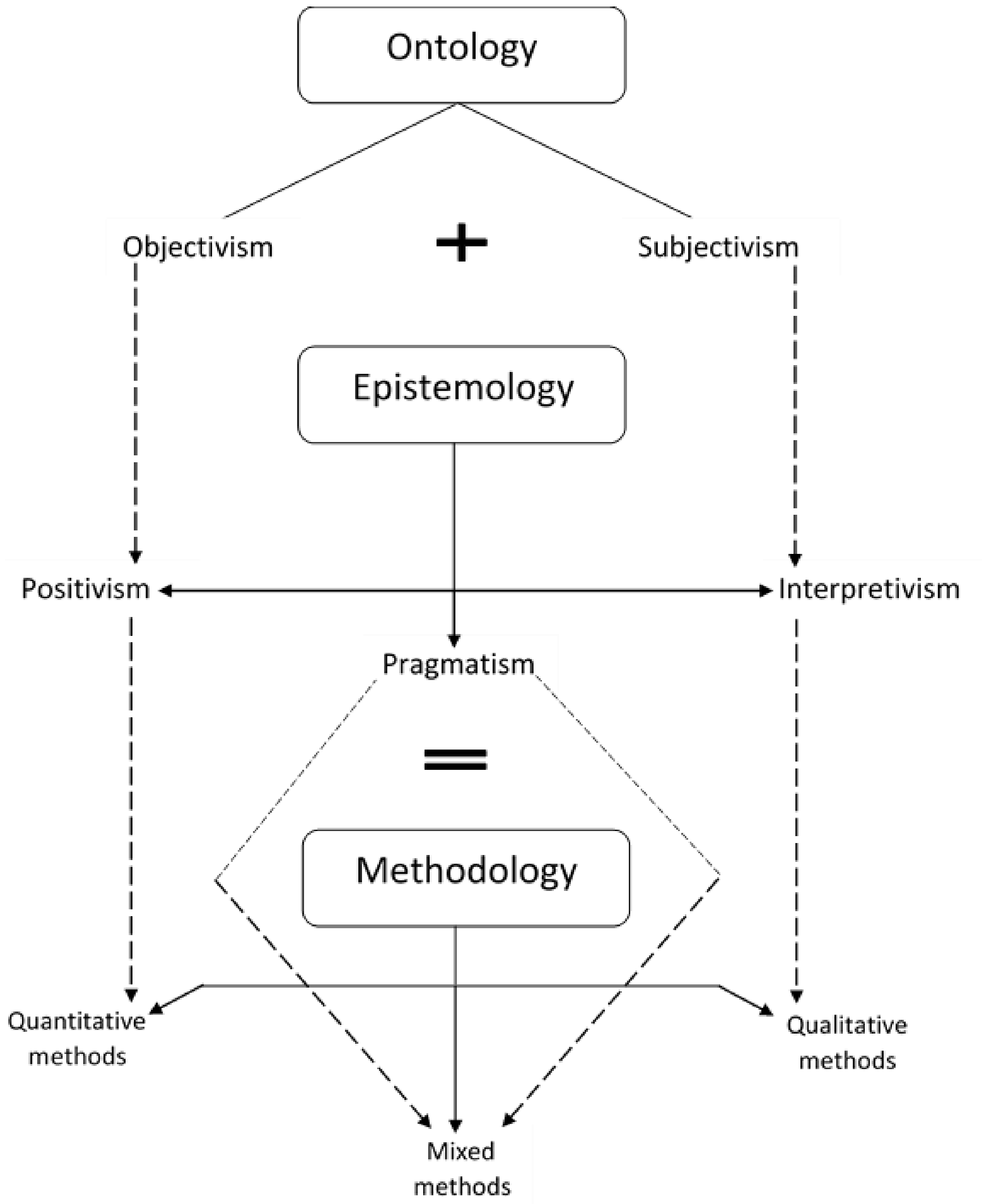


Figure 3.4 - Methodological assumptions

In mixed methods, qualitative and quantitative data collection techniques, and analysis procedures can either be conducted at the same time, that is, in parallel form, or one after the other, that is, sequential form (Saunders *et al.*, 2012). A sequential approach (Creswell, 2003) was used in this research, which consisted of two stages. An exploratory qualitative first stage, followed by a quantitative approach, along with a secondary data analysis conducted at the end.

The following section presents the research design of this research, and the reasons for adopting the above mentioned sequential approach.

3.3. Research design

The emphasis in combining qualitative and quantitative methods, in order to integrate their strengths, is on the research design (Morgan, 1998). Researchers need to make two key decisions, for effectively combing the two methods, that is, a *priority decision* and a *sequential decision*. Priority decision refers to which method, qualitative or quantitative will be the principle method throughout data collection and analysis process in the research (Ivankova *et al.*, 2006) (Creswell, 2003). Morgan (1998) suggested that a more practical strategy would be to have a principle method for data collection and then design a complementary method so as to effectively assist the principle method. The priority decision is based upon the strengths of a method that are most important to achieve the aim of the research (Morgan, 1998). Following priority decision is the sequential decision which involves the order in which qualitative and quantitative data collection and analysis is conducted (Morgan, 1998) (Ivankova *et al.*, 2006) (Creswell, 2003). In sequential explanatory method data is collect in two consecutive phases over time (Ivankova *et al.*, 2006). Another aspect to be considered, while making the sequential decision is the effective integration of the two methods (Morgan, 1998). The priority and sequential decisions depend upon the research purpose and the research questions (Ivankova *et al.*, 2006). According to Morgan (1998), sequence decision is mostly about whether the complimentary method comes first as a foundation input

In this research, a sequential exploratory design has been adopted in phase one, in which priority is generally given to the first stage (Tashakkori & Teddlie, 2010) followed by phase two, a parallel convergent design (Kettles *et al.*, 2011). A sequential exploratory design is characterised by an initial phase of qualitative data collection and analysis, followed by a phase of quantitative data collection and analysis, where priority is given to the qualitative aspect of the research (Tashakkori & Teddlie, 2010). In such a design, quantitative a study is in service to the more dominant qualitative study (Hesse-Biber, 2010). Morgan (1998) argued that such a design is best suited to expand the outcomes of the qualitative study, by exploring the generalisability and transferability of the results from qualitative research (Morgan, 1998). In a parallel convergent design different but complimentary data is obtained on the same topic, in order to fully understand the research topic (Kettles *et al.*, 2011). This method is best suited when direct comparison of the results of two methods is required (Kettles *et al.*, 2011). As such, when both sets of analyses have been conducted, the researcher can either write up the analysis separately or in an integrated form (Tashakkori & Teddlie, 2010).

3.3.1 *Phase I: Exploratory sequential design*

The exploratory sequential design consists of a qualitative approach, which was aimed at exploring and understanding the lesser known innovation landscape of the UK rail industry. This was achieved by analysis the data collected from 43 unstructured and semi-structured interviews. The qualitative research was informed by the innovation barrier themes identified in literature. Since little to no academic research was found in this particular research area, a qualitative approach was chosen to explore the situation in hand in-depth, and develop themes along the process. This protocol included unstructured interviews in the beginning, and once few significant themes emerged, semi-structured interviews were used to probe further. The unstructured interviews consisted of questions informed by the identified themes in the literature, and in relevance to the stakeholder being interviewed. As the interviews progressed and new themes emerged, this informed the following structured interviews to focus more on the emergent themes, in accordance with the stakeholder characteristics. This has been described in detail in the section 3.4.2 Interview approach.

Once saturation was achieved, that is, no new themes emerged, the qualitative data was analysed to derive concrete themes. These results informed the second phase of the research design – quantitative approach.

3.3.2 *Phase II: Parallel convergent design*

The parallel convergent design, forms the second phase of the research design. The data analysis results obtained in phase I, informed the design of the quantitative research instrument. The quantitative approach was adopted in parallel to a qualitative secondary data analysis. A questionnaire was developed based upon the concrete themes identified in phase I, in order to generalise the findings of phase I, and remove researcher's interpretation biases if any. The complementary nature and sequence of quantitative analysis, was aimed at confirming, supporting and transferring the results of phase I. The results of the qualitative and quantitative methods, were thus combined in a sequential form to identify the barriers to innovation in the UK rail industry.

Simultaneously, a qualitative secondary data analysis as conducted, on the published industry reports, in order to determine the industry perceived barriers to innovation. The outputs of the sequential design were then compared to the results of the qualitative secondary data analysis. The parallel convergent design enabled the researcher to conduct the two methods of research separately, and combine the results of the two forms by means of a comparison. The aim of the parallel convergent design is to identify how the industry presents itself to its stakeholders, how the industry perceives its innovation landscape, and to establish the direction of this research by identifying how the industry aims to present itself to its stakeholders in terms of innovation. It also enabled the researcher to find the gaps in industry knowledge, and to suggest recommendations accordingly in combination with the primary findings of this research.

The research design of this thesis is presented below in Figure 3.5:

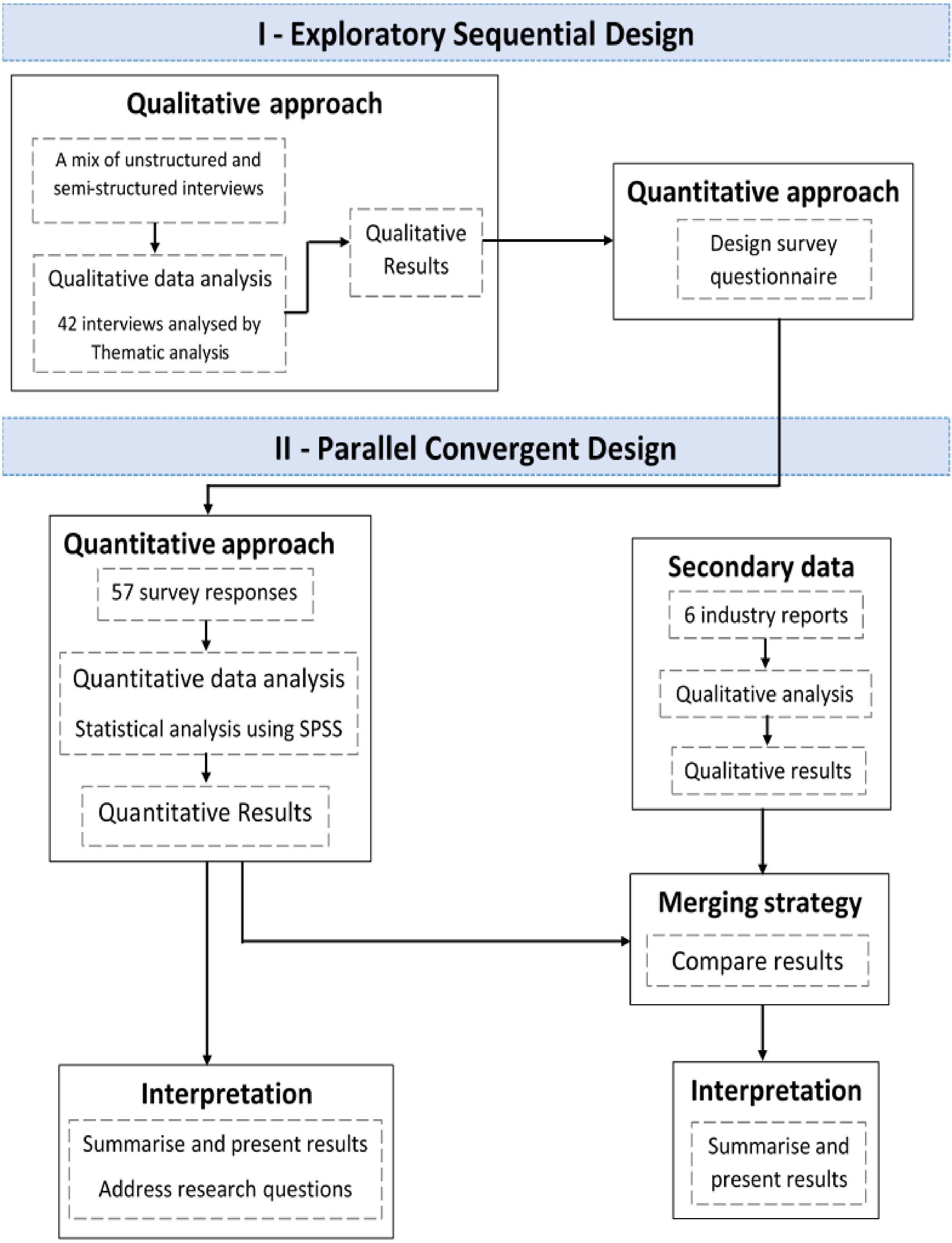


Figure 3.5 - Research design

Having discussed the research design of this thesis, the following section discusses in detail the tools and techniques employed for this research design.

3.4. Research tools and techniques

3.4.1 Data collection

Primary data collection is an important part of many research projects (Harrell & Bradley, 2009), including this thesis. The primary data forms the main body of data for this research. Data collection enables researchers to carry out high quality research and produce credible findings (Harrell & Bradley, 2009). It has a significant impact on how data is managed, and ultimately on how the research is performed (Wilcox *et al.*, 2012). At the beginning, information was collected by means of advanced literature review related to innovation and the issues observed in developing and implementing innovation within transportation. This preliminary analysis gave a direction to the data collection phase by identifying areas that experience barriers to innovation, to be further investigated in the UK rail industry. The qualitative data collection phase proved to be most challenging part of this research due to the difficulties of identifying and establishing contact with the most suitable individuals in the complex fragmented industry structure and the reluctance of the individuals to share their views. The aim of gaining a comprehensive view of the innovation scenario in the UK rail industry also had its challenges in terms of identifying the various stakeholders and establishing contact with the individuals that met the researcher's criteria. Since the stakeholders are spread across the country, scheduling and travelling made the qualitative data collection process hectic and very time consuming. Similar difficulties were faced while gathering quantitative data, as the low response rate despite being shared by prominent industry networks, resulted in having to identify industry gatherings and workshops in order to personally promote and convince industry individuals to share their views via the survey. This exercise further added time and costs to the data collection stage.

Qualitative primary data of this research was collected via interviews, audio recorded with the consent of the interviewees, and transcribed by the researcher and with the help of a professional transcriber. Along the interviews field notes were built and maintained throughout the data collection process. The quantitative data was collected by means of a survey. In addition, secondary data was collected via personal contacts within the industry and through industry data bases.

The following sections give an account of the research tools and techniques used to gather and analyse the data used in this research.

3.4.2 Interview approach

Interviews are widely used as a data collection technique in qualitative research (Barrett & Twycross, 2018). The process of qualitative research interview involves gathering information and facts, extraction of stories, and learning about experiences, emotions, relations, and meanings that cannot be observed otherwise (Rossetto, 2014). In order to develop in-depth discussion, the interviewer needs to engage in active supporting listening (Baxter & Babbie, 2003). Qualitative interviews have been categorised in variety of ways in literature (DiCicco-Bloom & Crabtree, 2006), fundamentally differentiating qualitative interviews as structured, semi-structured and unstructured interviews (Gill *et al.*, 2008). Many examples can be found in literature that utilise the three types of interviews as a data collection tool. Few examples in light of the methodological approach adopted for this research are: W. Nix and G. Zacharia (2014) in their study of the '*The impact of collaborative engagement on knowledge and performance gains in episodic collaborations*', used structured interviews which when thematically analysed revealed that collaborative engagement has a direct impact on knowledge gained, operational outcomes and relational outcomes. Similarly, Croxson *et al.* (2017) in their research utilised semi-structured interviews and analysed the data thematically, in order to gather in-depth understanding of GP's perceptions and attitudes towards workload. Aslam *et al.* (2018) used unstructured interviews to study the role of knowledge sharing to overcome the challenges of organisational change. Using thematic analysis the study revealed that in public sector employees oppose organisational change because of ineffective communication, lack of lower-level employee engagement, and barriers due to cultural, social, structural, and political nature.

Structured interviews involve pre-established questions, allowing only a limited number of response categories. Such interviews are rigid and allow minimal deviation from the set script. Same questions are asked to all the interviewees and in the same order in order to obtain brief answers or answers from a list. As such the organisation and analyses of the findings is generally straightforward (Qu & Dumay, 2011). On the other hand unstructured interviews are more informal and open ended as compared to structured interviews (Qu & Dumay, 2011). DiCicco-Bloom and Crabtree (2006) argue that no interview can truly be unstructured and is approximately equal to a guided conversation. Unstructured interviews shape to the individual situation and context, and the open-endedness enables the interviewer to access the perspective of the interviewee (Qu & Dumay, 2011). In the middle of structured and unstructured interviewees, lies semi-structured interviews (Qu & Dumay, 2011). According to DiCicco-Bloom and Crabtree (2006) semi-structured interviews are generally based on a set of predetermined open-ended questions and are the most widely used approach. As a dialogue between the interviewer and interviewee builds, other questions emerge in the process. The participant of such interviews can be a single individual or a group of individuals, lasting between 30 minutes to several hours (DiCicco-Bloom & Crabtree, 2006).

In this thesis, unstructured and semi-structured interviews were used to determine the barriers to innovation in the UK rail industry. As mentioned in Chapter One the initial focus of the research was to investigate the testing and trialling stages of innovation with respect to the testing voucher scheme. After the change in focus to the wider issues related to innovation, testing was considered for a separate case study. As such the focus of the first 10 unstructured interviews was more on testing and trailing. As the interviews progressed and the collected data highlighted the wider nature of the issue, the interviews became semi-structured and focused on the entirety of the issue. This approach allowed the participants to contribute as much information as they chose to share, and allowed the researcher to ask probing questions in order to gather rich data (Turner Iii, 2010). The following sub-section thus, moves on to discuss the interview design in detail which is crucial to the success of the data collection approach.

3.4.2.1 Interview design

The qualitative data of this research was collected using unstructured interviews followed by semi-structured interviews with the key professionals of the UK rail industry having been involved with innovation. As mentioned, this stage proved to be the most challenging stage of this research due to the low response to request for interviews. As suggested by Douglas (1985), unstructured interviews were used in the beginning of the data collection stage, when there was insufficient knowledge of the issue in hand. Unstructured interviews provided the interviewees with a relaxed atmosphere which can help break down sensitivities that might prevent the interviewee from telling the truth (Qu & Dumay, 2011), and enabled the researcher to explore the phenomenon under study in more detail. Once a broader set of themes was derived, bringing to light the wider scope of the issue the interview approach moved towards semi-structured interviews, which are often the sole data source for a qualitative research project (Magsi *et al.*, 2002), including individual in-depth interviews and four group interviews due to the limited availability of the participants and travel constraints of the researcher. Taking a semi-structured approach enabled to explore the determined theme in more depth and with the flexibility this approach offers, the researcher was able to capture other emerging themes depending on the experiences and role of the interviewee. Same process was followed till saturation was achieved, that is, no new themes emerged.

In the interview designing process, decisions related to who to interview, how many interviews to conduct, type of interview, and data analysis methods, were carefully considered (Qu & Dumay, 2011). As mentioned earlier, unstructured and semi-structured approach was used to interview the participants. In total 43 interviews were conducted with 49 professionals, as 4 interviews consisted of more than one participant due to availability issues. Due to the varied nature of the roles played by the stakeholders in the innovation process, one fit for all questionnaire would have not been produced effective results. As such, in addition to the various common questions, each questionnaire was tailored to the participants work and expertise, and had the flexibility to accommodate the complexity of the research topic (Saunders *et al.*, 2012). Examples of the difference in questionnaires for different stakeholders are presented in Appendix 1 – questionnaire of an innovator and Appendix 2 – questionnaire of TOC. The list of questions consisted of three parts: 1) common section about the interviewee's job role and expertise, to establish their relevance and contribution to the research study, 2) individually tailored section of specific questions related to the identified themes in the literature, with the open-endedness to accommodate more than the perceived themes, and 3) third section focused on interviewee's personal views and experiences regarding the barriers to innovation that might not have been covered during the interview. During the interview, questions to probe and prompt the participants were used for in-depth understanding of the phenomenon in hand. Each of the interview was informed by the literature and the analysis of the interviewees conducted prior to it. This approach enabled the researcher to collect a rich source of data, as due to very little research done in this area, concrete themes to question could not be established prior to the interviewing. As such, as the interviews progressed, the data evolved overtime in the desired direction to address the aims and objectives of this research.

The questionnaire content and design were adapted from OECD (2018). The manual suggests that for useful research, qualitative data on innovation objectives must include that which drive a firm's decision to innovate, such as competition, or opportunities for entering new markets, and how the firm responds to these drivers, for example, enhancing firm's operations or capabilities (OECD, 2018). It highlights key areas of influence for measuring innovation objectives and outcomes as markets production and delivery, firm organisation, and environment and society. In addition the manual suggest collecting data on the relationship between innovation and business strategy (OECD, 2018). Since the purpose of the suggestions is to measure the level of innovation in firms, it could not be directly adapted to this research. Therefore, a similar approach was taken, which was informed by the literature to form logical questions that had the potential of inspiring a discussion around the key identified themes, while making the interviewee feel at ease and overcome the nervousness of sharing information. The questionnaire consisted of questions related to the broader themes identified in literature (Saunders *et al.*, 2012), that is, information, funding, regulations and standards, communication, and market. The interviewing technique was broadly adapted from Saunders *et al.* (2012), including the nature of information supplied to the interviewee for example, interviewees were sent a brief outline of the research and sometimes when requested and as per the time constraints the questionnaire beforehand; opening comments to be made for example, gain confidence of and show interest in work of the interviewee; and the approach to questioning such as refined clearly paraphrased questions. As suggested by Saunders *et al.* (2012) a brief summary was provided to each interviewee at the end of the interview to test the scope of understanding of the researcher. Each interview was audio recorded and notes were taken as the interview progressed. Important elements of confidentiality were clarified and consent to record was verbally obtained at the beginning of each interview.

3.4.2.2 Sample population

Considering the nature of the research topic, sampling technique was used to collect the required data from specific group of cases (Saunders *et al.*, 2012) that were experienced and involved with innovation in the UK rail industry. In order to identify the potential interviewees, a stakeholder analysis of the UK rail industry was conducted. This was crucial to the research, as the UK rail industry comprises of a complex network of a large number of stakeholders. The stakeholder analysis consisted of three steps: identifying stakeholders, differentiating between and categorizing stakeholders, and investigating relationships between stakeholders (Brown *et al.*, 2016). These three steps were carried out in relation to the various stages of innovation, identifying, differentiating and categorising stakeholders' depending on their involvement at different stages of innovation. A stakeholder analysis enabled the researcher to identify the key stakeholders that are involved in innovation in the industry. The stakeholder analysis was conducted by identifying the various stakeholders involved at various stages of innovation. Figure 3.6 below presents the stakeholder analysis conducted for this research in terms of a flow chart. The next stage after identifying the categories of stakeholders, was to identify the respective organisations and establish contact with experts and request an interview. Connections were built through networking by attending various industry events across the country. Conscious efforts were made to capture both bottom-top and top-down perspectives of innovation. Hence a mix of engineers and middle management who were connected and well aware of the grassroots levels, and directors who had an overall top view of the business, were interviewed for this research. Customers were not included in the stakeholder perspective as exploration of customer perspective was outside the scope of the research which specifically focuses on the internal industry perspective and barriers to innovation. The researcher faced challenges in motivating the participants for an interview, as the purpose of the concerned event and that of the research did not always match. Even though only relevant rail events were attended by the researcher where samples had a higher probability of meeting the sample criteria, the purpose of the attendees was mostly focused on sales and finding solutions to their issues, rather than invest their time in research.

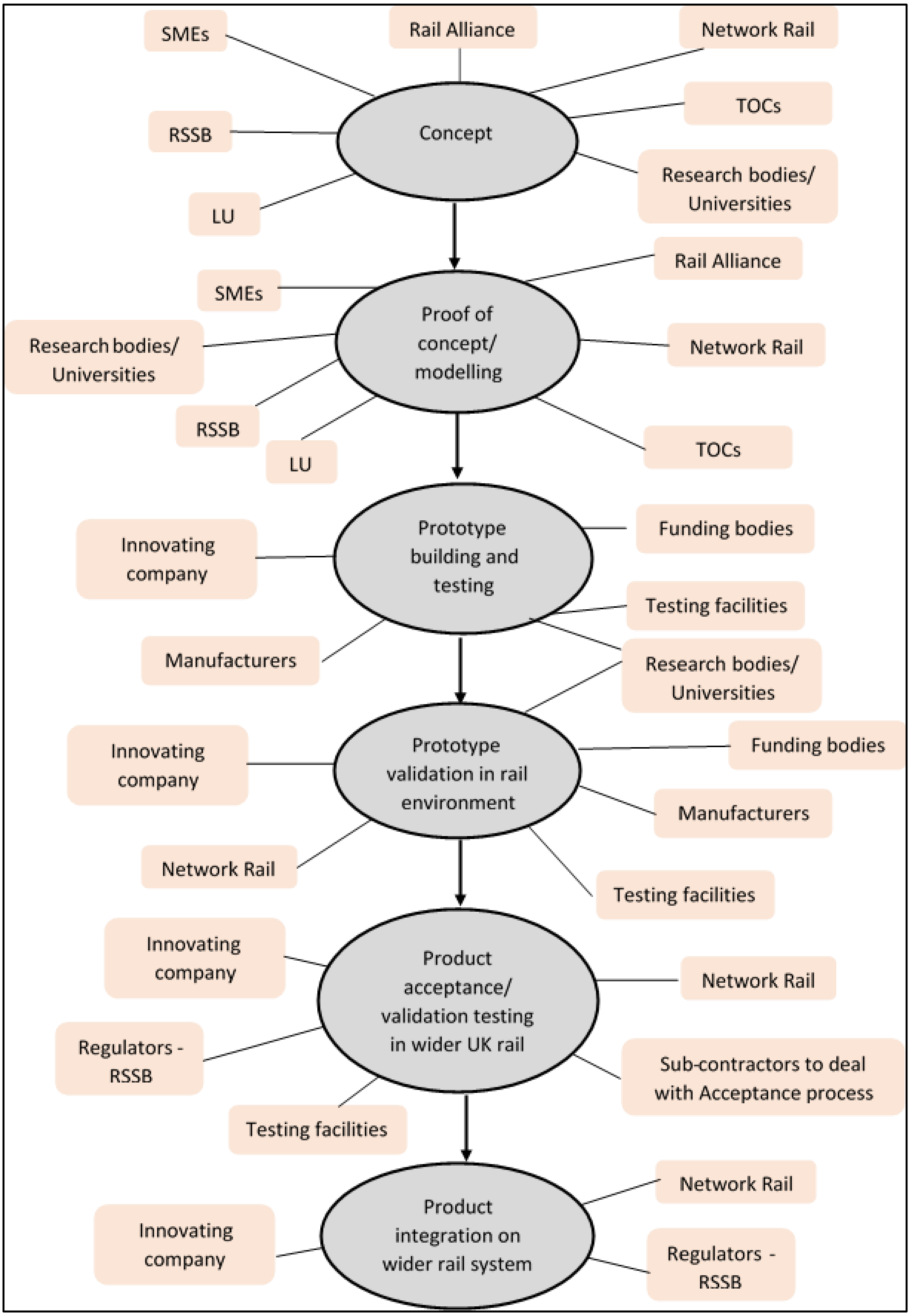


Figure 3.6 - Stakeholder analysis of UK rail industry

Considering the size of the industry, and the associated challenges, this technique was not enough. As such, snowball sampling or chain of referral methods were also used. Once the responses had been obtained from a qualified subject, a referral to another qualified subject was sought (Dusek *et al.*, 2015). Snowball sampling includes a qualified person sharing invitation with other similar subjects who fulfil the qualifications of the defined targeted sample (Dusek *et al.*, 2015). This method is more direct and purposeful (Bagheri & Saadati, 2015) as it enables a researcher to interview hard-to-reach samples (Dusek *et al.*, 2015).

After creating a list of potential participants after each set of interactions or based on referrals, the researcher contacted them primarily through email in addition to telephone calls. Each email consisted of an introduction of the researcher and the purpose of the email. It was followed by a brief description of the study and the industry body sponsoring the research in order to entice the interest of the potential participant and link the relevance of the research to the UK rail industry. In addition, a report of the future research outputs was offered to further motivate them. Of all the invites sent, the researcher obtained a success rate of approximately 30% - 33%. In total 43 interviews were conducted including 48 participants (4 interviews had multiple participants due to availability constraints). First few interviews with each stakeholder category were unstructured in nature, followed by structured interviews when few significant themes had emerged. Interviews were conducted till saturation was achieved, that is, no new themes emerged. The interview lengths varied from an approximate minimum of 30 minutes to a maximum of approximately 120 minutes. Each interview was audio recorded and then transcribed verbatim before being analysed. Table 2 below provides an overview of the interviews with respect to the stakeholder categories identified by the stakeholder analysis, and table presents a summary of all the conducted interviews.

Table 2 - Overview of the stakeholders interviewed

Stakeholder	No. of interviews
Train Operating Companies	11
Owner and infrastructure manager	8
Manufacturer (for example electric systems, trains)	6
Innovators (for example mechanical, materials, electric systems)	7
Consultancy and support/ Contractor	7
Government body (DfT)	4
Technology and innovation research Centre	1
Safety body	1
Representative of UK based suppliers	1
Testing facility	1

Table 3 - Interviews conducted

S No.	Interviewee Code	Interview Date	Interview Type	Interview Medium	Stakeholder Category
1	I1	04/03/2016	Unstructured	Face to face	Innovator
2	I2	31/03/2016	Unstructured	Face to face	Innovator
3	IR3	14/04/2016	Unstructured	Face to face	Technology and innovation research centre
4	M4	06/05/2016	Unstructured	Face to face	Manufacturer

5	IO5	10/05/2016	Unstructured	Skype	Owner and infrastructure manager
6	C6	11/05/2016	Unstructured	Telephone	Consultancy and support/ Contractor
7	C7	12/05/2016	Unstructured	Face to face	Consultancy and support/ Contractor
8	M8	17/05/2016	Unstructured	Face to face	Manufacturer
9	C9	18/05/2016	Unstructured	Face to face	Consultancy and support/ Contractor
10	C10	23/05/2016	Unstructured	Face to face	Consultancy and support/ Contractor
11	TF11	07/06/2016	Semi-Structured	Telephone	Testing facility
12	IO12	14/06/2016	Semi-Structured	Face to face	Owner and infrastructure manager
13	IO13	14/06/2016	Semi-Structured	Face to face	Owner and infrastructure manager
14	I14	15/06/2016	Semi-Structured	Skype	Innovator
15	IO15 (4 Participants)	16/06/2016	Semi-Structured	Face to face	Owner and infrastructure manager
16	M16	20/06/2016	Semi-Structured	Face to face	Manufacturer
17	M17	20/06/2016	Semi-Structured	Face to face	Manufacturer
18	TOC18	21/06/2016	Semi-Structured	Telephone	Train Operating Company

19	C19	27/06/2016	Semi-Structured	Face to face	Consultancy and support/ Contractor
20	G20	28/09/2016	Semi-Structured	Skype	Government body
21	M21	30/06/2016	Semi-Structured	Skype	Manufacturer
22	TOC22	04/05/2016	Semi-Structured	Face to face	Train Operating Company
23	TOC23	04/05/2016	Semi-Structured	Face to face	Train Operating Company
24	RS24	05/07/2016	Semi-Structured	Skype	Representative of UK based suppliers
25	M25	08/07/2016	Semi-Structured	Face to face	Manufacturer
26	TOC26	11/07/2016	Semi-Structured	Face to face	Train Operating Company
27	TOC27	11/07/2016	Semi-Structured	Face to face	Train Operating Company
28	TOC28	12/07/2016	Semi-Structured	Telephone	Train Operating Company
29	TOC29	20/07/2016	Semi-Structured	Telephone	Train Operating Company
30	TOC30	22/07/2016	Semi-Structured	Telephone	Train Operating Company
31	IO31	26/07/2016	Semi-Structured	Telephone	Owner and infrastructure manager
32	C32	28/07/2016	Semi-Structured	Face to face	Consultancy and support/ Contractor
33	TOC33	01/08/2016	Semi-Structured	Face to face	Train Operating Company

34	TOC43	05/08/2016	Semi-Structured	Face to face	Train Operating Company
35	C35	15/08/2016	Semi-Structured	Telephone	Consultancy and support/ Contractor
36	TOC36	05/09/2016	Semi-Structured	Face to face	Train Operating Company
37	SB37	06/09/2016	Semi-Structured	Telephone	Safety body
38	G38	08/09/2016	Semi-Structured	Telephone	Government body
39	I39 (2 Participants)	09/09/2016	Semi-Structured	Face to face	Innovator
40	G40	15/09/2016	Semi-Structured	Telephone	Government body
41	G41	30/09/2016	Semi-Structured	Telephone	Government body
42	I42 (2 Participants)	04/11/2016	Semi-Structured	Face to face	Innovator
43	I43	25/01/2017	Semi-Structured	Face to face	Innovator

3.4.2.3 Data analysis

Qualitative research is an esteemed paradigm of investigation, and the complex nature of the qualitative research requires rigorous and systematic approaches to generate useful results (Nowell *et al.*, 2017). One such foundational method for qualitative analysis is thematic analysis (Braun & Clarke, 2006). In addition to social sciences, thematic analysis has been used extensively in software engineering such as the works of Cruzes and Dyba (2011) and (Cruzes & Dybå, 2010), and Koro-Ljungberg and Douglas (2008) further urge the use of qualitative research methods in engineering to benefit from rich, descriptive information that can be gained to add to the fewer qualitative articles published in engineering (Koro-Ljungberg & Douglas, 2008).

Many authors have identified thematic analysis as an assistant tool to qualitative analysis rather than a separate method (Braun & Clarke, 2006). However, it has been used extensively both as an integral part of other methodologies, and as method in its own right (Brooks *et al.*, 2015). Nowell *et al.* (2017) argue that thematic analysis can be used across a range of epistemologies and research questions. This approach was found to be the most effective approach for this research, as it enabled the researcher to simultaneously look at emerging themes as a means of understanding more latent content, and use existing theoretical constructs to analyse data while allowing new emerging themes to become categories for analysis (Joffe, 2012).

There are no clear agreement on how thematic analysis can be applied to produce trustworthy and insightful findings (Nowell *et al.*, 2017). This research used Braun and Clarke (2006)six-step framework which is regarded as the most influential approach due to the clarity and usability it offers (Maguire *et al.*, 2017). Thematic analysis method is used to identify, analyse, organise and interpret patterns of meaning within qualitative data (Clarke & Braun, 2017). These patterns of meaning are called themes. A good thematic analysis does not simply summarise the data, rather it interprets and makes sense of it (Maguire *et al.*, 2017).

According to the six-step framework (Maguire *et al.*, 2017):

Step 1: become familiar with the data

This includes reading and re-reading the transcripts in an active way (Braun & Clarke, 2006) and become familiar with the entire body of data (Maguire *et al.*, 2017).

A snapshot of the process is shown below in Figure 3.7:

other sectors but I think in the rail industry that's particularly problematic because that is where you get into the sort of barriers that exist for people like train operators and other organisations, so if you were a Venture Capitalist you know looking to invest in a prototype product that had got to a certain stage and there was a market in the rail industry then a lot of the questions that you would want to ask about you know "how big is the market?, what's the appetite of the client?, etc". So if it is aimed at a train operator, then the train operator is saying well "I will think about it in my next franchise, or my franchise isn't long enough to payback this investment" and if the VC looks at the number of people that you need to get the nod in the right place and give their support and approvals. So a classic example would be an innovation that is a great benefit to say a train operator but you need collaboration from the infrastructure manager or vice versa, that is all on the whim of those parties and they have got to have the railway to run on a daily basis and so getting everybody to agree to allow an innovation to happen, you know who is taking the risk if it doesn't work. And that is even before I get to approvals because is it something that needs to be put on a train, then there is a whole series of approvals to demonstrate that it's safe to put on the train. Equally if it's going on the infrastructure there is a whole series of approvals and so compared to other sectors it's quite opaque and quite daunting for a supplier and if the supplier when asked those kind of questions by a potential investor, if they say well its quite opaque and uncertain then guess what, the investor goes and spends his money somewhere else.

True.

So I think one of my biggest challenges we have is getting the support to take things from TRL6 into commercial operation and fundamentally what that needs is it needs somebody, some organisation who is prepared to champion it and often the prize

Zibrij Ahmad (Researcher)
Poor business case for investing at higher TRL, due to fragmentation, franchising periods, and the number of stakeholders involved

Zibrij Ahmad (Researcher)
Risk management – complex number of stakeholders,

Zibrij Ahmad (Researcher)
Complex and large number of processes and approvals involved put off the innovator as well as the investors

Zibrij Ahmad (Researcher)
Lack of championing for innovation

Figure 3.7 - Data familiarisation

- **Step 2: generate initial codes**

This includes organising data in a meaningful and systematic way (Maguire *et al.*, 2017) to generate codes. Codes are the smallest unit of analysis that capture interesting features of the data which are potentially related to the research question (Clarke & Braun, 2017). It should be noted that analysis of not all features of data is guided by the research questions. The research questions can evolve throughout coding and theme development (Clarke & Braun, 2017).

A snapshot of the process is shown below in Figure 3.8:

Codes	Supporting Statements
1. Vision	So one of the barriers to innovation starts at the top because you don't have people with a vision actually holding the purse strings, so it is in strictly short supply.
2. Market	There is very little demand pull for innovation within the rail industry
3. Conservative 4. Cultural barriers	So I have mentioned already the rail industry is a very conservative industry, it is also a very old industry so there is they have a lot of cultural barriers not invented here, we tried that it didn't work.
5. Lack of ambition	It's when people try something and they don't succeed eventually they learn not to try, they learn to be helpless

Figure 3.8 - Data coding

- **Step 3: search for themes**

Codes are the building blocks of themes (Clarke & Braun, 2017). In this stage codes are analysed to consider how different codes can combine to form an overarching theme (Braun & Clarke, 2006). Themes as described earlier are the pattern identified in data that present something significant or interesting about the data (Maguire *et al.*, 2017). They provide a framework for analysing and reporting the researcher's analytic observations (Clarke & Braun, 2017).

Due to the larger number of data scripts and to be time efficient, small groups of interviews were analyses at a time. Theme generated from the first set of 10 interviews produced a set of potential themes that guided further analysis. Once all the interviews were analyses, the researcher ended with themes, sub-themes and all extracts of data that had been coded in relation to them (Braun & Clarke, 2006).

A snapshot of the process is shown below in Figure 3.9:

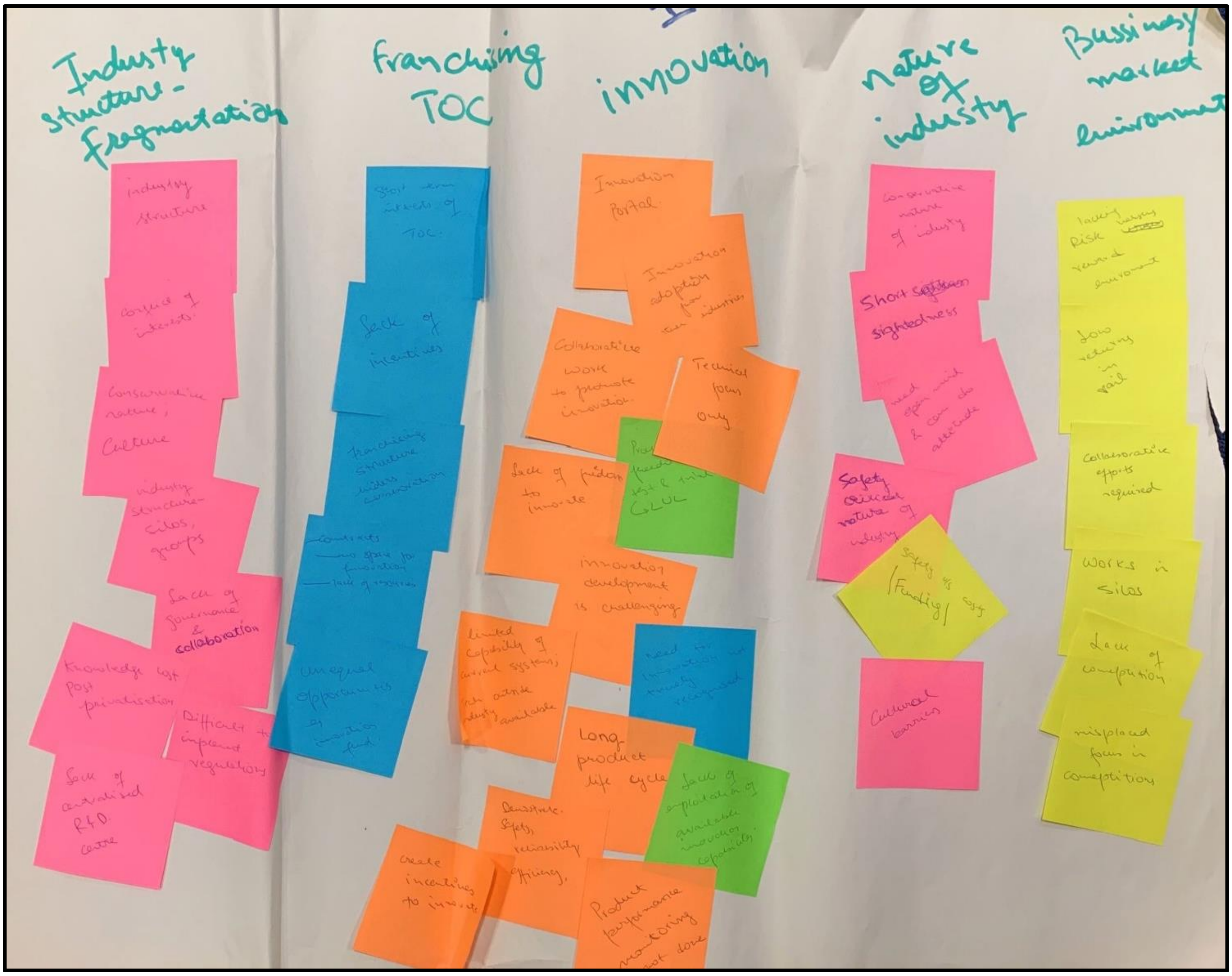


Figure 3.9 - Theme development

The mix of colour represents the codes that can be categorised under more than one theme. For example, the green codes listed under innovation theme could also be listed under management theme as below in Figure 3.10:

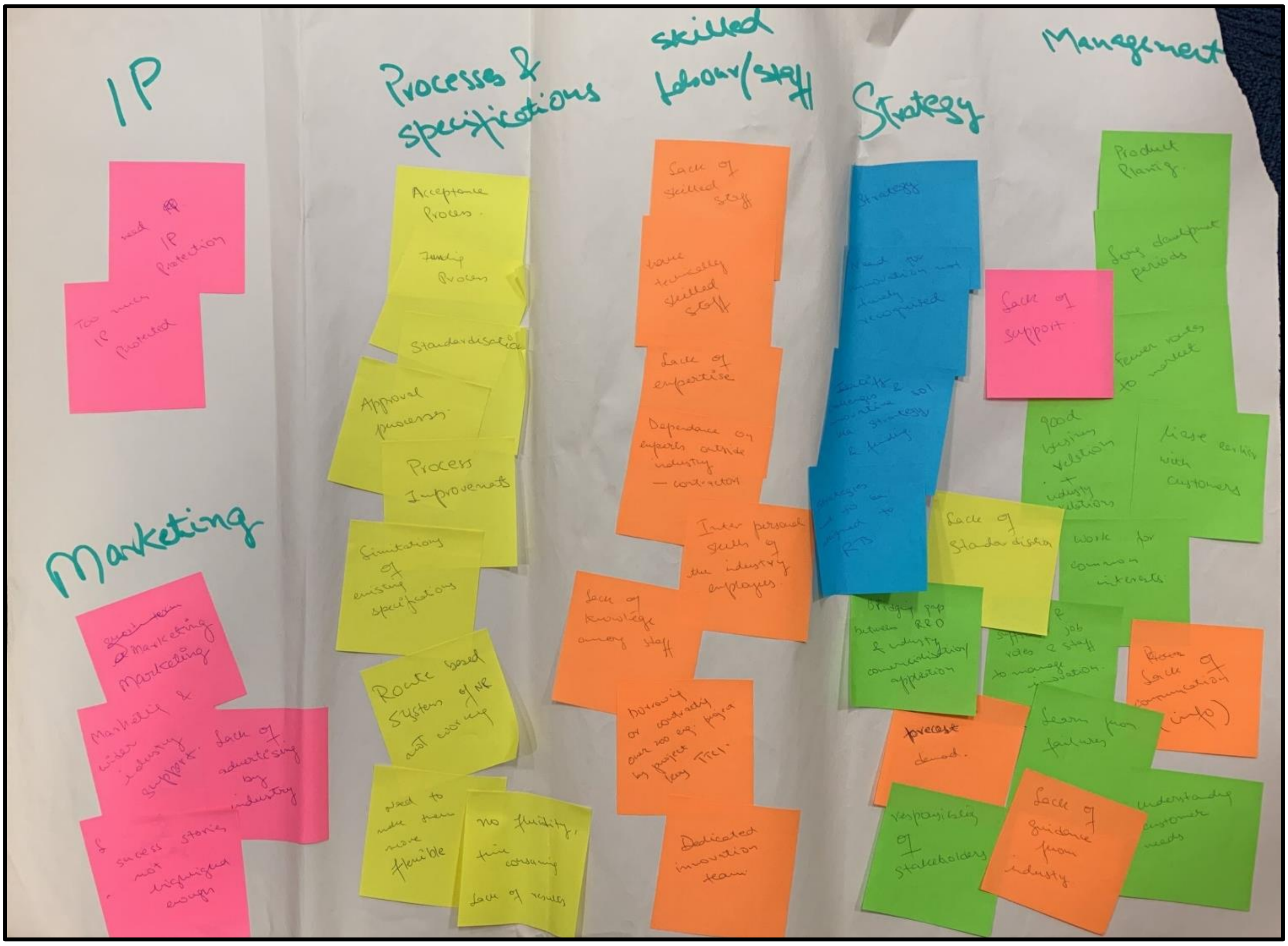


Figure 3.10 - Theme development

- **Step 4: review themes**

During this phase, the potential themes were reviewed, modified and developed in view of all the gathered data relevant to each theme (Maguire *et al.*, 2017). Decisions related to whether the data really supported the theme and whether the themes work in context of the entire set, were made (Maguire *et al.*, 2017). This stage resulted in coherent themes, distinct from each other (Maguire *et al.*, 2017), that told an overall story about the data (Clarke & Braun, 2017).

- **Step 5: define themes**

This stage involved defining and further refinement of the themes in order to capture the essence of each theme (Braun & Clarke, 2006). Each theme is considered individually, and in relation to other themes to tell the overall story of the data. Sub-themes if any were also identified at this stage (Braun & Clarke, 2006). Theme names were also refined at this stage to immediately give the reader a sense of what the theme is about (Braun & Clarke, 2006).

6 global themes were identified that best presented the innovation landscape of the industry, these are: 1) *structure of industry*, 2) *elements of the innovation process*, 3) *franchising*, 4) *people and culture*, 5) *funding*, 6) *external factors - political/government*, and *media*

For example, the initial codes as presented in Figure 3.8 were categorised into emergent themes, which were then further refined into global themes as demonstrated below in Table 4:

Table 4: Demonstration of thematic analysis

Code	Emergent Theme	Global Theme
Vision	Strategy	Innovation process (strategy, challenges and opportunities)
Market	Business/market/environment	Fragmented structure of the industry (business barrier)
Conservative	Nature of industry	Culture and people (cultural barriers)
Cultural barriers	Nature of industry	Culture and people (cultural barriers)

- **Step 6: write-up**

The final stage of thematic analysis involved write-up on the identified themes as described in the next Chapter Findings. The themes are presented in a concise, coherent and logical manner (Braun & Clarke, 2006), highlighting the links and interdependencies of the themes owing to the nature of the research area. Extracts from data have been embedded in the analytical narrative to build arguments in relation to the research questions (Braun & Clarke, 2006).

The main advantage of thematic analysis is its flexibility (Clarke & Braun, 2017), that can be modified as per the need of the research, resulting in rich and detailed, and complex account of data (Nowell *et al.*, 2017). It provides flexibility not only theoretically, but also in terms of research question (as they can evolve over the period of analysis as per the emergent themes), sample size (data is collected till saturation is achieved, that is, no new themes emerge) and, data collection method, and approaches to meaning generation (Clarke & Braun, 2017). Thematic analysis particularly suits those early in their research career, which relatively less familiarity with quantitative methods as it is easily grasped, and can be relatively quick to learn due to less prescribed procedures (Braun & Clarke, 2006). According to King (2004) thematic analysis imposes a well structure approach to handling data, highlighting the key features of large a data set, resulting in a clear and organised report. King (2004) and (Braun & Clarke, 2006) also argue the usefulness of thematic analysis in capturing different perspectives of the research participants, to examine the similarities and differences, and to generate useful unanticipated insights (Nowell *et al.*, 2017).

Initial coding was conducting using MS Word programme, and subsequently a post-it-note technique was used to group codes into themes. Another option available was the use of computer software packages, such as NVivo, ATLAS among others (Joffe, 2012) to facilitate qualitative analysis, saving time and to avoid tedious process of manual analysis (John & Johnson, 2000). However, as argued by John and Johnson (2000), use of software packages has its disadvantages as well. In light of the nature of the lesser known research area of this thesis, the relevant disadvantages of using software packages for qualitative analysis as stated by John and Johnson (2000), could be the distancing of the researcher from the data, time consumption in learning to use these packages, focus on quantity over meaning, and an obligation to obtain large amounts of data (John & Johnson, 2000). As, such owing to the familiarity of the researcher with the data, the analysis was conducted manually to produce optimal results. Using MS Word programme, each interview script was analysed and coded line by line. Post-it-notes and large working charts were then used to organise the codes under various identified themes. Initially the themes were those derived from the reviewed literature, and at a time sets of approximately 10 interviews were analysed. As the analysis progressed more themes emerged and a continuous process of analysis and organising and reorganising of themes occurred until all the interviews were analysed and concrete themes were generated. These themes are presented in the following analysis chapter (Chapter Four).

Having discussed the qualitative analysis, the following section discusses the second phase of the research design that is the quantitative analysis. The questionnaire design, the quantitative data analysis and the reason for using a survey have been described.

3.4.3 Survey approach

A survey is a qualitative data collecting method (Snijkers, 2013) used to collect quantitative information strategically and systematically (De Leeuw *et al.*, 2008) from a sample of interest (Snijkers, 2013). A survey enables to gain insight into what the entire population does or thinks, from a sample population (De Leeuw *et al.*, 2008). Surveys use a fixed questionnaire with pre-determined specific questions, presented mostly in a closed format along with specified response alternatives (Blair *et al.*, 2013). Surveys can be conducted through various mediums such as in person, over the internet, by phone or by email (Blair *et al.*, 2013). The survey for this research was conducted over the internet, and by manually distributing it at the 21st Unlocking Innovation Scheme Workshop, to improve the response rate. This enabled the researcher to collect more data as the researcher faced difficulties in gathering responses despite being advertised on prominent rail networking websites.

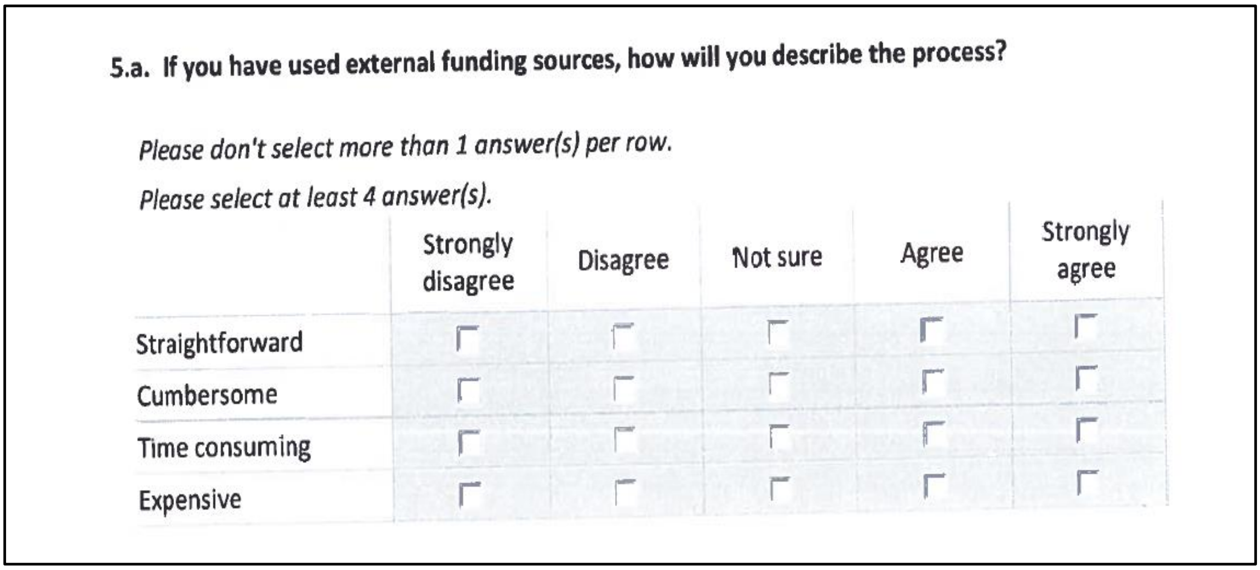
A survey was considered necessary for this research as it facilitates a better understanding of the drivers of behaviour and perception (Kelley-Quon, 2018). In addition making the survey available to a wider audience in rail, enabled to capture the perception and experiences of the secondary stakeholders, and to validate the results of the qualitative data analysis. In addition to selecting an appropriate survey form, the survey needs to be planned, designed and conducted (Snijkers, 2013). Therefore, the following sections give an account of the survey design, sample population and data analysis.

3.4.3.1 Survey design

Unlike the questions developed for unstructured and semi-structured interviews for qualitative analysis, the questions for quantitative analysis need to be defined precisely before data collection (Saunders *et al.*, 2012). The questionnaire used pre-coded closed questions, that is, the questions had a finite number of multiple responses to choose from (Brace, 2013). Since the questions were informed from the results of the qualitative data, rating type questions (Saunders *et al.*, 2012) were used to collect the opinion of the wider population. Such questions most frequently use the Likert-style rating scales, to record how strongly the participant agrees or disagrees with a statement or series of statements, usually on a four, five, six or seven point scale (Saunders *et al.*, 2012). Likert scales have been used widely to measure observable attributes in various social science areas, for example, to measure organisational behaviour in learning organisations, fondness of music education, and effectiveness of drugs in pharmaceuticals (Li, 2013). Allen and Seaman (2007) argue that there is no wrong way to build a Likert scale, however, it should include at least five response categories. These categories range from least to most, indicating how much the respondents agree or disagree with the given condition (Allen & Seaman, 2007).

Both positive and negative statements were included to ensure that the respondent reads questions carefully and thinks before responding (Saunders *et al.*, 2012). Particular attention was given to the wordings and structure of the questions, by using simple familiar words, and by ensuring that long questions were broken down into smaller sub-questions (Saunders *et al.*, 2012). The order and flow of questions was designed so as to appear logical to the participant, starting from easy questions to more difficult questions (De Vaus *et al.*, 2008). To assist the flow of the survey the questions were presented in sections (De Vaus *et al.*, 2008), and filter questions were used where necessary. These questions enable the participant to identify if the following questions are relevant to them (Saunders *et al.*, 2012). Also the layout was chosen to be as precise and short as possible to make it attractive to the participants.

A snapshot of the survey questionnaire is provided below in Figure 3.11:


5.a. If you have used external funding sources, how will you describe the process?

Please don't select more than 1 answer(s) per row.

Please select at least 4 answer(s).

	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
Straightforward					
Cumbersome					
Time consuming					
Expensive					

Figure 3.11 - Survey questionnaire

For the self-administered survey which are read and completed by the respondents themselves (Snijkers, 2013), such as the one used for this research, a covering letter was attached to the front of the questionnaire explaining the purpose of the survey and offering complete anonymity to the participant (Saunders *et al.*, 2012). This can be found in Appendix 4. According to Dillman (2011) the messages conveyed in a cover letter affects the response rate of the questionnaire. As such the need for the participant to complete the survey was communicated in the beginning (Saunders *et al.*, 2012). As an incentive, sharing the outcomes of the research was also offered.

The questionnaire was mediated through the internet via websites (Hewson *et al.*, 2015). The researcher used the university tools to create and administer the questionnaire using Bristol Online Surveys. Networks that were built during qualitative research, were used to advertise the questionnaire on prominent industry network organisation website – Rail Alliance and the researcher's personal LinkedIn account. Due to the poor response, the closing date of the survey was extended multiple times. In addition, the researcher manually distributed questionnaire at the 21st Unlocking Innovation Scheme Workshop to boost the response rates.

3.4.3.2 Sample population

Sampling strategy takes into account the research context and goals (Hewson *et al.*, 2015). Researchers use sampling techniques to collect data from a focused group (Saunders *et al.*, 2012) that meets the criteria of the research aims and objectives. Considering that the purpose of the survey was to validate the thematic analysis results from the wider industry and to remove researcher's bias if any, the targeted population was the sample involved in innovations in the UK rail industry. These included engineers, managers and directors of well-established organisations within the UK rail industry such as the Infrastructure owner – Network Rail, innovators trying to break into the UK rail industry, approved suppliers, rolling stock leasing companies such as Angel Trains and b2b organisation – Rail Alliance. As such, the mediums of distribution of the questionnaire were strategically selected. These included websites and forums specific to innovation within the UK rail industry. These were: Rail Alliance website, advertised on researcher's LinkedIn, requests through emails to contacts obtained through networking, and manual distribution at an industry event. Rail Alliance is a prominent organisation which prides itself as being the go-to-team for doing business in the rail sector. It supports all companies large and small to do business in the rail industry and memberships include all aspects of supply chain. Rail Alliance is premium business to business networking organisation in the rail sector. As such, the population exposed to the survey via the Rail Alliance website met the criteria of this research. Similarly, LinkedIn was used as the network consisted of mostly rail professional. The event chosen to manually distribute the questionnaires also met the research criteria as it was aimed at Unlocking Innovation in the UK rail industry. The qualitative data analysis results further strengthen this sampling technique as the participants were recorded to have an experience of working in the rail industry ranging from 1year – 47 years.

3.4.3.3 Data analysis

Quantitate data in its raw form conveys very little meaning, and as such needs to be processed to turn it into information (Saunders *et al.*, 2012). Qualitative analysis techniques have been incorporated into time efficient and less expensive computer based analysis software, which range from excel sheets to more advanced software packages (Saunders *et al.*, 2012). One such advanced software package – SPSS has been used to conduct the quantitative data analysis of this research. For such an analysis, each question or item is given a unique variable name (Pallant, 2016) and the answers to questions are converted into numbers (De Vaus *et al.*, 2008), called coding (Saunders *et al.*, 2012). The codes used for the responses on the five point Likert scale are: 1 = 'strongly disagree', 2 = 'agree', 3 = 'not sure', 4 = 'agree', and 5 = 'strongly agree'. The next stage was to enter the values obtained from each participant for each value, in SPSS software. Considering the purpose of the survey, a descriptive analysis, guided by Pallant (2016) was conducted, to obtain percentages and frequencies of responses depending upon the question. Negative research questions were converted to positive where necessary for the ease of analysis. These are presented in detail in Chapter Four – Findings.

Having discussed the quantitative data analysis of the primary data, the following section discusses the secondary data methodology.

3.4.4 Secondary data analysis

The analysis of an existing data set, previously collected by another researcher, usually to pursue a research interest distinct from that of the original work is called secondary data analysis (Heaton, 2003). It is the analysis of existing data to answer new research questions (Dunn *et al.*, 2015). Secondary data analysis applies theoretical knowledge and conceptual skills to exploit existing data to answer the research questions (Johnston, 2017). Secondary data can consist of a wide range of empirical forms, such as data generated through systematic reviews, through documentary analysis, as well as results from large-scale datasets (Smith, 2008). These include raw data and published summaries, organisational data used to support various operations of an organisation, quality daily newspapers, government reports, and online data bases containing organisation information (Saunders *et al.*, 2012). Expertise is required for locating and judging the best data sets (Goode *et al.*, 2017).

The secondary data sources identified in the research are presented below in Figure 3.12:

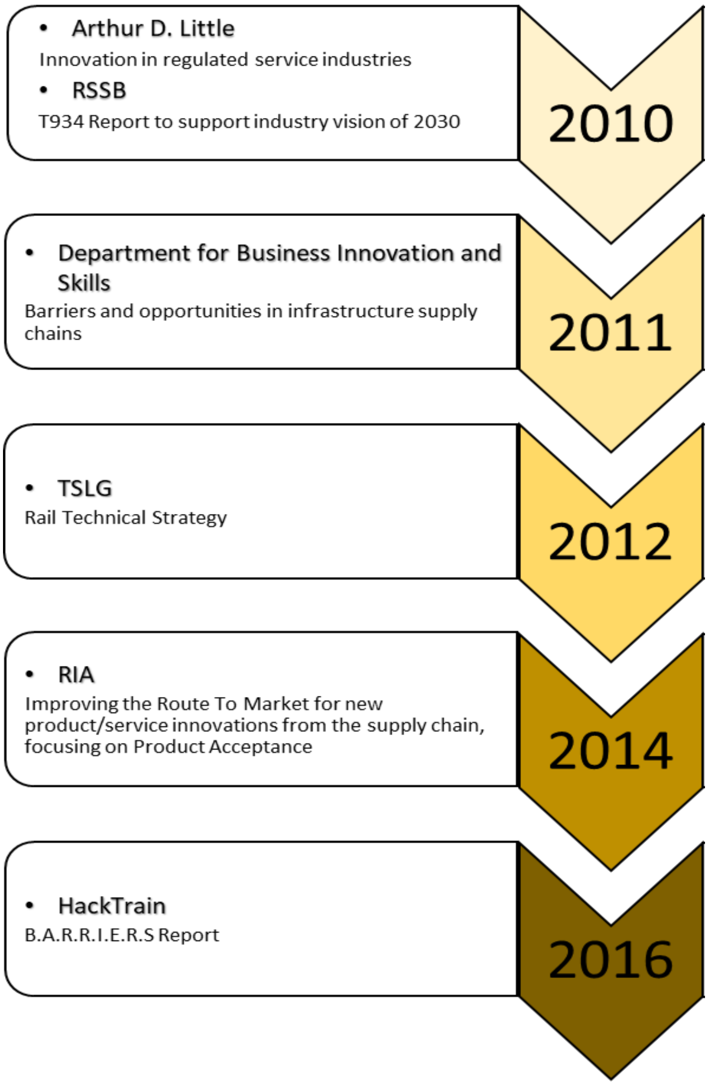


Figure 3.12 - Secondary data sources

The main purpose of conducting secondary data analysis in this research, is to establish the direction of the primary research, as identified necessary by the UK rail industry. In addition, the secondary data analysis enabled the researcher to draw comparisons of what is perceived by the industry and what remains unknown. As such, rail industry reports published by various industry stakeholders have been analysed to serve the purpose of the analysis by acting as validation tool and forming basis for identifying areas for further exploration. Industry reports can usually be of high quality considering the resources the company has at disposal, and due to the expertise of the professionals involved. For the analysis, secondary qualitative data was used to re-analyse the secondary data in light of the research top, to identify the perceived barriers to innovation in the UK rail industry. Various industry contacts and databases such a SPARKS was used to collect the relevant reports. Due to the low volume of the published data, each report was critically analysed to derive the perceived barriers to innovation and recorded in word documents. It should be noted that these reports were published by the various industry stakeholders with personal agendas. These documents were then complied under various emerging themes, to reveal the perceived innovation landscape of the industry. In the end an innovation model was developed using the results of the secondary data analysis to compare it to the unbiased evidence based findings of the primary data analysis. This is presented in Chapter Four - Findings.

3.5. Conclusion

This chapter started with a brief description of the research context and the research questions, for which an appropriate research design was developed in order to best answer them. The underpinning research philosophies were discussed and, the chosen paradigm and the rationale for choosing it was established.

The adoption of an exploratory sequential design followed by a parallel convergent design, along with the mixed methodology approach was explained and justified. The chosen approach assumptions and approaches enabled the research to meet the objectives of this research. Finally, the research tools and techniques, which included interviews and surveys to collect data, and thematic analysis and statistical analysis used to analyse the collected data respectively, was discussed. These diverse component and research approaches are presented in the following diagram.

Having discussed the methodological approaches of this research, the following chapter presents the outputs of the employed research strategy – findings. The two diverse data sets are effectively integrated to present the findings of this research.

4. Findings

4.1. *Introduction*

This chapter presents the research data collected for this research. The data collection process was the most challenging part of the research, and presented barrier mostly in terms of the reluctance of the individuals despite assuring non-disclosure of the individual's details. As discussed in the methodology in Chapter Three, the importance of selecting data sources based on their experience and knowledge in order to capture the overall innovation scenario in UK rail industry from all aspects, further narrowed down the number of willing and reliable data sources. For the interviews, only one-third of the requests were accepted, and for the survey the closing dates were extended on multiple occasions due to the poor response, despite being advertised on prominent industry platforms and networks. Thus, the findings presented in this chapter were obtained as a result of a privilege access to a closed domain.

The findings are presented in two sections, as primary and secondary data. The primary data consists of the qualitative data collected by the researcher by means of 43 unstructured and semi structured open interviews with a range of railway industry professionals, and quantitative data collected from a survey of 57 responses. The secondary data presents and analyses the available industry reports on barriers to innovation as published by the UK rail industry. These reports are collated and span the period from 2010-2016, to form an integral part of the findings chapter as it throws light on the perceived aim of the industry and its interactions with its stakeholders.

The first section presents the analysis of the very challenging process of primary data collected from 43 unstructured and semi structured open interviews, and from the survey results of 57 responses. The interviewees were very carefully selected in order to get a wider picture of the innovation landscape from various angles. First a stakeholder analysis was conducted in order to identify the stakeholders involved at various stages of the innovation process. The second step was to identify the organisations under various stakeholder categories, such as for the stakeholder - train operator, organisations such as Virgin Trains and First Trans Pennine were listed. Similarly, various other organisations were identified using the stakeholder analysis along with the understanding of the UK rail industry structure. The rail industry structure was taken into consideration in order to get an overall view of the innovation landscape from various perspectives. An array of professionals ranging from technical bodies such as engineers to senior management such as directors were interviewed for this research.

As mentioned in the Chapter One of this dissertation, the focus of the research shifted from concentrating only on the testing and trialling stages to considering the overall innovation process. As such, the interviews were extensive and in depth depending on the interviewees experience and job role. It was important to conduct the vast number of interviews despite the challenges and time constraints, with a range of individuals due to the lack of literature and research in the area, as is evident from the second section of this chapter. Therefore, it was critical to first identify what the barriers were, and as the research takes into consideration the whole of the innovation process, these barriers required to be investigated through the overall structural, business, and procedural aspects. The primary data findings includes qualitative data results supported by the quantitative data results where necessary.

The second section of this chapter presents secondary data in order to identify the perceived barriers to innovation as identified by the UK rail industry. This secondary data gives an insight into the work done by the industry with regards to innovation and where it currently stands in the innovation scenario. It includes 6 reports addressing various areas of innovation. The analysis of the secondary data highlights the gaps in knowledge and the need for an extensive research done via the primary data analysis. It reveals the industry aims and vision in terms of innovation and its interactions with its stakeholders. The secondary data enabled to validate the direction of investigation aimed to address the innovation issues faced by the UK rail industry.

The findings chapter hence helps put the pieces together to present an analysis of the perceived issues at hand. It also lays the foundations of the discussion chapter by instigating the development of suggestions and discussions. Therefore, this chapter, as an overview, first provides extensive results of the primary data findings which is the analysis of 43 interviews to find what the barriers to innovation are in the UK rail industry supported by the statistics from the survey of 57 responses, followed by secondary data analysis of literature published by the industry on barriers to innovation.

4.2. ***Primary data***

4.2.1 Introduction

The primary data of this thesis comprises of a mixture of qualitative data collected through interviews with various UK rail industry experts, and quantitative data collected with the help of an online survey. The quantitative data analysis results are presented in this section in support to the qualitative data findings where necessary and appropriate.

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Due to the fragmented nature of the UK rail industry which comprises of a large number of stakeholders, it was crucial to consider the issue at hand from multiple perspectives. As mentioned previously in Chapter Three, first a stakeholder analysis was conducted to identify the various stakeholders involved in the process of innovation. The next and the most challenging stage was to find contacts among the identified stakeholders and convince them for an interview. Of all the invitations sent, only one-third were accepted. Table 5 below shows the variety of stakeholders that were interviewed for this research.

Table 5 - Stakeholders interviewed

Stakeholder	No. of interviews
Train Operating Companies	11
Owner and infrastructure manager	8
Manufacturer	6
Innovators	7
Consultancy and support/ Contractor	8
Government body	4
Technology and innovation research Centre	1
Safety body	1
Representative of UK based suppliers	1
Testing facility	1

It was very important to interview professionals which had a broader view of the business, so as to collect rich data which considered not only a single department of an organisation but the entire business. Therefore, directors and managers were mostly interviewed along with engineers to get a closer view of the problem. Table 6 below shows the number of professionals interviewed based on their position in their organisation.

Table 6 - List of professionals

Job profile	No. of interviews
Director	14
Senior manager and Manager	25
Chief engineer and engineer	6
Consultant	2
Management graduate	1

The questionnaire was based on the findings of the secondary data, but it also provided a platform and space for further discussion. The open structure of the questionnaires enabled to collect data outside the areas known from the secondary data. Interviews with different stakeholders formed a collection of data which represented barriers experienced across the UK rail industry.

The interviews were analysed using thematic analysis. Six global themes have been identified which present the innovation landscape of the industry, these are: 1) *structure of industry*, 2) *franchising system*, 3) *barriers along the innovation process*, 4) *culture and people*, 5) *funding*, 6) *external barriers-political/government hindrances,* and *role of media*.

Building on the findings of the qualitative data, a survey was designed to distribute to a wider audience. This activity served the purpose of recording the views of a wider audience and to remove bias from qualitative data analysis, as the survey was structured and close ended in nature in contrast to the interview questionnaire. This also helped in further strengthening the saturation in the qualitative data and eliminated the need for further interviewing. The survey analysis helps support the qualitative data by providing statistical figures where and as required. The survey results were analysed using SPSS software and appropriate descriptive analysis were conducted to compare and present innovation scenarios as per the findings of the quantitative data.

Before discussing the primary findings of this research, it is important to know why the industry feels the need to innovate. A descriptive analysis of the qualitative data was conducted to find the same and is presented in Figure 4.1 below:

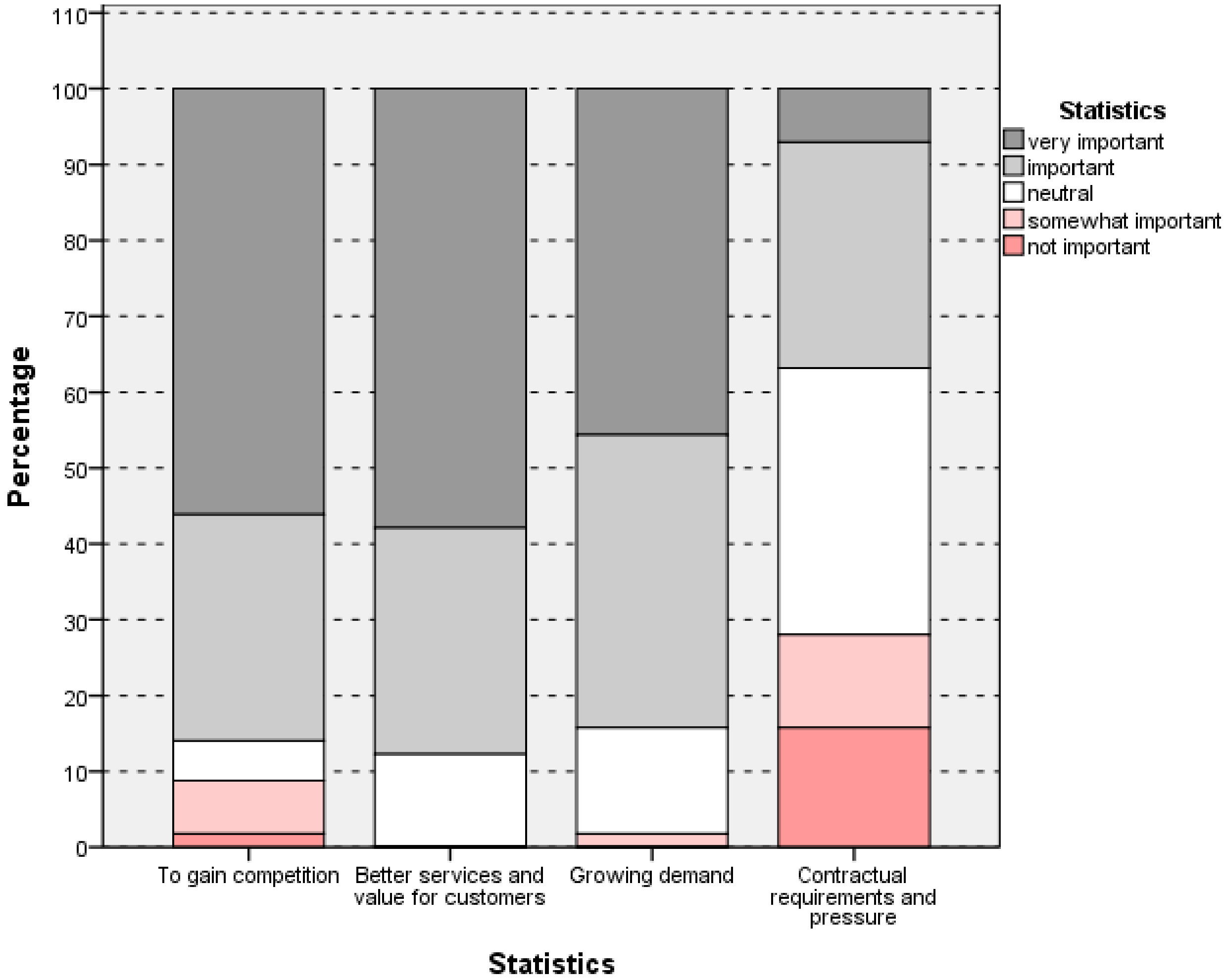


Figure 4.1 - Why innovate?

Figure 4.1 shows the percentages of 57 response depicting the reason why the industry should innovate. The analysis clearly shows that the industry response was mostly to gain competition and to provide better services and value. Though a small percentage disagreed with competition to be their reason to innovate, providing better value and services and to meet the growing demand were recorded to be the most common reasons for innovation. Fulfilling contractual requirements was found to be the least dominating reason for innovation. The subsequent sections of this chapter explore the innovation scenario of UK rail industry in more depth by presenting the findings of the qualitative and the quantitative data.

4.2.2 Findings

To begin with it is necessary to visualise the current innovation scenario within the industry, and the innovation scenario that the industry aspires to achieve. These have been presented below in Figure 4.2 and Figure 4.3:

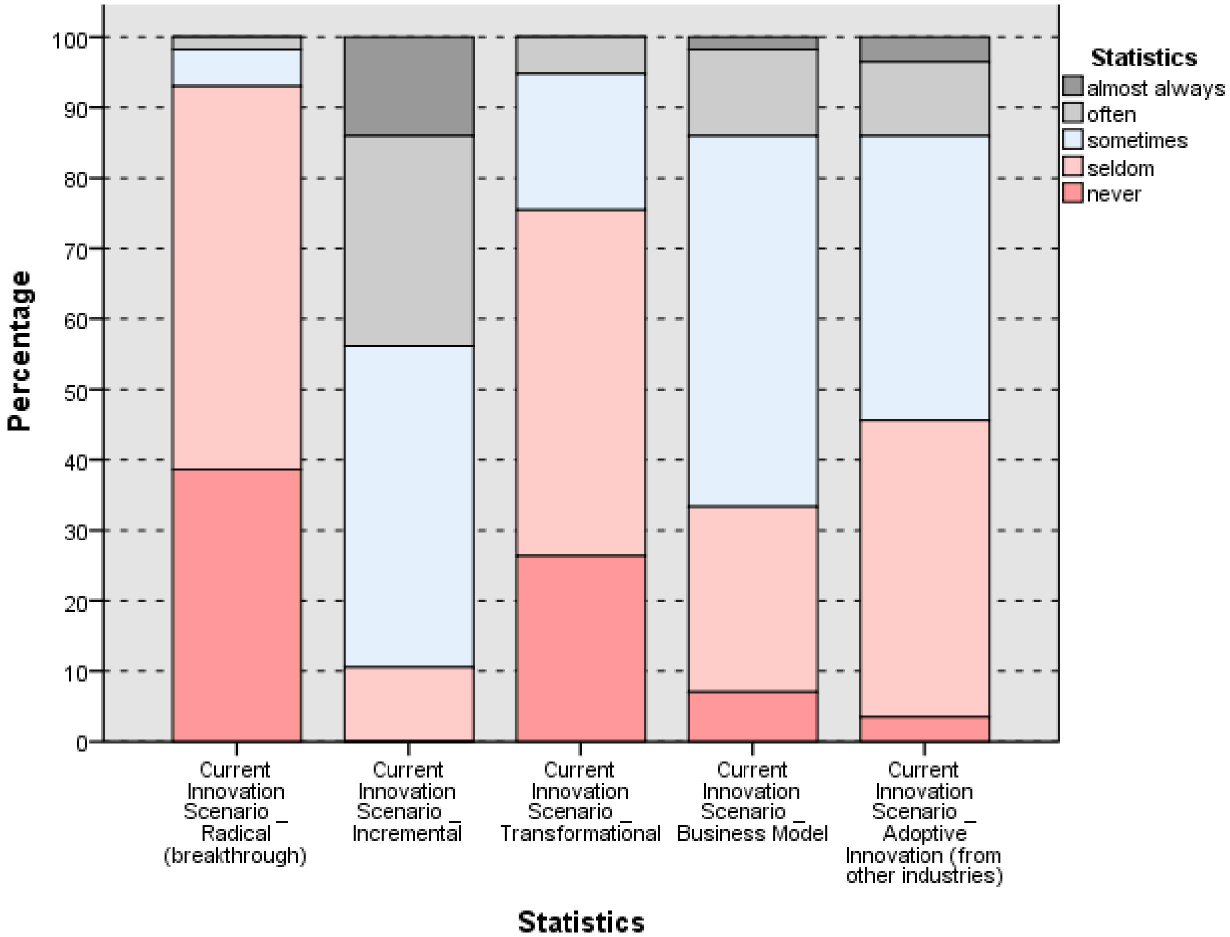


Figure 4.2 - Current innovation scenario

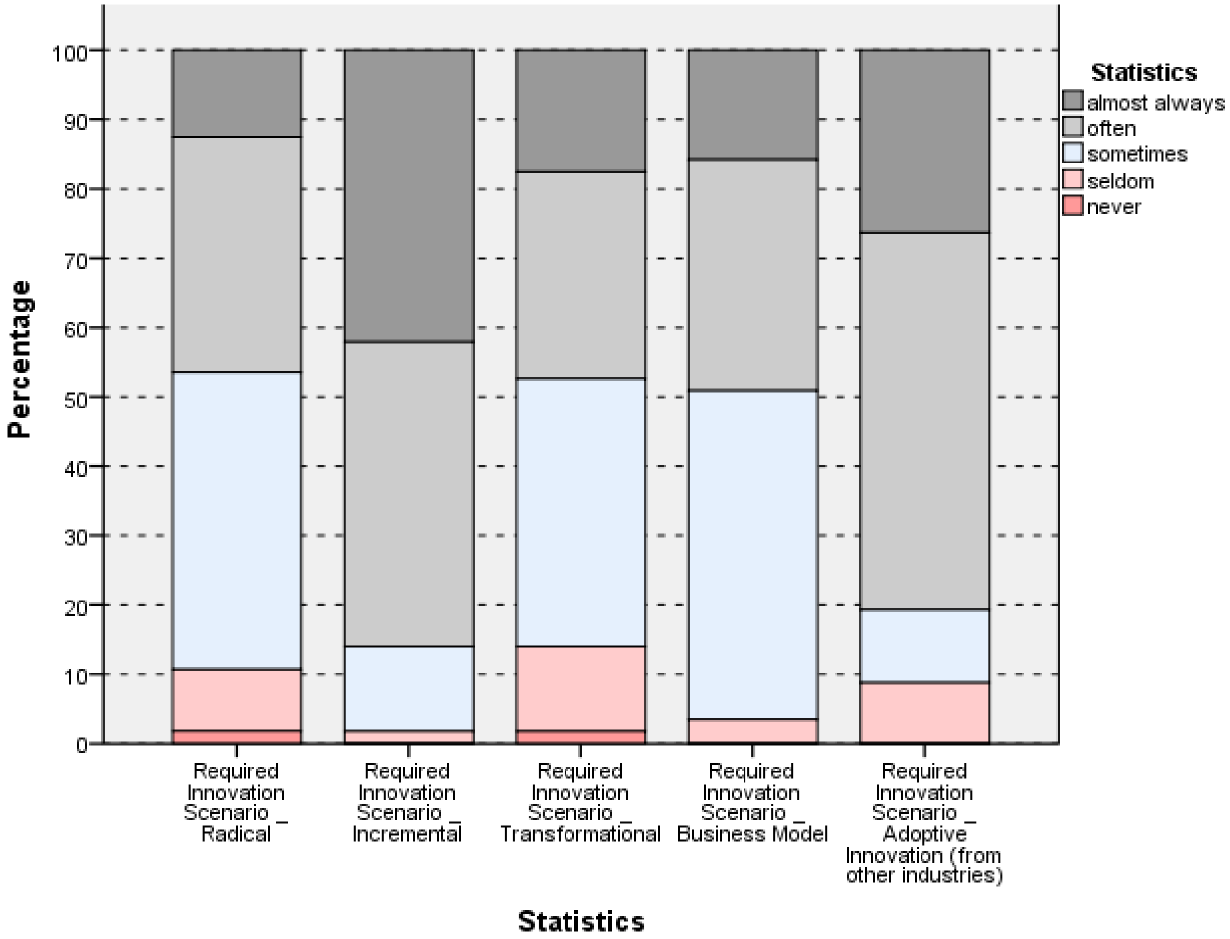


Figure 4.3 - Aspired innovation scenario

Comparison of Figure 4.2 and Figure 4.3, highlights the gaps in innovation. As is evident from Figure 4.2, the response from 57 participants shows the current innovation scenario depicts lower levels of innovations in each of the types of identified innovations. Subsequently, Figure 4.3 presents the innovation scenario the industry aspires to achieve. The aspired scenario depicts high levels of innovation (presented by grey shades) that the industry considers necessary to transform the current UK industry into an innovative sector.

In order to help the industry bridge the gap between the two scenarios, the chapter explores the barriers to innovation within the UK rail industry. The primary data collected via interviews was analysed using thematic analysis. Each interview was coded in detail to identify and analyse the patterns of meanings in the data, grouping them into themes that best describe the phenomenon under study. These themes were then grouped together into global themes, thus identifying the key areas of the UK rail industry that witness barriers to innovation the UK rail industry. Six global themes have been identified which present the innovation landscape of the industry, these are: 1) *structure of industry*, 2) *elements of the innovation process*, 3) *franchising*, 4) *people and culture*, 5) *funding*, 6) *external factors - political/government*, and *media*. The findings of this section enabled the development of conceptual model presented in Figure 4.18. The barriers identified in the various areas of innovation in the UK rail industry (the identified global themes) are discussed in the following sub-sections:

4.2.2.1 Fragmented structure of industry

The primary data findings largely identified that the fragmented structure of the UK rail industry gives rise to various key barriers to innovation. The structure of the industry plays a vital role as it impacts a firms profit margins and productivity significantly (Karabag & Berggren, 2014). Vast literature has been generated on how market concentration is an important factor in innovation since the work of Schumpeter (1942) which theorized market concentration as one of the determining factors of business innovation (Alfranca *et al.*, 2014). As the findings of this research identify the rail industry structure as complex and haphazard, it significantly impacts the innovation landscape of the UK rail industry by being the source of various barriers emerging due to its complicated structure. The below quote by a senior engineer TOC18, gives a glimpse of the frustration arising due to the fragmented structure among the industry experts:

"People often say to me well why it is so hard to do innovation in the rail industry; it's because it is bloody fragmented that's why." (TOC18)

This section therefore presents in detail the barriers arising from the fragmented structure of the rail industry. These have been classified into structural barriers, business barriers and process barriers.

Structural barriers

The thematic analysis revealed that the fragmentation of the UK rail industry into a large number of private companies gave rise to a complex industry structure that does not support innovation. The industry comprises of a large number of stakeholders with an unclear hierarchical structure. It is not clear as to who is the leader or the driving force that has the vision to drive the industry forward towards being an innovative industry. One of the interviewees - C19, stated it as: *'It is too fragmented, too complex. So you have got too many contractual interfaces, it has ossified it has become too rigid and there is no guiding vision and no decision making process'*. The industry structure is described as too complex, rigid, and lacking a guiding vision and a decision making process. This lack of authority leads to a long chain of stakeholders to be convinced for the success of a project, adding time and costs. As is evident from one of the interviews as stated by M16: *'So you have got to bring together the technology, the manufacturer, the rolling stock operator and the track owner to be able to do real testing on the railway and that is very difficult, it gets very contractual, it is protracted in timescales'*. The varying interests of the shareholders do not aid innovation as it doesn't aid aligning of the strategies and also impacts investments as different components of a project can be controlled by a number of stakeholders. This is clear from statements such as - C19: *'One of the things that has gone wrong is that because the trains and track are being invested in by different people now. There is no point in having fabulous track if the trains are rubbish'*. And another interviewee, a senior manager TOC34 adds: *'But they tend not to be strong enough in really aligning strategies and approaches and getting the most out of best practice'*. This also creates interdependencies where an organisation can suffer for the lack of innovativeness of another, TOC22 said: '*And so we rely on them to be innovative and we suffer if they are not innovative*'. This large number of stakeholders and agendas thus pulls the industry in many directions instead of bringing together all the efforts for one common good.

This is also influenced by other factors, such as franchising periods and control periods where the stakeholders are more interested in making temporary profits for themselves in the given set time frames and long term investments make for poor business cases. This has led to the stakeholders not being used to engaging as an industry and working in silos, thus creating cultural barriers. The following statement made by TOC36, expresses it as: '*I think you know there are so many shared industry problems out there where we all have the same problems and yet we insist on solving them separately and wasting time and money'*. As such, the industry lacks an overall strategy and makes aligning of the strategies of the many stakeholders challenging.

Another issue that remains unclear is that, who determines the future requirements of the industry in order to help the various stakeholders to better channel their efforts and investments. With a lack of future vision and disconnect between the stakeholders, this haphazard structure makes it difficult to streamline innovation processes. It also raises barriers to entry for small companies, as finding the right contacts can be challenging. This leads to issues such as the one stated by M16: *'so those sort of big picture items are very clear. But you are right the* *smaller needs are not so clear because there is nobody pulling it together'*, highlighting disconnect with the grass root levels of innovators/SMEs.

The fragmentation has also impacted the knowledge base of the industry as significant knowledge and expertise was lost post privatisation. As one of the interviewees TOC23 mentioned: *'I think maybe that is something that has happened out of fragmentation the corporate memory has been lost somewhere'*. The current industry groups that have been established to aid innovation, SME engagement and the overall functioning of the industry, are also not widely known, especially in terms of their roles and responsibilities. Lastly the complex industry structure gives rise to issues such as: TOC33: '*there is this dynamic around the infrastructure and the landlord/tenant relationship that we have with Network Rail*', TOC25: '*being slowed down by the bureaucracy of the big organisation*' and TOC27: '*I think we are struggling to get, in the fragmentation we are struggling to get the message out far and wide around some of these schemes, so the communication structure around where, how do we get the knowledge out there that these things are being looked at*'.

Business barriers

The fragmented industry structure with its complicated network of stakeholders leads to disconnect between the organisations that appear to work in silos. The industry offers a poor business environment where, as stated by one of the interviewees C19: '*no one is actually invested in the rail industry apart from the ROSCO's (Rolling stock operating companies), everybody else just takes money out*'. Various factors have been identified in the research which can contribute to this poor business environment. These are: the research found that there is a short sightedness in the industry which lacks future planning of goals and objectives for the industry to achieve. These is mostly due to the short financial control periods often five years, and because of varying operational time frames of various stakeholders (e.g. the franchise periods of the Train Operating Companies do not begin and end at the same time). This leads to lesser collaborative opportunities among the stakeholders and a contractual operating environment mainly focused on delivering contracts and gaining short-term returns. The following are few supporting statements by various interviewees: TOC27: '*So I think the principal issue is about how we are implementing a scheme which doesn't have a payback within the franchise period, how you argue the benefit of that*' and G38: '*the fact that the train operating companies for example regard themselves rather too much as contractors but no purposes to deliver the contract that they have won, rather than normal companies that are* *there to make money and delight the customer'*. Lack of mechanisms and frameworks for collaboration, and secrecy in innovative projects further increases the difficulty to collaborate.

The secrecy element is found to be misplaced, as the primary data analysis suggests that there is a fake perception of competition among the industry stakeholders. Some of the interviewees have described it as basic differentiators and varied key selling points, while others regard the outside industry competition, such as automotive industry, as real competition. The primary data analysis suggest that the stakeholders operate in different markets with different customers and in true essence are not in real competition with each other. The industry fails to recognise what aspects are better off collaborating and what aspects of the innovation process can be competitive. An example of this view can be seen in the following statement byTOC34: '*I mean you can differentiate and create differentiators but in general there is no competition. The competition is out there; it is the car*'. As such in words of TOC34: '*there is a lot of secrecy and you know no sharing, reluctance to collaborate*'. This in hand with the diverse business interests of the many stakeholders results in a business environment based on usage and implementation, rather than investment and development.

The primary data analysis also found poor market, that is, there is a lack of a market which has the driving elements of innovation, such as demand, risk versus rewards, incentives, profitable returns within considerable timescales and the ability to attract investors. The market has been described as a: TOC30: '*a captive market or when you are in a market with very little number of suppliers it stifles innovation*', which creates monopoly and eliminates competition. This results in lack of incentives as the suppliers does not see the need for innovation, and as such the industry relies on limited solutions offered. The following statement made by TOC27, reflects the above mentioned view as: '*which means we are perhaps not as faced with the same competitive pressures or market requirements to innovate*'.

Another business barrier that was highlighted is the poor management of innovation risks. These have been described as having little to no room to fail, penalties for not meeting the contracts, and low profit margins in the industry, further disincentivises the stakeholders to innovate. An interviewee, TOC34, described the situation as: '*the margins in the rail industry are tiny so there is no room error. So you can't afford to take your eye off the ball on the day to day […]*'. Lastly, the less widely shared views of barriers to business caused by the complex structure of the industry, was that of disconnect between industry and universities which can aid Research and Development, and that regarding the leadership of the industry, which predominantly is led by engineers. It was recorded that the interviewee felt that a business perspective was highly required in the leadership tier of the industry in addition to the existing technical expertise, TOC23: '*I think it's about industry deciding [...] not to be led by the engineering*'.

Procedural Barriers

The fragmented structure of the UK rail industry also gives rise to few procedural barriers which slow down the innovation process. Primary data analysis suggests that the large number of stakeholders working in a complex network, makes effective communication challenging. This was conveyed by an interviewee, RS24 as follows: '*there are certainly some lost opportunity and poor communication between various groups*'. This disconnect between the organisations can result in loss of opportunities. An example is disconnect between the academic groups and the industry which can have significant impact on Research and Development, as stated by M21: '*you realise the R&D that is when I think academia can also have an input and for whatever reason it doesn't in my opinion*'. Due to the large number of stakeholders, M16: '*who is picking up the cost at various stages versus who is going to ultimately benefit and therefore who should be paying and that is a difficult scenario to get right as well*'. Also, the UK rail industry has a contractual/project based operating nature which make it challenging to innovate as failures and delays add costs to the project. The complex fragmented structure gives rise to large number of contractual interfaces which causes delays. It also results in the roles and responsibilities of the large number of governing bodies and steering groups not being well communicated. For example, an interviewee, TOC36 stated: '*However, my concern would be that all of these steering groups and working groups are not widely known, if I was asked to name them all I couldn't I don't know about them. I don't know who sits on them, I don't know what they do, we never see any outputs*'. There is also a lack of communication between the various industry groups that can improve its productivity and help identify opportunities. As stated by an interviewee TOC22: '*I think in our efforts as an industry to create collaborative forums we have created a very complex environment. So knowing where you should go to find out about industry expertise is quite difficult*'. Poor communication, that is this lack of information and complex structure also makes breaking into the industry and SME engagement very difficult. This in turn impact procurement as TOC36 said: '*I have a feeling that we are reluctant to procure from new suppliers because we have made that process take so long'.*

The above discussed results of the qualitative data analysis were found to be supported by the results of the descriptive analysis of the quantitative data. The results show that the qualitative data analysis results are extensively accepted/agreed upon by the wider industry.

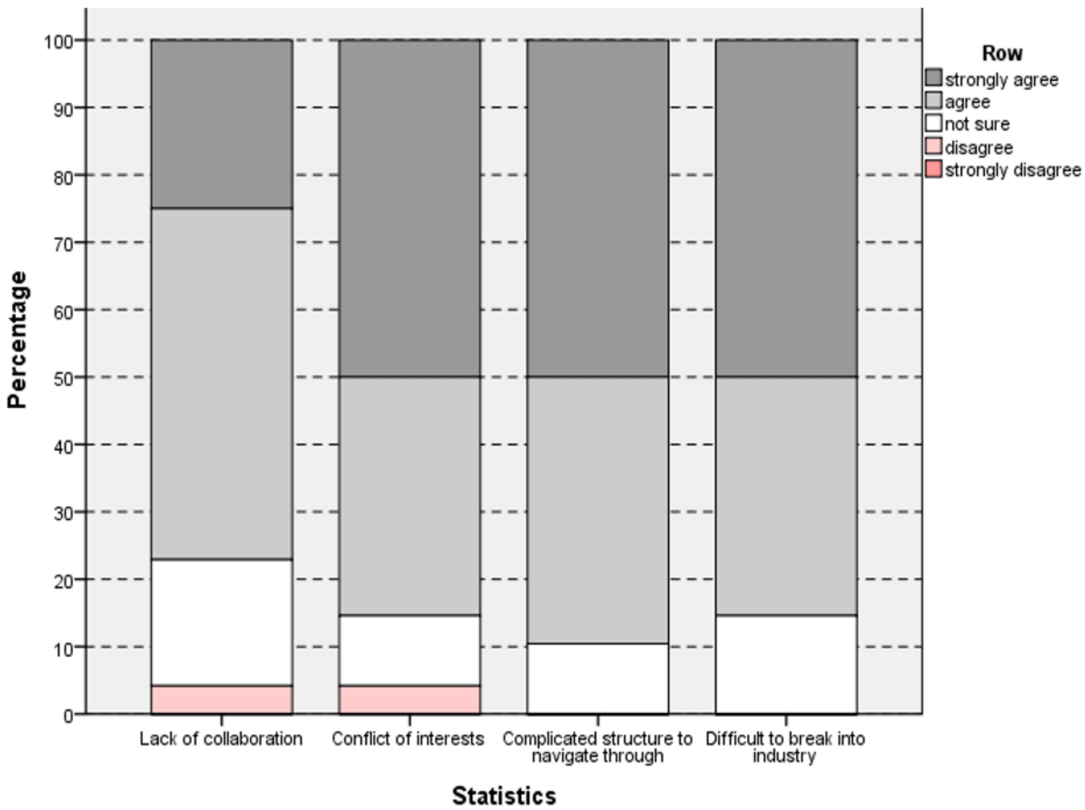


Figure 4.4 - Industry structure bi-products

In the above descriptive analysis figure of 48 responses - Figure 4.4, it can be seen that most of the participants were recorded as agreeing to the various identified bi products of the industry structure. Figure 4.4 reveals that the most common barriers resulting due to the industry structure are the difficulty to break into the industry, and the difficulty to navigate through the complicated structure. None of the respondents disagreed with these two barriers arising as a result of the industry structure, a very small percentage though were not sure. This can be due to various reasons such as, not having reached that stage of innovation to have come across these barriers, and the area of work/expertise. Being an open survey, this characteristic of the survey participants could not be monitored. In case of collaboration barriers and conflict of interests a very small percentage of the respondents were recorded to have disagreed, however, the majority of the respondents agreed or strongly agreed to it. Overall, in terms of the barriers arising due to the structure of industry, the quantitate data analysis was found to agree with the results of the qualitative data analysis.

Conclusion

In conclusion, the fragmented structure of the UK rail industry was found to give rise to numerous barriers in terms of its structure (structural barriers – SB), its effect on business (business barriers – BB) and its effect on procedures (procedural barriers – PB). Figure 4.5 below presents a conceptual model of the findings of this section. As evident from the conceptual model in Figure 4.5, various barriers were found to be common between the three sub-categories Structural Barriers, Business Barriers and Procedural Barriers. The common barriers reveal the interconnectivity of the barriers to innovation due to the fragmented structure of the UK rail industry. The interconnectivity further complicates the network of barriers to innovation and increases the challenges of addressing these barriers. However, it can also be deduced that change, whether positive or negative, in one area is directly proportional to the change experienced in another category.

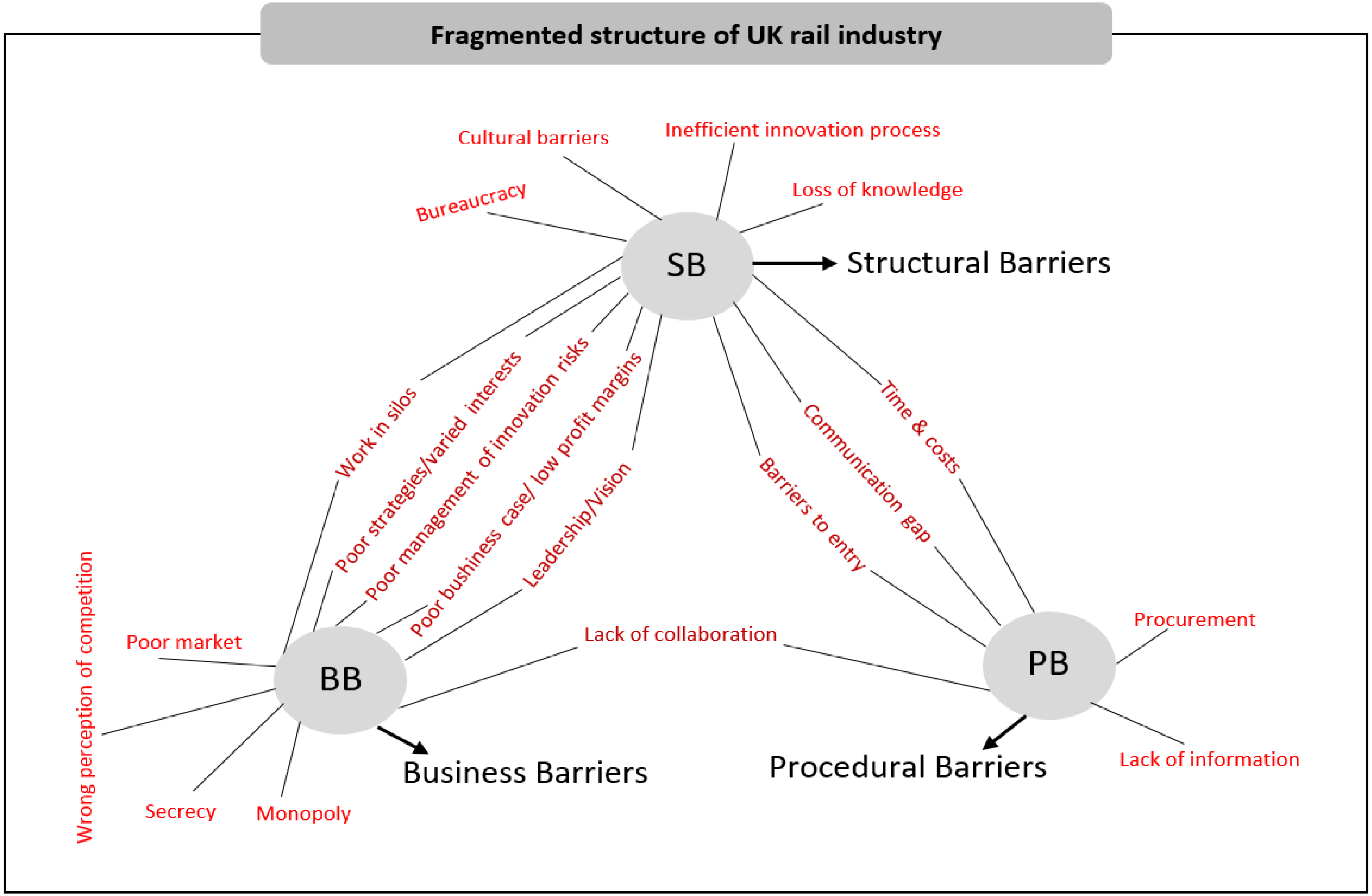


Figure 4.5 - Conceptual model of barriers to innovation due the fragmented structure of the UK rail industry

4.2.2.2 *Innovation process*

The second main area that presents the most number of barriers, as identified by the primary data analysis, was the process of innovation in the UK rail industry. It was found that the industry experiences barriers at each stage of the innovation process. As defined by Kotsemir and Meissner (2013), innovation is not a result of various innovation models used by the firm, but is a process and flow of activities deployed with an aim of solving a problem. However, this process in the UK rail industry was found to be inefficient and lacking the flow. As such each stage of the innovation process was meticulously researched to identify the respective barriers. These barriers have been presented in four sub categories with respect to the broader innovation stages they are experienced at. These are: 1) strategy, challenges and opportunities, 2) standards, processes and regulations, 3) testing and trialling, and 4) information and communication.

Strategy, challenges and opportunities

Starting from the first stage of the innovation process, to identify the challenges, opportunities and develop consequent strategies, the primary data revealed that there is a lack of understanding of the problems that the industry faces, which is crucial in identifying the industry needs, innovation planning and to get targeted solutions from suppliers. TOC23 conveyed the same as: '*So I think selling what the industry is about, where the industry is going, and what the industry actually needs and some of that is stuff that they don't even know what it needs*'. There is a lack of customer engagement, as said by an interviewee, TOC36: '*I think it is a barrier that we don't tend to understand our customers before we go and do stuff*'. In addition: TOC18: '*there doesn't seem to be any great overall strategic plan*'. The quantitative data analysis results were found to support this view as 75% of the respondent agreed that the industry lacked a robust strategy.

The Rail Technical Strategy was found to be widely criticised as: TOC36: '*I would honestly say that the RTS at the moment is an advisory document at best. It is there, out there to try and influence what we do; I wouldn't say it governs what we do at all*'. Also: G38: '*It's the business side of things that has not fully bought into this*'. And further added: G38: '*So the biggest barrier is the lack of realisation of the business people in the industry is to realise the significant benefits that the innovation could provide if it was done properly, if it was done well*'. This lack of a business strategy to support the Rail Technical Strategy results in short-sightedness: M16: '*what's the market going to require in the next ten years*' of the industry owing to the lack of an overall strategy. Due to the fragmented structure, lack of communication and short operational periods, there is a lack of relationship development for long term strategic planning and development with suppliers.

Another barrier revealed by the primary data analysis is the lack of understanding of what is innovation. It was found that innovation is mostly interpreted as radical only: TOC22: '*and when you probe them on this you find that they are always thinking about that radical change*', resulting in loss of other innovation opportunities. The innovations that take place in the industry are mainly reactive, that is, in reaction to a problem that has occurred. Such as: TO5: '*In the larger organisations there is the idea, if it's not broken don't fix it, but that doesn't necessarily mean you don't need to improve it*'. This poor planning and management of innovation makes it very challenging to develop products in UK rail industry. An interviewee, C6 stated: '*It's probably because they know it's more challenging to do that in the rail sector to do that initial development*'.

In addition, the primary data analysis revealed that the industry is poor at communicating the innovation needs, for example: RS24: '*clients don't make clear to the innovation fraternity what their challenges are*'. Innovation is still mainly technically based: TOC29: '*Generally we are just looking at technology solutions, erm, the process changes we are looking at but we are probably not bannering it as innovation*'. Further, the lack of support to develop and implement ideas creates more barriers to innovation. The industry was found to focus most of its resources mainly on safety: C19: '*Why are we spending money on making rail safer, when if we spent that same money on making it more attractive, more innovative, more customer friendly we would save loads of lives because we would get people off the road and onto the train*'. As such: TOC23: '*understanding the resourcing needs and bringing that to fruition and making sure you have got both in place otherwise it is just ideas*'. Lastly, the need for short term business cases leads to: TOC34: '*Why would you plough money into something if you couldn't see a pay back, so that's been lost to a large extent and because everything has to have a commercial case there isn't really a great deal of R&D*'. This lack of Research and Development in turn negatively impacts innovation as: TOC18: '*time when BR had a research division and it also had a headquarters engineering division that did a lot of development and it is where a lot of this innovation stuff would be now if it were still here*'.

A descriptive analysis of the quantitative data was conducted to get a wider view of the industry on the lacking strategic factors in the innovation process. These results are presented below in Figure 4.6:

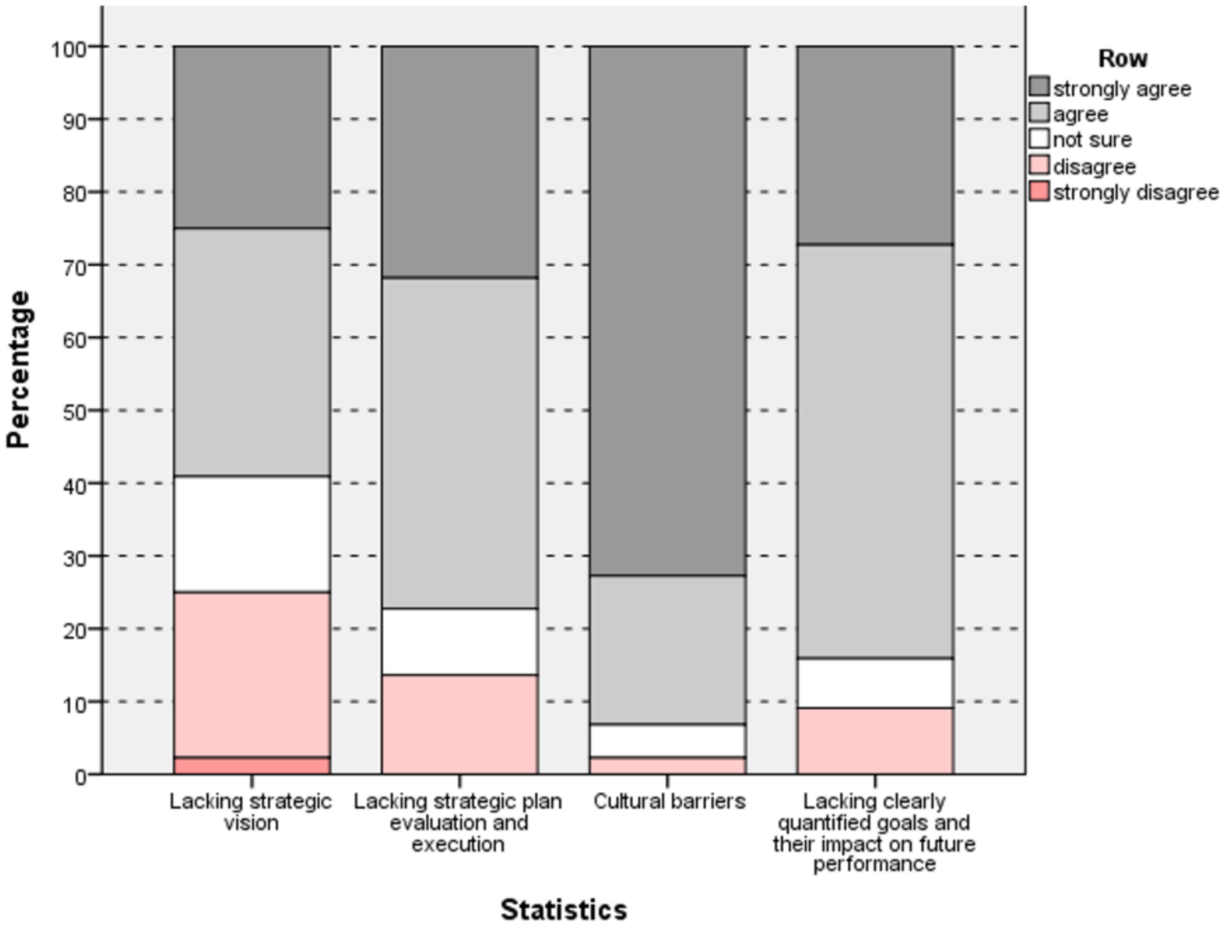


Figure 4.6 - Strategic factors and innovation

The descriptive analysis of 44 responses revealed that most of the participant agreed that cultural barriers hamper innovation. Figure 4.6 shows that there is a lack of strategic vision in the industry, but more dominantly the barriers are experienced in terms of identifying clearly quantified goals, future planning, and the execution and evaluation of the strategies developed in the UK rail industry.

Standards, processes and regulations

The second important stage of innovation is to develop it according to the industry standards and follow regulations to gain compliance. Unfortunately, the standards, regulation and processes involved in the UK rail industry are described as: TOC34: '*I think this is a really big issue in the UK Rail Industry is the constraints of these overzealous national standards and* *this overzealous approach to safety*' and TOC30: '*it is very highly regulated so that I think also is something that stifles innovation when it is too regulated and I mean if you look at the digital information screen, […] you know that technology moves very quickly*'. The process and regulations are: RS24: '*it's quite opaque and quite daunting for a supplier […]*', which results in: RS24: *'[…] if they say well its quite opaque and uncertain then guess what, the investor goes and spends his money somewhere else*'. The process mechanisms existing in the industry were described as: TOC22: '*it is just the mechanism by which we move from the current state to that future state that is where we start to introduce these excessive complexities*'. The large number of stakeholders adds further complexity in terms of the time involved in navigating through numerous processes involved, as stated by an interviewee, TOC33: '*but then being able to turn them into reality because there are lots of barriers to that in this industry. It takes an awful long time to, and can be very bureaucratic depending on the scale of what you are trying to change because we are not all custodians of the assets of Network Rail and Network Rail Infrastructure*'.

Standards can be a barrier particularly for SMEs due to the costs associated and due to the lack of SME engagement mechanisms in place. In light of the barriers arising due to culture and people (discussed in the next sub-section), the standards partially effect SMEs as: TOC35: '*to implement anything on a big scale then would be getting it through our leadership, our procurement coupled with that our legal team who whenever they are presented with a ten-page contract will turn it into a fifty-page contract. And unfortunately start-ups have no expertise or time or money to go through that, so we turn a lot of people off*'. There is also a lack of standardisation of the processes and procedures which often results in work duplication. A supporting statement provided by one of the interviewees is as following: I2: '*I think as there should be more standardisation. Because duplication of approaches is wasteful*'. The current specifications are also limiting when it comes to new innovative solutions. For example: C7: '*The existing specifications that Network Rail had just didn't cover the product*'.

The barriers related to standards, processes and procedures are widely experienced in the acceptance process of the UK rail industry. The acceptance process has received large criticism and was described by an interviewee as: I2: '*All sorts of acceptance processes of Network Rail who he says are an absolute nightmare, nobody knows what they are doing*'. The acceptance process was described as bureaucratic and lengthy which makes it difficult to bring about changes as: TOC34: '*the other thing that the sort of acceptance process does is it limits* *competition and it creates almost a monopoly situation*'. In view of the large number of stakeholders involved, the acceptance process: TOC36: '*around getting our directors to buy into things, getting our frontline to be engaged on things we want to do and then all of a sudden you have got to go and get approval from Network Rail or RSSB or ORR or ATOC or any number of other people who claim to have a holding power over it. And all of a sudden you have brick wall, after brick wall, after brick wall to overcome and you never get anything done*'.

Lastly, the procurement regulations were found to be outdated, as described by an interviewee, RS24: '*so if the specification for procurement has been written based upon the knowledge of what is possible "today", then if you have got something that is better than "today's" capability then it may not be procurable through that route*'. This impacts the overall innovative mind-set of the work force in the industry as: TOC27: '*I think the mind-set in many functions within railway companies and Network Rail is not necessarily that innovative because there are many processes and procedures that haven't changed I would actually say in generations*'.

Testing and trialling

The next stage in the innovation process is to test and trial an innovation. However, the primary data analysis shows that there are barriers in terms of testing and trialling particularly in the intermediate stages of taking innovation from lab to track, as an interviewee, M8 said: '*But in general taking it from that laboratory stage to final product approvals requires some kind of intermediate test and that particularly within rail can be quite hard*'. The testing facilities have not been found as sufficient to meet all the testing demands of the industry. This might be in terms of the lack of capabilities of the testing facilities such as the tests and equipment they offer, and/or their availability. An interviewee, I2, described one of the largest testing sites in UK as: '*I have to say I think Long Marston was a bit of what is the word, bit amateurish*'. The information on the types of testing facilities in the UK and their availability is also not widely known. The primary data analysis conveys a need for a centralised test facility and/or a realistic test lab which enables innovators to test and plan ahead for the future. An interviewee, I2, highlighted this by saying: '*I am surprised that I haven't come across within the rail industry the same degree of testing facilities that there are associated with Defence and Aerospace. And bearing in mind that rail industry is going for 200 years and Defence and aerospace certainly 100 years old*'. This could enable pilot testing which can eliminate issues in the initial stages of the innovation process, thus saving time and money. For example: G38: '*You also need if you like a realistic laboratory [...] so a place where you can try out your ideas and your technologies in an easy and innovative and positive risk free environment*'. This proves to be a problem particularly for SME as the waiting times for the testing facilities: M25: '*It is privately run, so to get in there you have to pay and you have had to wait a long time for a slot*', and costs of testing can be prohibitive: C7: '*But I mean it could be prohibitive. There was a lot of test work involved in it*'. Similarly, for trialling an innovation, there is little room left for it as the capacity of the network is full. One is thus: M8: '*you're relying on the goodwill of the customer to give you that live rail'.*

Another barrier in terms of testing and trialling is the lack of faith in test results. The primary data suggests that there is very little faith in simulations and virtual testing which can be cost effective and provides wider range of testing in short durations of time. For example, an interviewee, I2 said: '*I think there should be more acceptance and realisation of the model simulation process*' and '*I think it's [not doing virtual testing] a barrier because you get bogged down in doing nugatory work. Where some of that activity will be far best spent doing other things. And to be fair, testing and trialling is a very expensive process*'. Test results from other environments and test facilities outside UK are also not widely accepted which results in test duplication and lack of exploitation of current available innovations. One of the examples given by an interviewee C19, to explain this is as follows: '*So basically if we provide the test certificate with our ION17050 stamp on in the Netherlands no more testing is needed. If we give the same thing to Network Rail they still have to do their tests on it*'.

An alternative aspect captured in testing and trialling is from the acceptance body's point of view who regard testing and trialling as a barrier because: IO31: '*a lot of the time the provision of evidence back from the applicants is usually what is holding up the process. You know if they come to the table with everything that is required it didn't take the engineer as long to you know go through it and approve but it would if he keeps having to go backwards and forwards*'. However, it should be noted that accepting bodies only get involved at higher TRL levels, that is, TRL7 onwards. This creates further barriers for the innovator as there is a lack of engagement, feedback and guidance to develop the product to industry requirements. Lastly, there is a lack of commitment from the customer: C7: '*and the response is we would prefer not to give you any suggestion or feedback on that because we can't commit to anything there. We are unable to help there*', and having to develop a product to TRL7 without any support and guidance is particularly expensive and very difficult for SMEs. The following statement recorded gives an example for this as: RS24: '*So if I illustrate by example, if the innovator has got a great idea for a sub system on a train and the procurement is for the whole train then what then happens is clearly the innovator in this or an SME can't tender for the whole train so they have to start a lot further up the food chain much earlier working with the vehicle/the train builders in order to get their innovation adopted*'.

A quantitative data analysis was conducted to explore the barriers in testing and trialling amongst the wider industry. The results of the analysis are presented below in Figure 4.7:

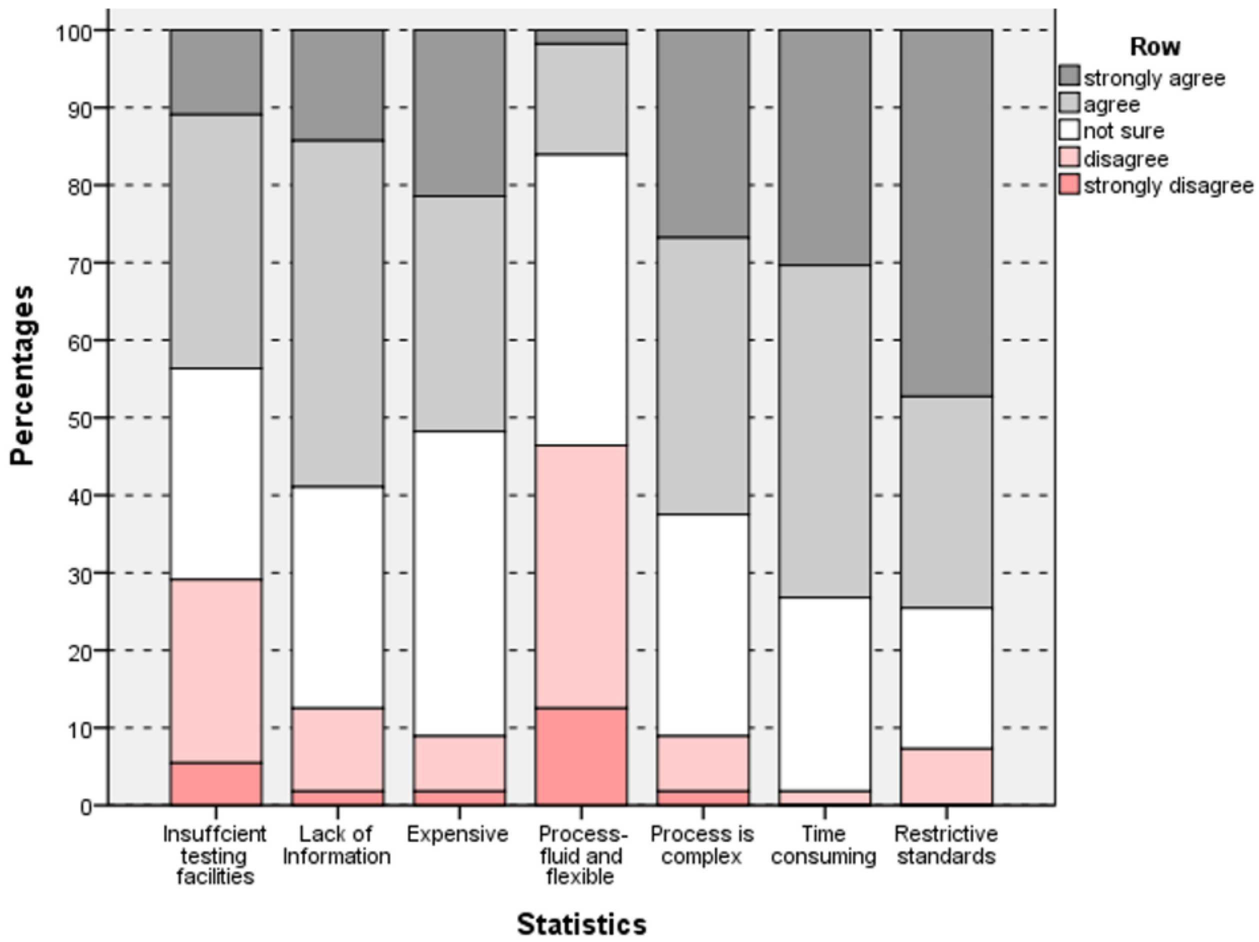


Figure 4.7 - Testing and trialling and innovation

First look at the quantitative data analysis of 56 responses in Figure 4.7, shows a lot of white bars which represent the responses marked as 'not sure'. This can reveal two things: 1) the respondents did not have enough knowledge about the testing and trialling process, and 2) respondents did not have enough knowledge to comment on the testing and trialling in the UK rail industry as a barrier to innovation because: a) if the respondents were innovators, the results show that they have not reached the testing and trialling stages in their innovation development and/or do not have enough information about this key stage of innovation development, and b) if the respondents were not innovators rather industry experts, then being involved in the innovation process requires enough knowledge about all the stages of innovation development which the results found were lacking.

The dominant results presented in Figure 4.7 show that standards are widely agreed to be barriers to innovation, and the testing and trialling process is found to be time consuming, complex and not fluid and flexible. Respondents significantly were recorded to agree that there was insufficient information available regarding the testing facilities and the tests and equipment they offer.

Information and communication

In addition to the above mentioned barriers, the primary data analysis revealed that the innovation process in the UK rail industry is very disjointed from its end users, for example an interviewee, C19 said: '*So the process issue it is about having a process that joins the customer's needs with what is available*'. The analysis also revealed that the full potential of innovation is not being fully exploited. This was expressed in two perspectives: 1) the tested and approved innovations are not being used: M8: '*you could have the world's best products and its fully approved and everyone is available to buy […] but if they don't buy it there is no point in doing it and then it's all about the exploitation and they could be blockers to exploitation*' and 2) the scale at which the innovations that get into the system are used: G38: '*so the real potential is selling a million of these items a year. A lot of companies are content at selling say a hundred, so the full value of innovation is not therefore seen*'. There is a barrier to low impact innovations also, which do not have a large scale business case: RS24: '*but because its impact on the whole railway system is not big enough nobody is going to spend a lot of time championing it*'. These low returns were found to deincentivise and to not push the industry to innovate.

Innovation in the UK rail industry faces few other barriers in area of information and communication. These have been detailed as follows:

The primary data suggested that there is a lack of information in various areas of the innovation process. To begin with, there is a lack of data on product performance. This includes performance data of already existing systems and components, which the new technology is trying to interact with. Collecting such background information before testing and trialling adds costs and time to the innovation process, especially of the SME. For example, an interviewee, C7 said: '*We don't have masses and masses of data on that. So a lot of data we have to extract, expedite and conduct tests to understand the performance of the material. And therefore some of the costing data has to be expedited as well. We don't have actually data to say this is how much it will cost*'. Due to the lack of relevant information, the innovators also struggle with finding the right contact in the industry. Such as: TOC18: '*they always complain that they can't break into the market, or they can't find the right person to talk too. It's nearly always unfortunately going to be train operator that they need to speak too, and as train operators they are nearly always the people who are the least resourced to deal with it*'. There is a lack of knowledge capturing practises in order to feed it back into the system. As such the industry was characterised as: TOC26: '*we are quite data rich in the industry but we are a bit information poor, so we are not integrating it and we are not using it and I think there is a real opportunity for innovation to help us*'. However, one of the barriers recorded to information sharing was IP issues as an interviewee, M16 said: '*but it is a lot of effort to get it resolved and a lot of cost with lawyers*'. Also the primary data analysis suggested that the demand for innovation was not clear in the industry, for example an interviewee, M8 said: '*no one will build anything till there is a demand that no one will give you any demand until you prove you have got a product*'.

On the communication front, the primary data revealed that in the innovation process there is a disconnect with the customer, for example: C19: '*That organisation is three or four stages detached from the users of the trains, so the innovation that it comes up with are almost certainly not going to be aimed making the rail experience better which should be the end result*'. It was found that there is poor communication within the industry organisation as well since an interviewee, M16 suggested the following: '*allows us to put relationships in place where we can be more strategic and more open about what we are doing for the future, so that helps us then allow more long term planning, it gives the supplier more visibility so they can do longer term planning as well so that they can be more stable in the work*'. The poor communication also results in work duplication as the work done by various organisational groups is not well communicated and this leads to re-doing what has already been done before. From the SMEs perspective, it was recorded that there were communicational gaps from the industry side to guide and provide feedback to the SMEs on innovation development.

Lastly, few other barriers such as, low returns, slow developments, inability to successfully adopt innovations from outside industry, old rolling stock which hampers development and product performance, were less widely recorded across the primary data. Overall the data suggested that there as great need for communicating good innovations and to recognise the power of the end user. Another suggestion made by an interviewee, C6 was to consider the performance of an innovation as a part of the wider system and '*if the industry allowed you to apply some pragmatism it would so much easier to get those products launched and pushed through*'.

The qualitative data analysis was used to explore few other potential barriers to innovation as presented in Figure 4.8 below:

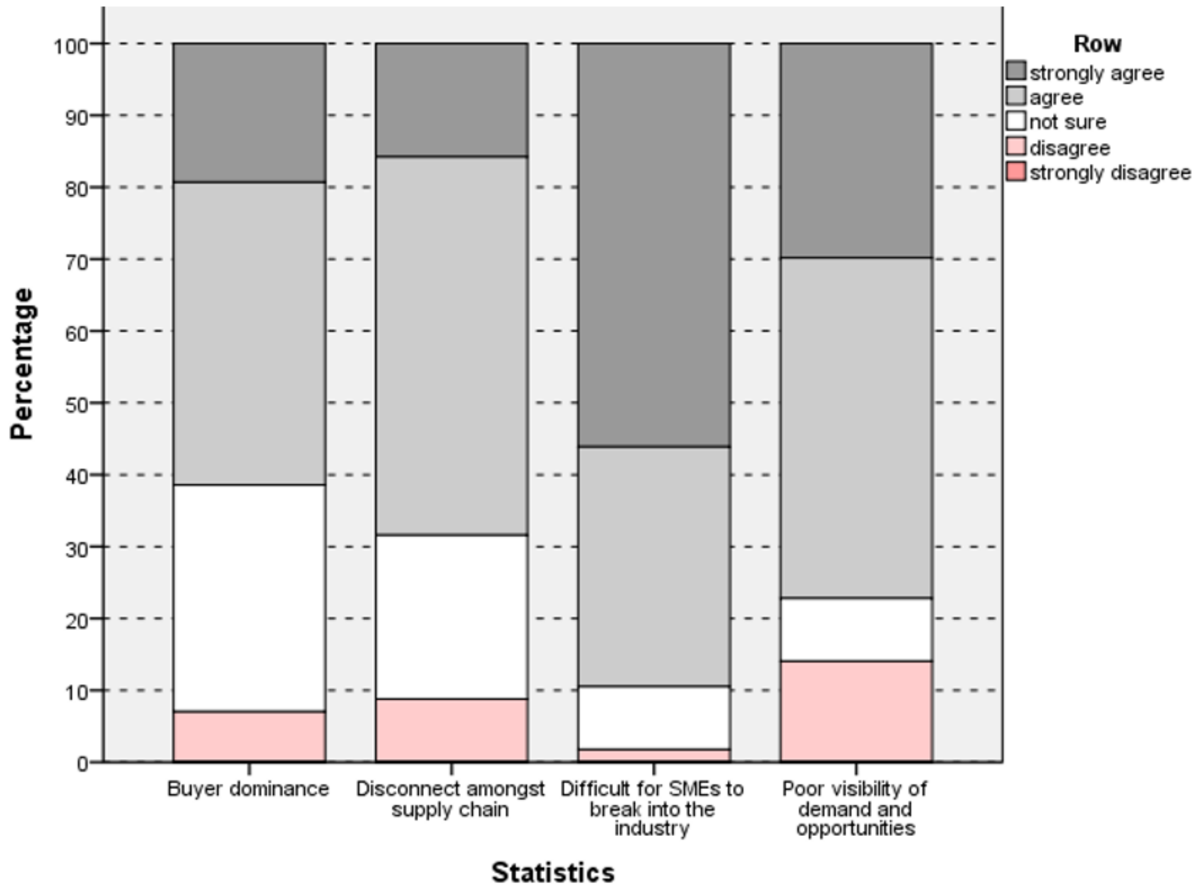


Figure 4.8 - Addition barriers to innovation process

Figure 4.8 presents additional barriers to innovation experienced in the industry as perceived by 57 responses. Starting from the left, some of the respondents were not sure of buyer dominance being a barrier to innovation, however majority agreed. This was reflected in the qualitative data where only the senior management recognised and were able to comment on the market barriers. The respondents widely agreed that it was difficult for SMEs to break into the industry and that there was poor visibility of demand in the industry. Significant percentage of respondents agreed that there is disconnect between the elements of the supply chain.

Conclusion

In conclusion, the innovation process in the UK rail industry was found to witness numerous barriers at each stage of formulating strategy and recognising the challenges and opportunities (I), gaining compliance (II) through testing and trialling (III), in view of the available information and communication regarding innovation (IV). The conceptual model presented in Figure 4.9 shows the complex nature of the innovation process in terms of the barriers experienced at various stages. From the finding of this section, it can be concluded that the innovation process in UK rail industry is not strategically managed, it falls short on the processes and procedures to gain compliance in view of the not always fit for purpose specifications and complex acceptance process, with additional barriers arising from the testing and trialling scenario, fuelled by lack of communication and required information. Innovation is often wrongly seen as a result of a linear process (Brunori *et al.*, 2009). Figure 4.9 suggests the non-linearity of the innovation process by revealing the common barriers between the 4 stages, thus, suggesting the interdependencies among the classified 4 stages of the innovation process.

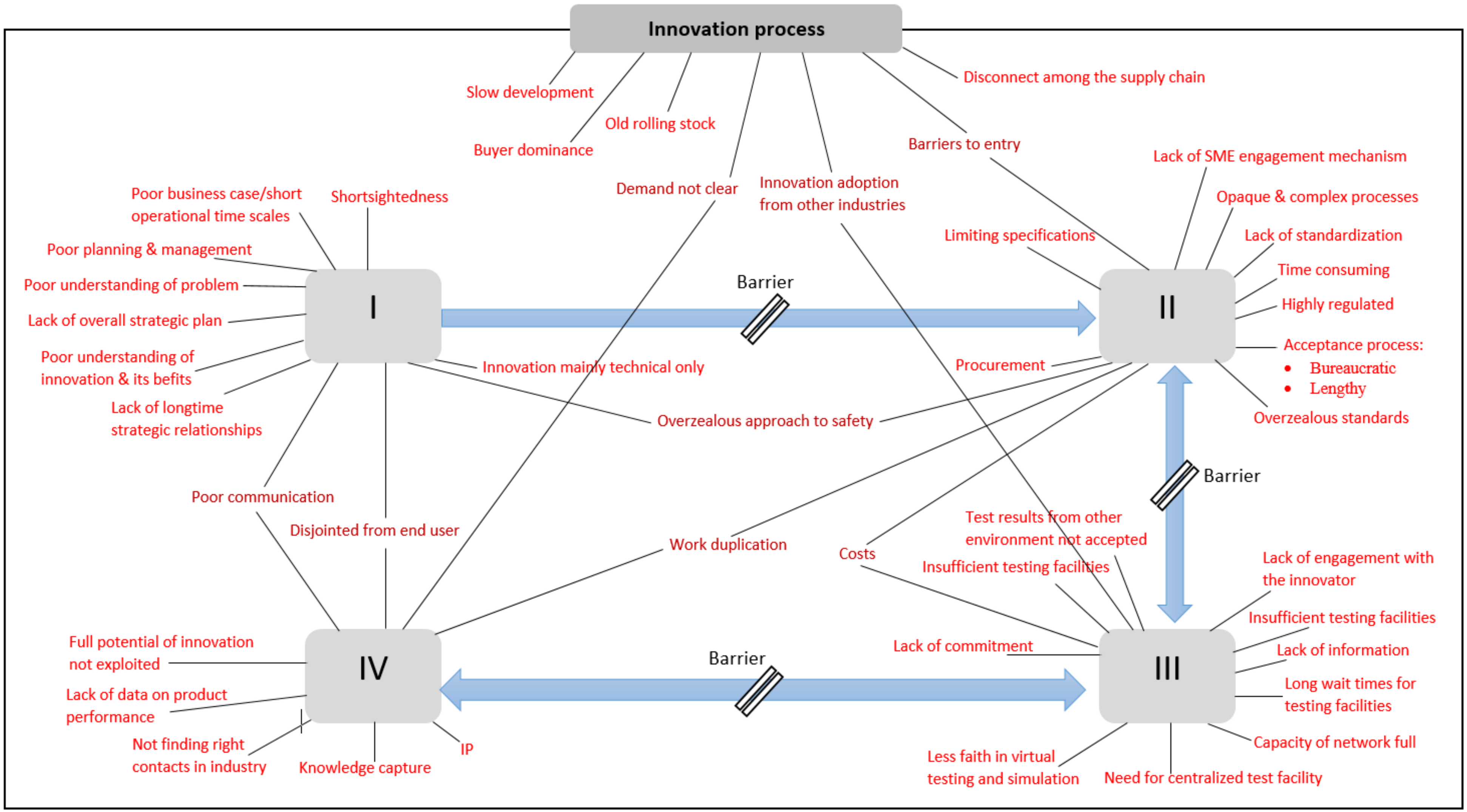


Figure 4.9- Conceptual model of barriers in the innovation process

4.2.2.3 Franchising in TOC

The third barrier to innovation as revealed by the primary data analysis was the franchising in the Train Operating Companies. The quantitative data analysis also revealed that approximately 75% of the participants agreed to franchising system being a barrier to innovation. The reasons for franchising not supporting innovation are further discussed in detail in the following sections:

TOCs have not traditionally been the innovating bodies of the UK rail industry, and still are in their embryonic stages, which implies, as stated by TOC34: 'w*e are not ready, we are not innovators you know we have got a lot to learn and a lot to do beneath the surface before we can even think about the types of project that too suddenly switch, to change*'. The innovation capabilities of the TOC have been defined by G38 as: '*[…] train operating company innovation capability is fairly embryonic, it is not terribly extensive and it needs to be encouraged and developed*' and TOC26: '*because we haven't done this and we have never really done this in the way that now we are being asked to do this you know we are a bit immature*'. It seems that there are bigger innovation expectations from TOC that have described themselves as resource (time, people and money) limited organisations. Following are few supporting statements that highlight the helplessness of the TOC as recorded in primary data collection: TOC18: '*but really to ask the train operating companies to deal with innovation on the scale that they need to[…] they haven't got the resource and they haven't got the time*', TOC18: '*The biggest barrier is time because there are only so few of us, I mean my engineering team consists of me and about five others and we just don't have the resources within the business to plan, execute, design, whatever innovation schemes without having to buy in lots of external third party resource*' and TOC26: '*you know we haven't got the money or the influence to change the way some industry decisions have been made either through RDG or ATOC or Network Rail*'.

In a study on the local government in UK, Munro (2015) in his research has defined few key enablers of innovation, which include prioritising action, agreeing on a clear strategy, communicating it across the organisation, fostering a culture of innovation within an organisation, dedicate sufficient resources, and collaboration among councils on major innovations (Munro, 2015). However, the franchising structure in the UK rail industry has been found to lack these enablers. The below section presents the barriers to innovation in the TOC franchising system in two sections. The first section gives an account of the barriers witnessed in the process of winning a franchise – stage I, followed by the second section which gives an account of the barriers witnessed during the length of the franchise period – stage II.

Stage I barriers, winning a franchise – biding and contracts

In the franchising system, the first stage is that of biding and winning the franchising contract. The biding process is a barrier as it is defined as, TOC22: '*some of the franchises are still very tightly specified […] you can specify purely outputs, passenger service requirements and leave people entirely free to make decisions that they want to achieve that […] but you still have a very bad contract*', however that is slowly changing. The biding process has been described as condensed and not giving enough time to thoroughly plan and identify innovation needs to include in the bid. The primary data analysis suggests that in case a never tried before innovation is included in the bid, TOCs get penalised in terms of the risk adjustment returns, and risk losing to other TOCs with low risk innovations. This in light of the short franchising periods, TOC primarily concentrate on short term return innovations to make better business cases. This further disincentivises TOC as there is not much need to innovate as long as the contractual terms are being fulfilled. As stated by interviewee M25: '*[…] this is the passenger satisfaction that you have to meet as part of your franchise. Once they are meeting that level there is no incentive to push it further really, that is the problem*'. Another feature of the franchising contracts found to form a barrier to innovation is the: TOC34: '*rigid contracts because that is again one of the constraints…you are going to deliver your contract. So where else are you going to find the resource or the time to do anything else?*' The primary data analysis also recorded that the franchising model, as stated by interviewee M25: '*does not create competition, effective competition and wherever you get a monopoly or a lack of competition you do not get innovation, innovation doesn't happen, fact!*'

Stage II barriers – barriers rising along the length of the franchise period

After winning a franchise, the initial barriers to innovation are created by the short franchising lengths which are often five-seven years. It creates barriers as: TOC30: '*if you think about it the licence to provide the service is only for a few years. So the vision if you have a franchise for four years, there is only so much you can do in four years*', TOC27: '*I think they are quite short franchises which affects business case […] where you have only let's say a three or four-year payback on a scheme*'. The short franchising periods thus, provide less incentives for the TOC to innovate, e.g.: M4: '*Am not going for 20 years I am not interested in* *forward view. 5 years I have hit my targets I am out of here'*. Innovations generally take time to mature and to pay return and the short franchising periods makes it difficult to keep innovating throughout that stage. As such most of the innovations are delivered in the first few years of the franchising period as after that it becomes very difficult to build profitable business cases. TOCs are not incentivised to develop large scale innovation with possibly a longer pay back term and such proposals were also found to be not rewarded in terms of winning a franchise. These concerns have been stated interviewee TOC26 as: '*How do you then have the capacity to as an owning group even consider that there is still sort of sufficient margin to justify lots of R&D?*' and '*So being able to, it is hard to make the payback on massive items when you have only got another three years left, so longer franchises allow big investment*'. Owing to the short franchising periods and the nature of the franchising contracts, operational requirements always take precedence and consume most of the resources of a TOC, leaving very little to invest in innovation. There is very little room for innovation and keeping service running is already very challenging. As TOC26 stated: '*So we are a 24/7, we deliver trains and we rarely are not running trains so if anything is an innovation that is about improving the customer offer or for improving our service how do we test that in a way that we can be confident. We can't afford to put an innovation in and service fall flat on its face, so that is a bit of a challenge in this environment*'. This results in very little Research and Development as: TOC30: '*they don't do any R&D, they buy everything off the shelf from the supplier and that's it*'.

The lack of resources and power further hampers innovation as to bring about any change a case has to be built for the partners, which considering the complex structure of the industry and monopoly situation existing in the industry (as detailed out in the previous sub-section) complicates the process and makes it very time consuming. As conveyed by an interviewee TOC33:' *It's the same with trying to make any changes to the fleet, there are some very long lead times to be able to change or come up with new ideas because they have got to go through an engineering change process which can be quite long*'.

Another barrier to innovation created in the franchising system is the lack of collaboration among the TOCs because of cultural issues of not having done that before and due to confidentiality issues and also because each one of them operate at different timescales. So TOC26: '*we are all on different times is you find that again that can be a barrier to collaboration, because if you have only got twelve or twenty-four months left on your franchise* *you have very little incentive at all to be getting involved*'. The confidentiality comes from the sense of competition among the TOC. However, it is found that there is sense of false competition. The franchising structure does not create real competition as the TOC operate in different environments with different customers. This competition is also misplaced as there is lack of understanding of what actually substitutes for competition. Such as: TOC22: '*because is the engineering solution really going to be the thing that makes you win or lose a bid in a franchise, we think probably not [...] generally speaking we are better off sharing what we know and enjoying what other people know as well'.* TOCs companies tend to compete for technology which in the case of franchising framework does not serve as an advantage, (owing to short-term pay back periods, lack of collaboration, more focus on operational side). However, the implementation and use of knowledge, data, etc. can be a competitive factor. It can be more benefiting to collaborate in this case for example, than to work in silos and not share vital information that can benefit the whole industry, as: TOC27: '*[...] because we see that to be kind of confidential information but it is also bloody useful information to inform people*'.

A quantitative data analysis was conducted to find more about the effects of franchising on innovation in the UK rail industry. Figure 4.10 below presents the results of descriptive analysis of the quantitative data:

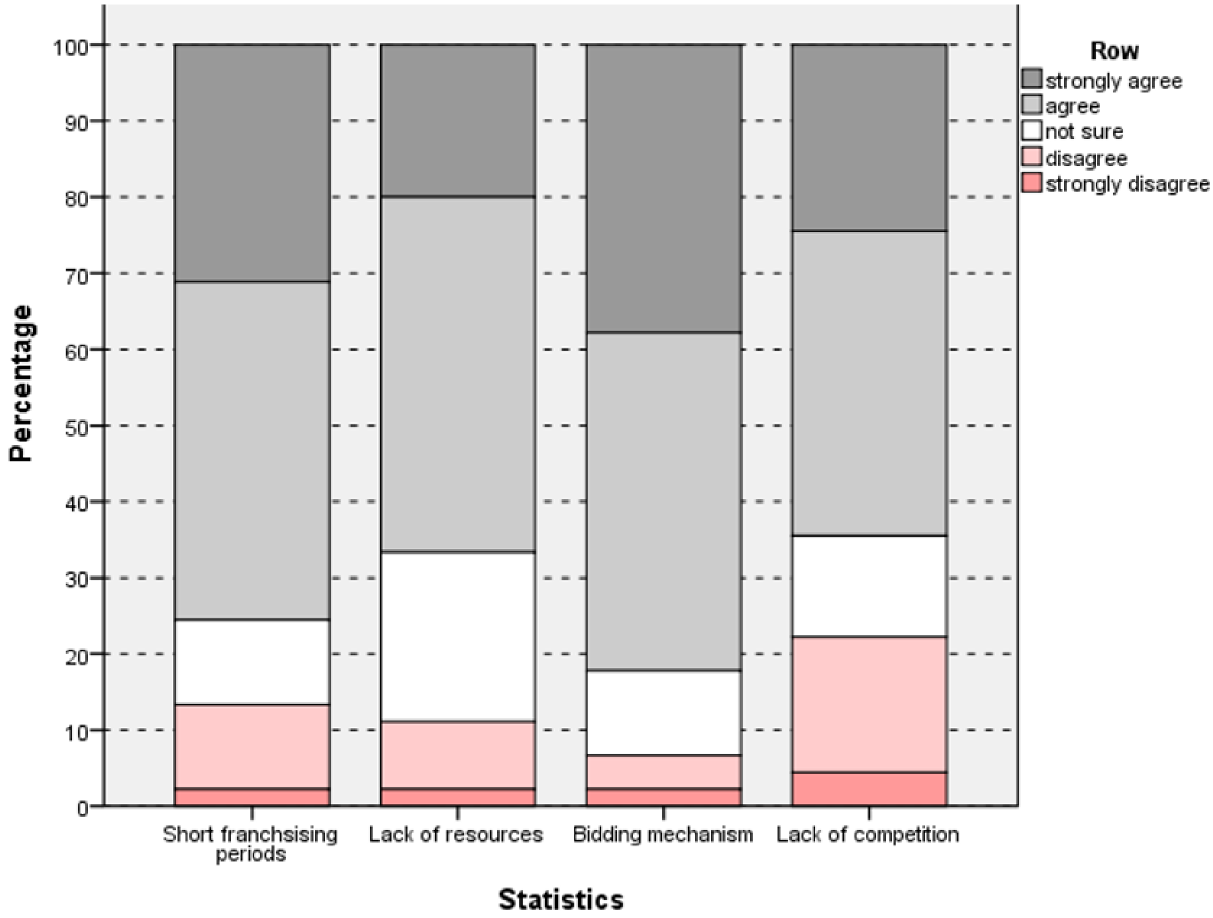


Figure 4.10 - Barriers due to franchising

The descriptive analysis of 45 responses revealed that majority of the survey respondents agreed to the various elements of the franchising system as identified in the qualitative data that form barriers to innovation. Biding mechanisms was found to be the dominant barrier, followed by the short franchising periods. 65% of the respondents agreed to the lack of resources of the TOC to be a barrier to innovation in the franchising model. Among the 35% that did not agree, majority of the respondents did not have sufficient experience or knowledge (response: not sure) to pick a side. The most disagreed barrier was the lack of competition with a disagreement percentage of 22-23% only, with the majority of 65% recorded in agreement.

Conclusion

In conclusion, the current franchising system in TOC was found to not support innovation in terms of the bidding mechanism and over the length of the franchise. The primary data revealed that overall the TOC are ill equipped to carry out innovations in terms of their capabilities, resources and culture. Figure 4.11 below presents a conceptual model of the barriers identified by the primary data analysis, arising in the franchising system of TOC.

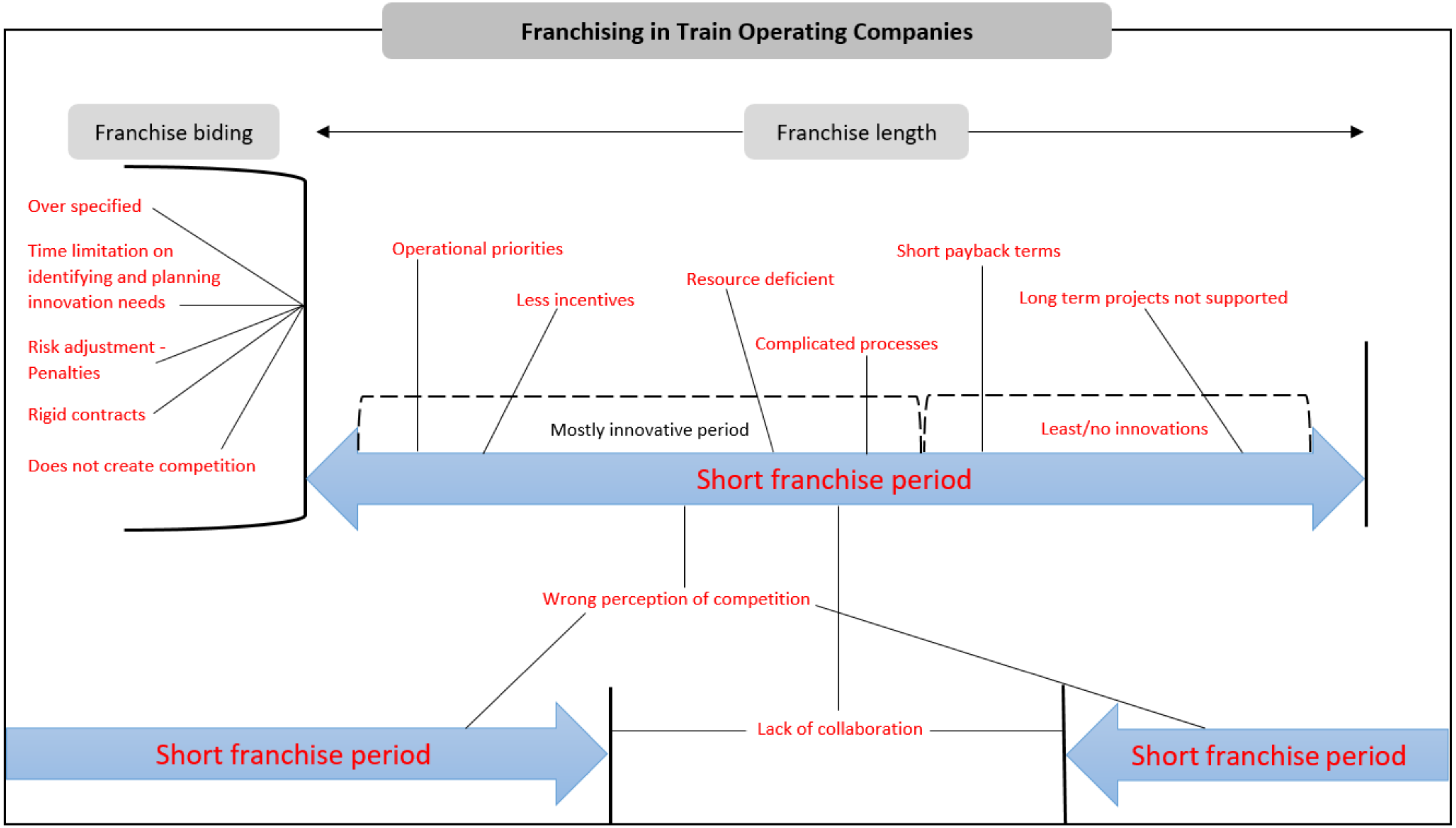


Figure 4.11 - Conceptual model of the barriers to innovation in the franchising system of TOC

4.2.2.4 *Culture and people*

A key contributor to innovation are the people and the organisational/industry culture. Integration and leadership are the mechanisms that can overcome the innovation barriers of resistance to change and lack of experience in advanced products (Beliz Ozorhon *et al.*, 2014). Organisational culture and team management have a significant impact on the success of a project (Patanakul & Aronson, 2012). The strong devotion and leadership of the senior management can result in the resources and employees being well organised creating a platform to share and implement new ideas. (Beliz Ozorhon *et al.*, 2014), thus, forming an innovation favourable environment (Aronson *et al.*, 2008).

Given the significance of the role played by the culture and people of an organisation in the innovation process, its implications were broadly analysed in the primary data. On analysing the primary data, it brought to light certain barriers arising in terms of culture and people that hinder innovation. These have been discussed in the following sections:

Cultural barriers

The primary data analysis found that the UK rail industry faces various cultural barriers that hinder innovation. In describing its attitude towards innovation, the industry has been extensively characterised as: C19: '*the rail industry is a very conservative industry, it is also a very old industry so there is they have a lot of cultural barriers not invented here, we tried that it didn't work'*. The industry has been described as being paralysed by: TOC36: '*it is fascinating when you go round the business and you ask "why do we do something that way" and the answer is very frequently "we have always done if this way*' and as such mostly adhering to how it's been done before makes the industry a very risk-averse industry. This '*we have always done this way*' culture presents a barrier to innovation as it eliminates the probability of entertaining a new idea, and taking risks to develop it and accepting that failures are a part of the process of innovation. Over all the industry was found to have: G38: '*very low appetite for risk*'. The failures of the past and the media coverage it received: M4: '*historically that comes from a number of historic incidents*', has significantly contributed in this risk-averse character adopted by the industry. Overly cautious decisions are made to not repeat the mistakes of the past. As mentioned by an interviewee, G38: '*unfortunately there have been many examples of introducing new technology too soon, when it hasn't been suitably de-risked which has reinforced this poor culture*'. As such, the industry has taken up an overzealous attitude towards safety and developed a risk averse culture which only improves upon the successes of the past and does not provide room for failure and to innovate.

Due to the massive shift towards innovation and the speed of change, the industry struggles to cope with the pace as mentioned by an interviewee, TOC27: '*That speed of change is just not something that we in the rail industry have had to face*'. This safety critical and risk averse culture then adds time and costs to the innovation as: G38: '*anything new needs to be very clearly demonstrated to work before a bidder will make it a major plank of their bid in a franchise*' and TOC27: '*it does add time into processes and resources into process in order to go through that thorough process*'.

In addition, cultural barriers have also been recorded in terms of adapting technologies developed in other sectors: C19: '*so there is they have a lot of cultural barriers - not invented here*' and TOC27: '*are very negative in people have traditionally had quite closed minds to if it's not invented here*'. Apart from the bigger/specific innovation projects, the industry workforce was found to: TOC34: '*as I said people just aren't used to thinking in that space*'. An outcome of this is work duplication: TOC22: '*because culturally we like to solve things themselves and they don't like to admit that other people have done things better*'. Lastly, this cultural arrogance results in: TOC22: '*a culture which fails to bring all of the workforce in to an innovative environment*'.

A quantitative data analysis was conducted to gather a wider industry view of the present innovation culture. The result of the analysis are resented below in Figure 4.12:

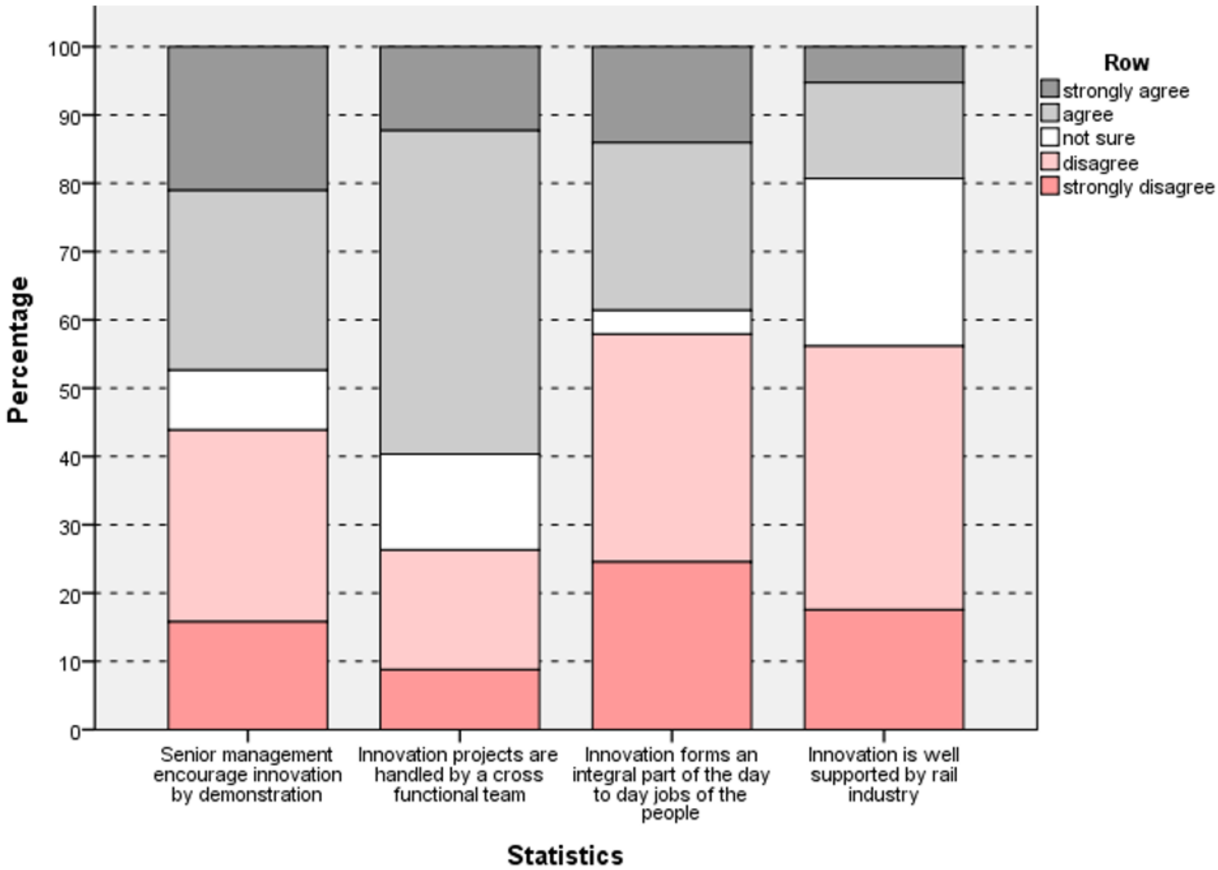


Figure 4.12 - Culture and innovation

Figure 4.12 analysing the obtained 57 responses reveals that innovation is not widely supported by the industry. It also suggests that innovation is not integrated in day to day jobs among organisations, which as supported by the qualitative data reveals that only technical and mostly radical innovations are considered as innovations. There is less emphasis on process innovation and on building an organisational culture of innovation by promoting innovative thinking/ways in daily jobs. However, the analysis also reveals a positive enabler of innovation, that is, innovation is handled by a cross-functional team, which means the innovation teams utilise multiple expertise and views, and thrive on creativity.

People as a barrier

This safety critical culture is so deeply engraved in UK rail industry that it has become an automatic reaction to innovation proposals, without fully considering the benefit of innovation. This forms one of the biggest barriers as the leadership: G38: '*The ones that can save costs or can increase revenue of their companies on the whole they don't appreciate and realise the value of innovation or innovations*'. Under the shadow of various additional factors such as media, fragmented structure of the industry, and the franchising durations, the directors were recorded to be unwilling to take risks and commit, especially when returns on investments could not be proven due to limited operational time frames. For example, an interviewee TOC36 said: '*If you have been a safe pair of hands for twenty years you can become a director, and that goes completely against innovation which has to be a bit more risk taking and experimental*'. With the directors deciding down to the very granular levels without giving the staff the freedom to find and apply innovative ideas and solutions, gives rise to the TOC36: '*what is in there for me*' attitude and inhibits the development of an overall organisational culture of innovation.

Similarly, the middle management is also found to act as a barrier to innovation as: TOC36: '*The middle management who have always done their job in a certain way for ten, fifteen, twenty years […] can't understand how to change to and are not bought into innovation at all*'. Also the leadership in Train Operating Companies: TOC36: '*are a barrier through lack of understanding of what innovation is and lack of willingness to make it work*'.

Overall, the workforce of the UK rail industry has been described as: TOC27: '*aren't used to applying innovation in their jobs or been as receptive to change as they might be in other sectors which are more dynamic*'. The primary data analysis reveal that the diversity profile of the work force is very low as: TOC22: '*the majority workforce statistically tends to be late/middle aged white men*'. This raises issues of skill replenishment as most of the current work force was found to be retiring in the next ten years and TOC22: '*I think people who have been around in particular in one industry for a long time they think they have seen everything before and they might have seen an idea before but not in the same circumstances. So what didn't work in 1975 would work well in 2016*'. So even though one may assume from this statement that the rail industry is rich in expertise, the primary data analysis suggests that there is an overall lack of expertise in terms of new technology. The industry is found to need: TOC30: '*surely bringing people from different industry into the railway can only be a good* *thing because you know people have done the same thing for thirty years and they have never seen anything differently and they just don't know how things are done elsewhere*'. This lack of diversity and skills makes the UK rail industry unattractive to fresh talent as it is directly linked to the wages of the employee, as explained by an interviewee, TOC30: '*skills are the requirements for salary and skills are not as high as in very leading edge technology in the industry so like IT and Telecoms and other industry to some it is an impact on innovation I will say*'. This also results in huge amounts of consultation to bring about change which stifles and slows down innovation. As stated by an interviewee, TOC22: '*the railway industry is the most consistently criticised for being slow to take advantage of opportunities [...] they have great difficulty in persuading people and mobilising people to get things done that we miss competitions*'.

Lastly, a less widely mentioned barrier in terms of the human factors are the trade unions as: TOC23: '*Innovation is change and the unions don't react particularly well to change*'. The role trade unions have been described as: TOC34: '*they don't want to work with you, they don't want to move forward – all they are interested in, is they are getting more money for their members doing as little as possible, reducing hours, maximising benefits*'.

Conclusion

In conclusion, the UK rail industry was found to face significant barriers to innovation due to the culture and people. Culturally, the dominant barriers were found in terms of the conservative nature and the overzealous attitude towards safety. The conceptual model of the barriers to innovation due to culture and people presented in Figure 4.13 clearly concludes that the culture has a dominant influence on the people. As the culture barriers were found to lead to negative interpretation of innovation as displayed by the leaders and managers. In addition, innovation was not found to be a part of the day to day jobs of the workforce, thus, hampering the development of an organisational culture of innovation.

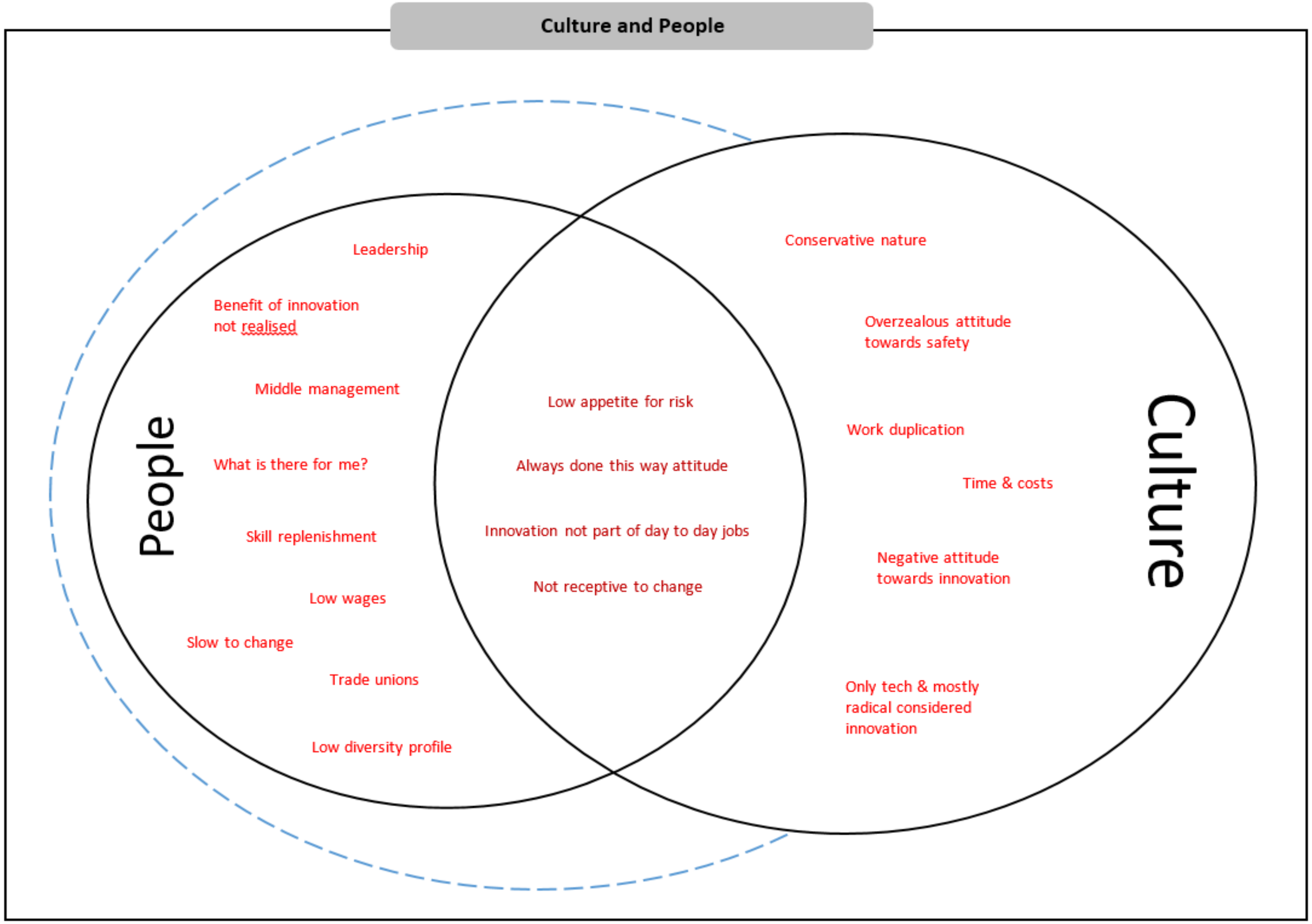


Figure 4.13 - Conceptual model of barriers to innovation due to culture and people

4.2.2.5 Funding

Funding can be described as a fuel for innovation. Being a key resources in the innovation process, funding provides the potential to test ideas, mitigate failures and equips the firm with confidence to take risks. As discussed in the literature section **Error! Reference source not found.**, the presence of a resource is not sufficient. It requires effective management via its capabilities to gain competitive advantage. As such the presence of funding is not sufficient. Like any other resources, its timing, diffusion and utilisation are key factors in determining the success of an investment.

The UK rail industry faces certain barriers in terms of the funding and the funding mechanisms. The following sections give a detailed account of these barriers as derived from the primary data analysis.

Firstly, it is found that there is an overall lack of funding in the rail industry. The same as been conveyed by an interviewee, G38 as: '*it is at least three times lower than the average, and the railway is quite a technical sector so you would expect it to be above average rather than three times below average and also it is much lower than the investment levels of other countries*'. As such: RS24: '*there is very little R&D and innovation funding*'. This restrains the innovator as, RS24: '*because to have people you need money and that is a bit thin on the ground compared to other sectors*'. This also restrains the industry from taking risks and caps the ambition of the innovation. Funding is also associated with cultural barriers as: TOC22: '*what we are not very good at, at the moment is finding funding from external sources, the Toc'16 it just hasn't been our culture*'

Another barrier with regards to funding is the lack of knowledge of the available options. The following statements are an example of this: C7: '*we haven't looked at any and again that's probably because we weren't either aware of them or weren't sure how to go about them*' and C19: 't*hat is the hurdle that we have always got to cross is this issue of how you actually kick start, how you find the investment funds*'.

A descriptive quantitative data analysis was also conducted to further gather knowledge about the funding scenario in the UK rail industry and how it was perceived. This is presented below in Figure 4.14:

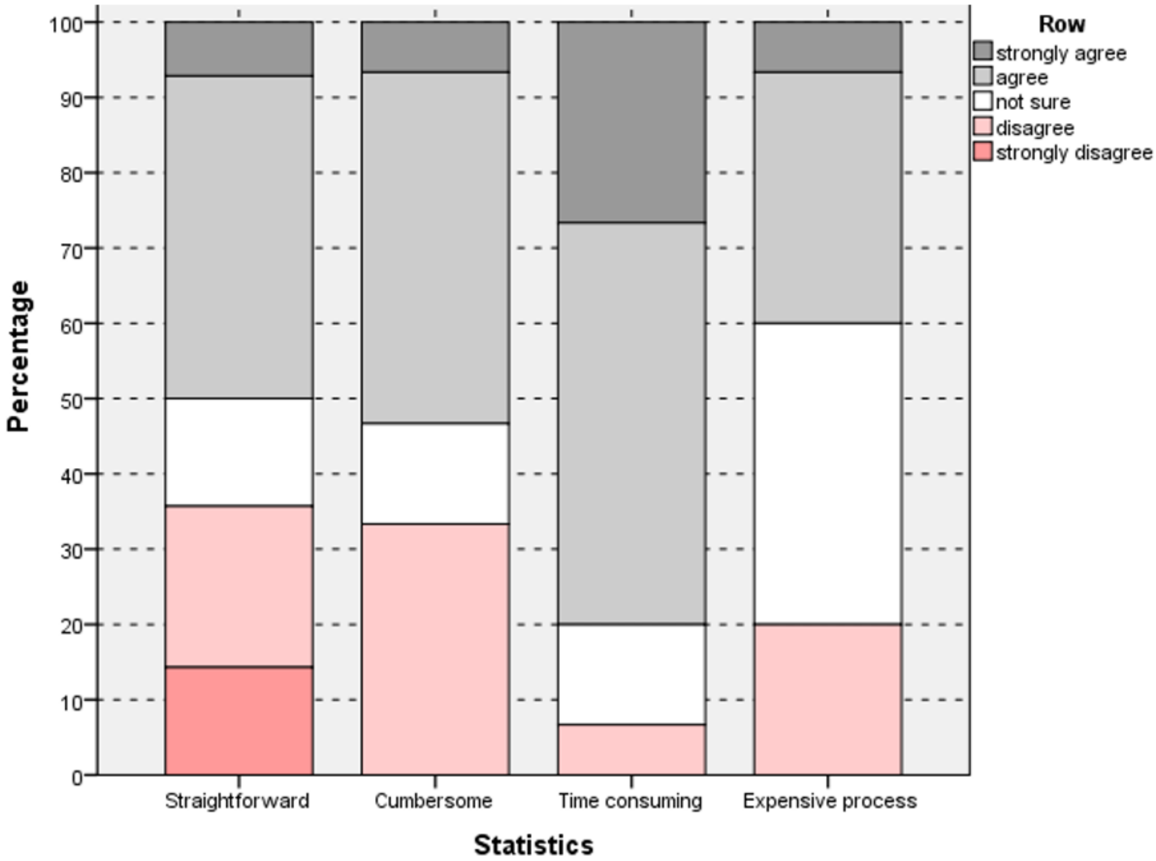


Figure 4.14 - Funding characteristics

Figure 4.14 shows the responses of 14 participants, that the funding processes are found to be very time consuming and a split is recorded in whether the process is straightforward or cumbersome. Again, the issue with the sample could be the inability to monitor the experience of the participants with the funding process, as was taken into consideration while targeting industry experts for the collection of qualitative data.

Funding is particularly a problem with SMEs, as in addition to the lack of knowledge of the options available, the SMEs lack expertise to manage/successfully complete funding applications. As such, many innovators find the process of obtaining the funding very daunting and risk losing various finding opportunities. The helplessness of the SMEs is demonstrated in the following statement made by an interviewee C6: '*It hand strings you immediately and smaller organisations such as how we operate we can't afford the funding*'.

Another perspective captured in the primary data analysis are the barriers: C19: '*there is enough money but it is wasted*', rising due to the funding mechanisms in the industry. The funding systems: TOC26: '*I think also some of the funding situation is a barrier. So you know the time taken to decide and secure funding for a given project*', slows down the innovation process. Second perspective captured by the primary data analysis is the timing of funding. The funding timing in TOC is not considered beneficial as the TOCs are not yet ready for innovation. At a time when the TOCs are busy trying to overcome their cultural barriers, and keep the service running, investing in innovation can be very challenging which might result in wastage of funding. This concern is illustrated in the following example, as shared by an interviewee TOC34: '*My personal opinion the funding is timed in the wrong place because…are you trying to get over this hurdle of now we want you to think really radically, but it is also trying to find the space and time to do that and the resource to be able to do it internally when everything else is going on at the same* time'. Another barrier that funding raises is the lack of collaboration among TOCs as: TOC26: '*What we have got is that some TOCs have got it and some that haven't. So I am not sure again how we will be able to collaborate with those TOCs that haven't got that fund at their disposal*'. Also due to the fragmented nature of the industry, it is unclear who pays for what and who benefits the most from it. So typical innovation project in the UK rail industry will influence multiple stakeholders with varying operational time frames and percentages of final benefits, making it difficult to justify profitable business cases and disincentives stakeholders from investing and making the effort to innovate.

The external funding options have been found to be associated with Intellectual Property issues, as shared by an interviewee, M25: '*reason for that is because once you got to external funding you will have to declare what you are working on, which from an IP perspective isn't necessarily the best*'. Lastly the primary data analysis suggests: TOC30: '*I think they need to be possibly more funding from the government*', and that there: TF11: '*needs to be some national recognition for funding and it should be under one umbrella it seems like it's too broken down and all you want to do this go talk to that person and if you want to do this go talk to that committee and it just to has it seems all haphazard*'.

Figure 4.15 below presents the results from quantitative data analysis, which throw light on what are the perceived barriers for SMEs to exploiting the available funding option.

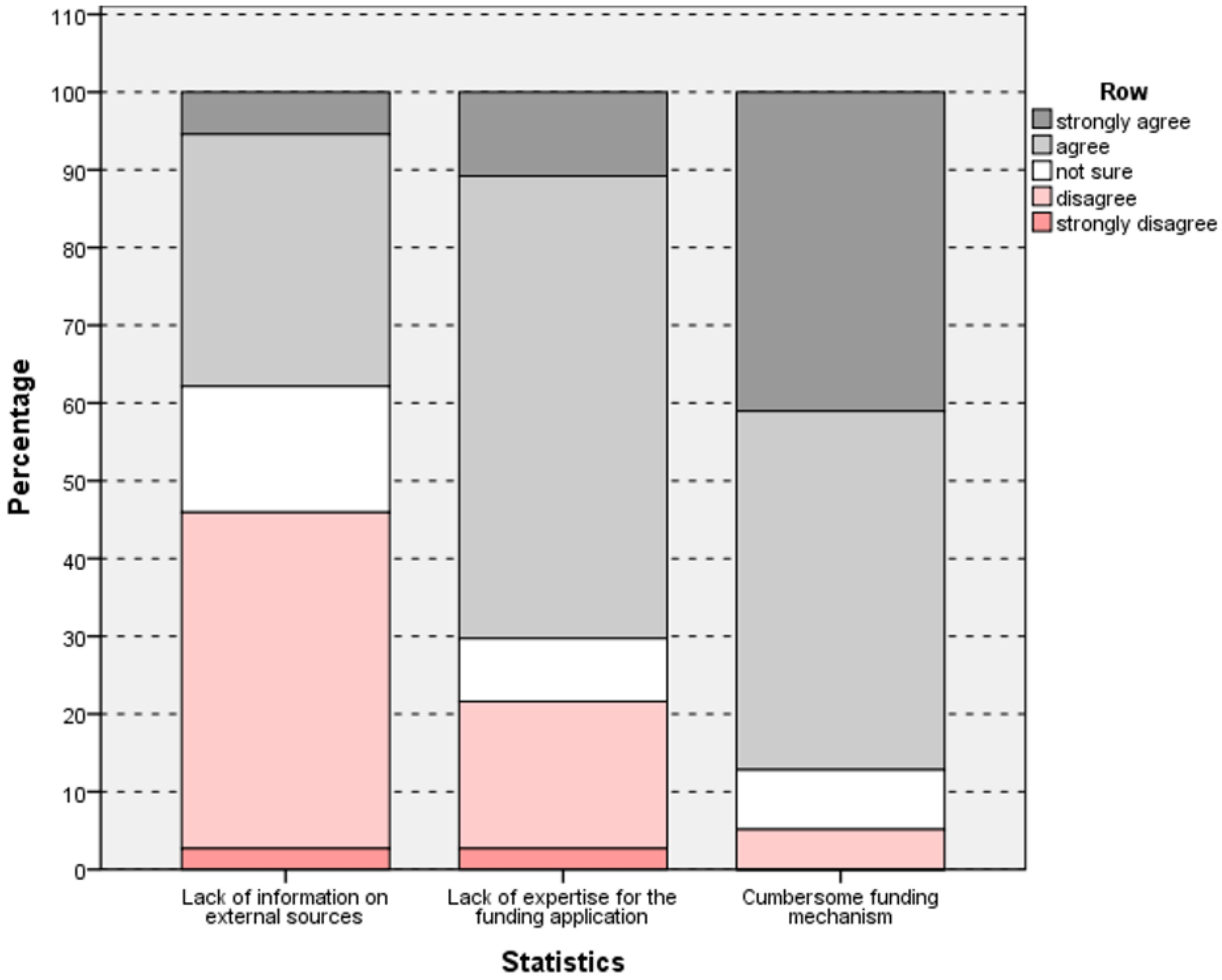


Figure 4.15 - Funding and innovation

As evident from Figure 4.15, the results from 39 responses show that there is a sufficient knowledge about the available funding options in the industry. However, the key funding barriers were found to be the cumbersome funding mechanisms, and the lack of expertise to make a successful funding application.

Conclusion

In conclusion, the funding scenario was found to present barriers to innovation as presented in the conceptual model in Figure 4.16. The barriers were found to emerge due to the lack of funding and the funding mechanism. Overall, the funding scenario was found to slow down the innovation process and cap the ambition of innovation.

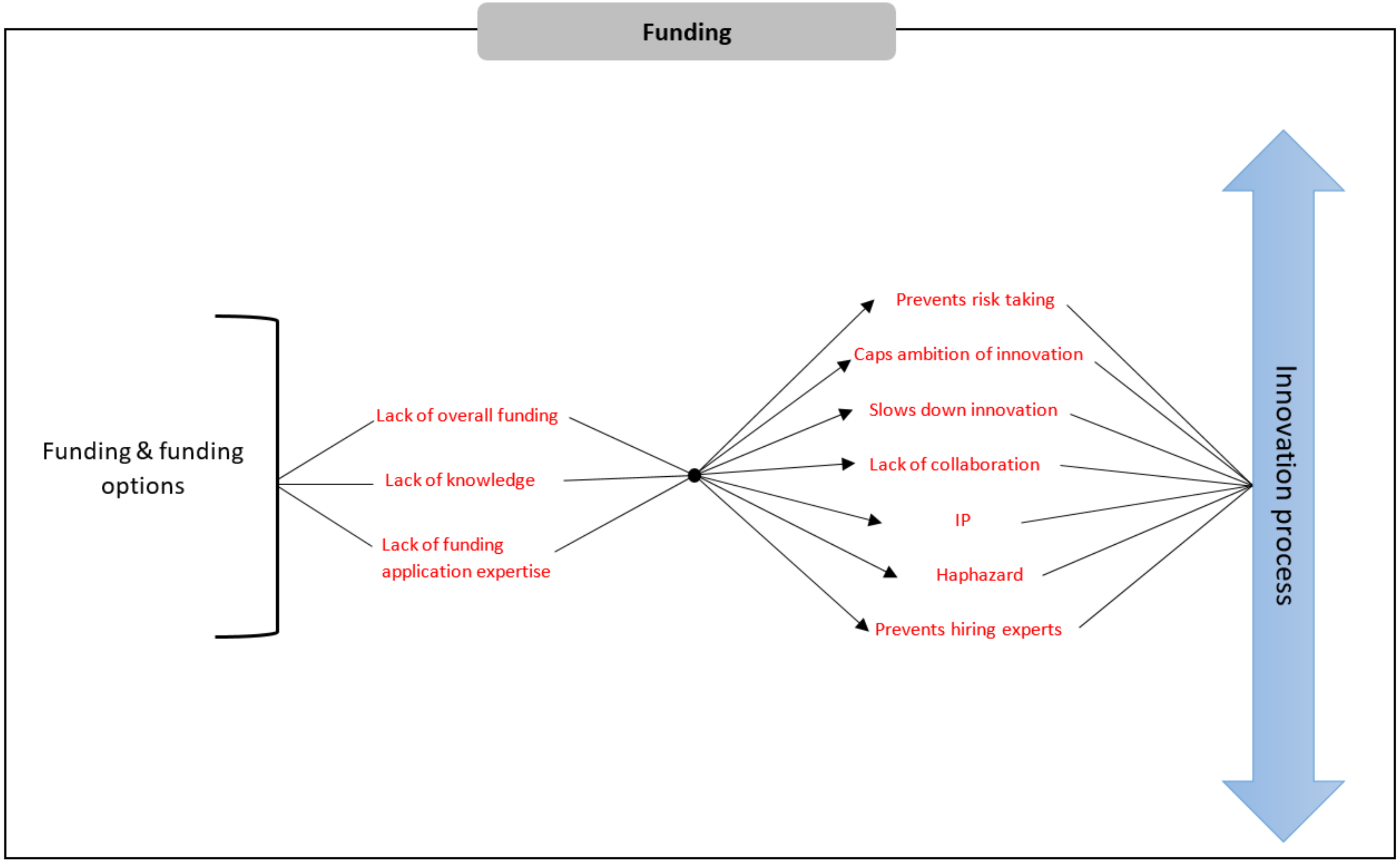


Figure 4.16 - Conceptual model of barriers to innovation due to funding

4.2.2.6 External factors - Political/Government and Media

In addition to the above mentioned barriers to innovation in the UK rail industry, the primary data analysis revealed two external agents that can prove to be a barrier to innovation because of the influence they exercise over the industry. These external factors are: the government and the media.

In terms of the influence of the government, their lack of engagement/interest and funding have been recorded to be the keys barriers to innovation. The fragmented structure of the UK rail industry, demands an overacting body that is able to drive innovation. The primary data analysis points out that: TOC30: ‘a*ctually in the government I think they lack vision*’. Having various different reporting bodies, aligning of strategies becomes challenging and gives rise to a lack of direction for the whole industry. As said by one of the interviewee TOC22: ‘*So it’s making sure that the regulator and DFT who often don’t seem to get on very well are specifying that Network Rail and the TOCs all push in the same direction*’. Because of lack of structure, vision and direction, bureaucracy prevails in the industry and some investments are made according to political priorities. It is also noted that: M4: ‘*You can’t without having an overacting body, and you know regulators if you like the government or regulator probably don’t like to get involved*’. Another view captured was that the current changes in the politics can also hamper innovation, as it might not be the best time to plan the future considering the prevailing uncertainties in view of Brexit.

Media also, can have a big impact on the innovation scenario of the UK rail industry in terms of branding and positive promotion. Unfortunately, media plays a negative role in the promotion of innovation in the UK rail industry. The industry lacks positive media presence. For example, an interviewee, C7 said: ‘*But the failures get spoken about than successes’*. There is an urgent need to sing the success stories more than the failures. As the success stories are not advertised/communicated as extensively as there is a need for, it limits entry of potential innovators and investors into the industry, who might look at UK rail industry as an unprofitable and risky business venture. An interviewee, M16 conveyed the same as: ‘*I think that is the struggle in terms of investment, we struggle in terms of getting the right sort of scales in because it is not seen in a very good light I think. So that has been a barrier to a lot of things*’. The nervousness of bad publicity also prevails amongst management within the industry and therefore demotivates them and creates an environment which does not enable taking risks to innovate. A supporting statement provided by an interviewee TOC36, is as following: '*We would get battered in the press, and that is probably where that nervousness comes in from our directors because they don't want any negative publicity on their watch*'.

Conclusion

In conclusion, the primary data analysis suggested that the UK rail industry also faces barriers to innovation due to the political satiation and the media. The main barriers identified, as presented in the conceptual model in Figure 4.17, were the lack of vision and engagement from the government, and the lack of positive publicity by the media.

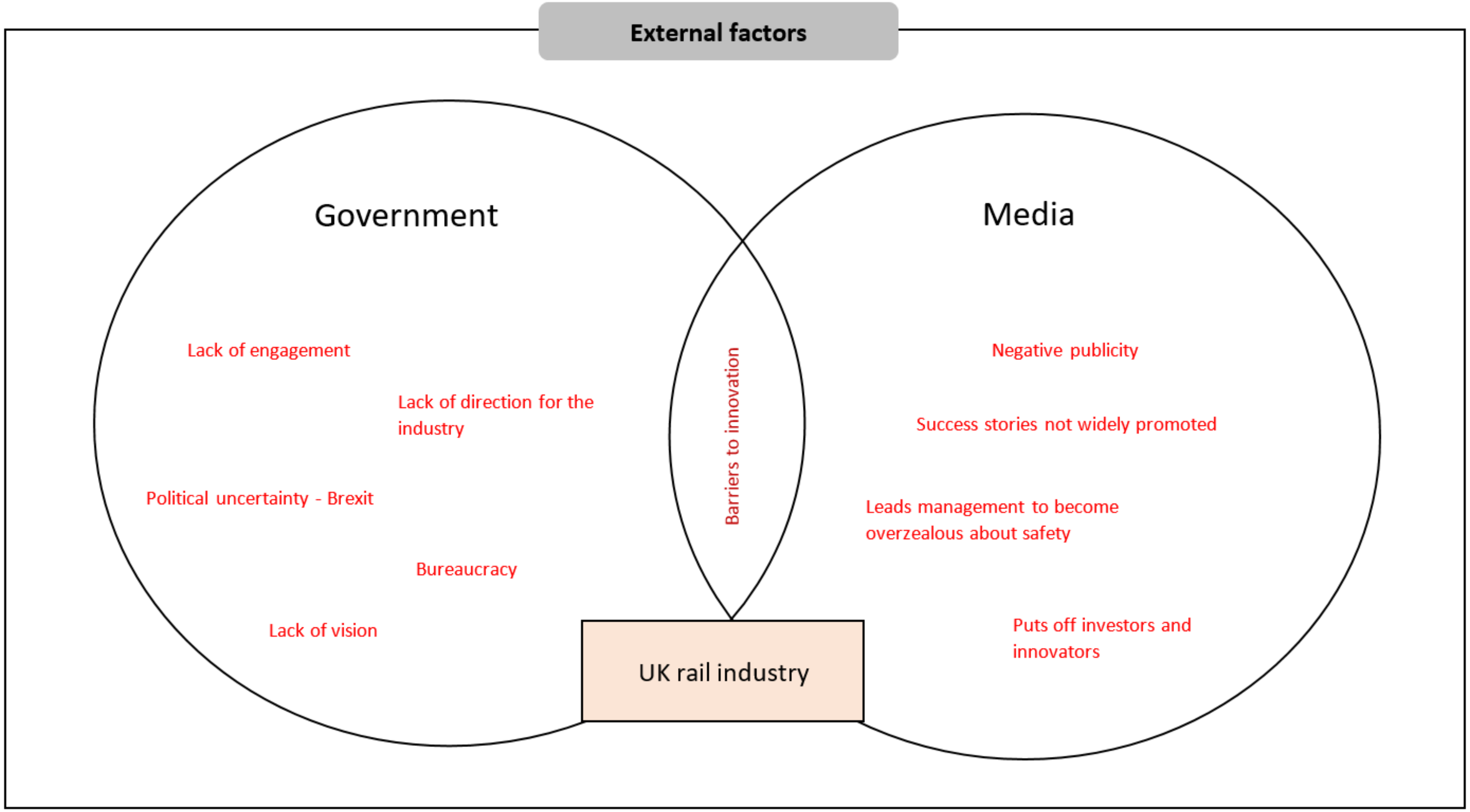


Figure 4.17 - Conceptual model of barriers to innovation due to the external factors

4.2.3 Conclusion of primary findings

In conclusion, the data analysis clearly identified the barriers to innovation in the UK rail industry. The primary data findings not only identified the barriers in the innovation process, but cover all the elements influencing the innovation process. As such, in light of the research topic, it was crucial to establish the link between the primary data findings and innovation, in order to conceptualise the relationship between the identified barriers and innovation. Adapted from the works of Dervitsiotis (2010) and Slater *et al.* (2014) a conceptual model was created, presented in Figure 4.18, to summarise the findings of this section in relation to innovation. Presenting the enabling elements of developing a successful value generating innovation, that is, organisational culture, leadership, organisational characteristics, supports of innovation, and the innovation process (Dervitsiotis, 2010; Slater *et al.*, 2014), Figure 4.18 links the primary findings of this section to innovation, by identifying the characteristics of these enabling elements that pose a barrier to innovation.

The conceptual model presents the interactions and interrelations of the various elements of developing a value generating innovation. These in addition to the findings of this section make it clear the complexity of the issue in hand and the need of considering an overall industry approach to resolve the issue. By taking a holistic approach to the problem of innovation in the UK rail industry, the primary data analysis thus, proves the need to shift from the initial focus of the research of concentrating only on testing and trialling process.

The conceptual model of the findings of the primary data are presented below in Figure 4.18.

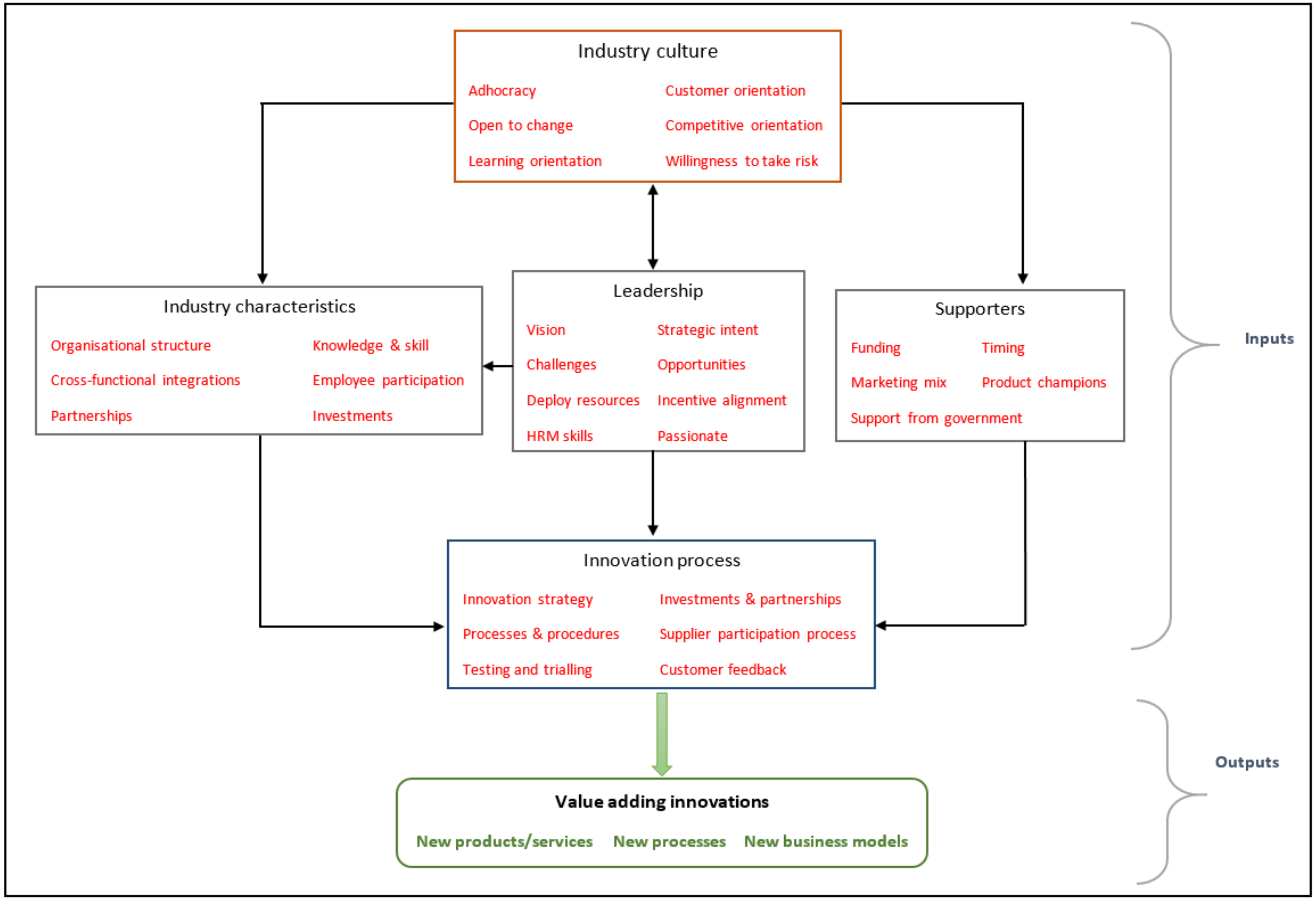


Figure 4.18 - Conceptual model of primary findings (Adapted from (Dervitsiotis, 2010) and (Slater *et al.*, 2014))

Having established the barriers to innovation in the UK rail industry, it is necessary to validate the direction of investigation and its results. Being commissioned in the UK rail industry, the outputs of this research are aimed at supporting the industry to resolve its barriers to innovation. As such, analysing the secondary data enabled to conceptualise the innovation scenario in the UK rail industry and the means of aligning the primary data findings with the industry perception of barriers to innovation.

4.3. Secondary data

4.3.1 Introduction

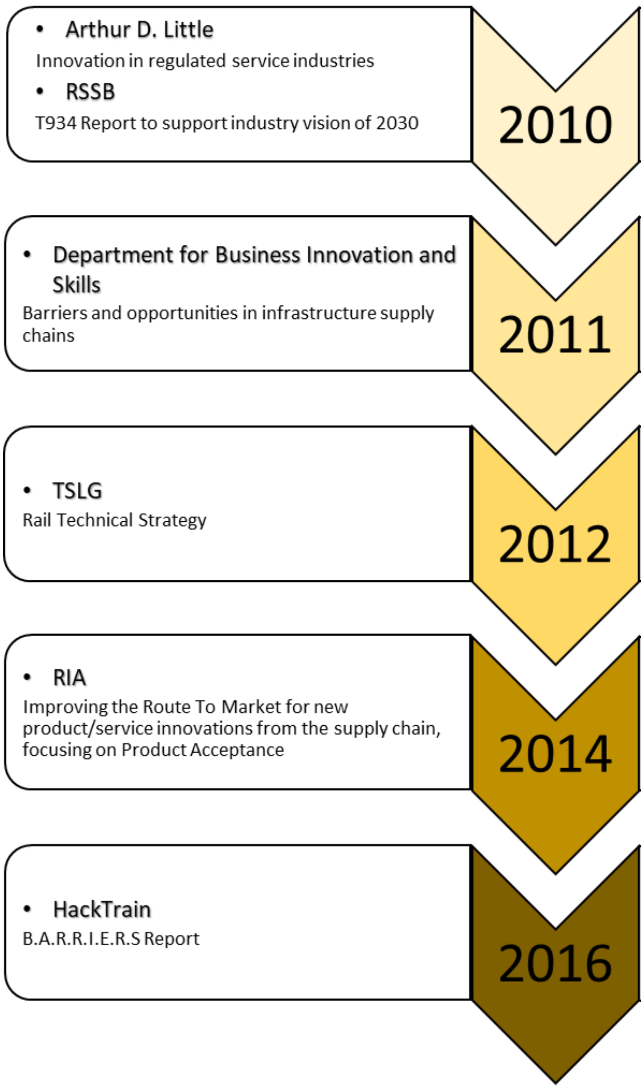
This section presents the results of the synthesis of existing industry reports commissioned and published over time by various organisations of the rail industry. Such data which has the key feature of not being published and distributed by commercial publishers, but by organisations involved in business rather than publishing, is commonly referred as secondary literature (Corlett, 2011). This type of literature can be produced by government, businesses, industries and academics in print and electronic formats. As such, it can exist in the form of dissertations, conference papers, government reports, committee reports and industry reports. This wide range of formats and scope can often makes grey literature a rich source of evidence (Paez, 2017). Such literature is not peer-reviewed and might not be easily accessible due to issues such as intellectual property issues, privacy concerns and plagiarism. However, for this research, one can argue that industry literature forms an important part of the findings for various reasons, such as, 1) the lack of academic published data in this particular field under study, 2) the organisations that have commissioned the reports usually have access to wider financial resources, and as such the reports might contain some very valuable information that the researcher cannot have access to on a personal level (Corlett, 2011), 3) these reports may provide null or negative results, thereby presenting a more balanced view and understanding of the issues under consideration (Paez, 2017) (Corlett, 2011).

Secondary literature is widely used in health care industry and is encouraged by the works of authors such as Swart *et al.* (2015) in their work of establishing guidelines for GPs for optimal use of secondary data. Johnston (2017) also advocate the use of secondary literature as a viable method due to vast amounts of data collected, compiled and archived as a result of technical advances. Researchers in production and supply management also often use secondary data due to the difficulty in gaining significant response rates using survey methods

(Ellram & Tate, 2016). Kenyon *et al.* (2016) also used secondary data in their study of production outsourcing and operational performance.

Therefore, it was felt necessary to include the findings from the secondary literature in this research to establish a validation point for the research direction and results as being in alignment with the industry vision of overcoming barriers to innovation. Table 7 below presents a timeline of secondary data sources as identified by the UK rail industry over the last few years, and published by the various organisations active in the rail industry. These publications date from 2010-2016 as the efforts to build a stronger innovation environment in the UK rail industry has been a very recent initiative.

Table 7 - Secondary data sources



In order to get a better understanding of the reports under discussion, the below sub sections first provide a brief background information of the reports mentioned in Table 1, followed by a detailed discussion of the findings of the secondary data analysis.

4.3.1.1 Introduction to secondary data sources

- **T934 Report - RSSB**

In 2009, Rail Industry Association (RIA) issued a report that indicated that the conservative nature of Great Britain (GB) rail industry is hampering progress and limits the achieving of the objectives of the Rail Technical Strategy (RSSB, 2010). Based on this report, under Rail Safety and Standard Board's (RSSB) Research and Development programme, The Technical Strategy Advisory Group (TSAG) - which is responsible for developing and delivering the Rail Technical Strategy, commissioned another research project to validate the results and better understand the critical barriers to innovation in the UK rail industry. This report is called '*Enabling technical innovation in the GB rail industry - barriers and solutions*' (also known as the T934 report). The analysis was validated by consulting over 40 senior and expert stakeholders. The research identified three types of barriers to innovation: *lack of a holistic system view and limited time scales, weakness in innovation capability,* and *perceived implementation risks*. The report further proposes strategic interventions and implementation plans to overcome the identified barriers.

- **Arthur D. Little Report**

Eagar and Boulton (2010) produced an article namely, '*A systems approach for accelerating innovation in the regulated service industries*', which was published by Arthur D Little on innovation in regulated service industries. The article explains the prerequisites for innovation within an industry, the barriers that make it challenging or regulated industries to meet the prerequisites of innovation and how they can be overcome. The report suggests that after being privatised, service providers such as public transport, are still heavily regulated in terms of safety and/or environment, discouraging innovation. This is due to the practise of prescribing solutions and costs associated with gaining approvals. Eagar and Boulton (2010) identified three characteristic of regulated service industries that make it challenging to meet the essential elements of innovation. These are: *fragmented structure of the value chain, restrictive regulations*, and *buyer dominance.* The report further suggests what policymakers and companies can do to address these barriers.

- **Report by Department of Business Innovation and Skills**

In 2011, Department for Business Innovation and Skills (BIS) published a report, called '*Infrastructure supply chains: barriers and opportunities*', to identify barriers and opportunities in infrastructure supply chains of five sectors including rail transport (Department for Business Innovation and Skills, 2011). The paper was produced to meet the commitment made in the National Infrastructure Plan 2010 to identify barriers and opportunities in the infrastructure supply chain and publish them. The report presents findings of supply chain in five infrastructure sectors: transport, energy, digital communication, water and waste. For this research, findings of only the railway transportation sector, which is worth at least £9bn annually, are presented. The barriers identified in this report are: *policy risks, procurement, standardisation, innovation and standards, communications, and skills and training.*

- **Rail Technical Strategy – TSLG (Technical Strategy Leadership Group)**

Based on the research conducted by RSSB (2010) that identified innovation barriers in leadership, industry capability and risk reduction (RSSB, 2010), the '*Rail Technical Strategy*' (RTS) was published in 2012. The RTS was published with an aim to assist industry's planning processes, to inform the policy makers and funders of the potential benefits of innovation and to provide the suppliers with a guidance on future technical direction of the rail industry. The RTS (TSLG, 2012) recognises the transport industry as an increasingly competitive sector, where innovation is the key to introduce new products and services and to attract new investors. Innovation has been identified as a key enabler for the continuous and significant success of the rail business. (TSLG, 2012). However, the report finds that the investments in innovation have been less than in other transport sectors, reported as 0.5% against the international best practice of 3.5% (RSSB, 2010). The Rail Technical Strategy recognises the changing environment to establish long-term technical plans to improve railway performance. It focuses on improving the railway performance by targeting improvements in four dominant areas, which are customer satisfaction, capacity increase, cost reduction and carbon reduction, also called the 4Cs. It is a long term action plan, covering the next thirty years of development and progress of the railway industry. RTS 2012 aims at providing a view of how the technical developments should benefit the industry in coming years and how it will aid operators, enterprises, and managers etc. to deliver better cost and time effective services. It states strategies for the main operational and engineering technical domains in the rail industry which includes trains, tracks, energy, information, control and communications and customers.

- **Report published by RIA**

In view of the acknowledged barriers towards the timely acceptance of new products and services, Rail Industry Association (RIA), the Rail Alliance, the Enabling Innovation Team and Network Rail collaborated to help identify ways of accelerating the product acceptance process. This collaborative effort produced a report – ‘ *Scoping study for improving the Route To Market for new product/service innovations from the supply chain, focusing on Product Acceptance*’ which was publish by Arthur D. Little in 2014 (Arthur D. Little, 2014). The report was aimed at addressing the timely acceptance of new products and services from suppliers onto the rail network (Arthur D. Little, 2014). The report identified gaps in four main areas, which are, *leadership and strategy*, *organisation, roles and responsibilities*, *processes, practice and resources,* and *people and culture*. In addition, barriers related to *funding, poor communication, risk averse culture, difficulty to access live rail for testing*, and *lack of clarity on testing facilities available and the services they provide*, were identified in the report. The Arthur D. Little (2014) report also identifies the *business model barriers*, *lack of market knowledge* and that the *business advantages of innovation were not always clear*.

- **B.A.R.R.I.E.R.S Report - HackTrain**

The latest of the reports published that identifies the barriers to innovation is produced by HackTrain, which is focused on a niche market of low risk, easy to implement innovations. HackTrain identified 4 key barriers, which are: *franchising*, *procurement*, *data* and *funding*, and identified a 5th barrier – *culture* in their update. Taking the lead from the innovative past of the UK rail industry, the report aims at providing a consolidated view of the barriers to innovation to enable the industry to respond to the new direction (shifting from innovation as a priority to introducing outcome specifications in rail franchise) laid down by Department of Transport. The report advocates the use of innovation to transform customer experience and link it directly to customer needs, by illustrating examples from recent innovative venture including Netflix and Uber.

Therefore, after understanding the background of the secondary data sources, the next section of this thesis discusses the findings of the secondary data detail in further detail.

4.3.2 Findings

The findings of the secondary literature suggested that over the recent years (2010-2016), the railway industry has commissioned various projects to educate themselves of the issues related to innovation. These projects were commissioned by various different organisations, depending on their need to resolve particular issues they faced. The main barriers mentioned in these reports are those related to A) *the poor strategy, fragmented structure and leadership in the industry*; B) *the procurement and buyer dominance*; C) *restrictive regulations, standards, processes and practices*; D) *weak innovation capabilities and implementation risks*; E) *franchising system*; F) *people and culture*; and G) *funding*.

4.3.2.1 Poor strategy, fragmented structure and leadership in the industry

The secondary data widely suggests that in the UK rail industry barriers to innovation are mainly due to its poor strategy and the fragmented structure of the industry. A long term technological strategy is often difficult to be established in a fragmented structure as it is unclear who provides the overall leadership, making it difficult for long term strategic directions to be established (Eagar & Boulton, 2010). The lack of a holistic system view and limited time scales make it difficult to commercially justify innovations traversing multiple stakeholders and control periods or franchises (RSSB, 2010). The fragmented structure of the value chain (e.g. vehicle manufacturers, infrastructure builders and contractors, rolling stock operating company (ROSCO), train operating companies, regulatory bodies, safety bodies, Department for Transport - DfT and funders, and other industry organisations) presents difficulties in monetising the benefits of innovation when the benefit of the innovation can accrue to a party other than the originator. For example in case of regenerative braking technology, which is a part of the train and requires investments in rolling stock, the energy saving benefits are collected by the infrastructure provider (Eagar & Boulton, 2010). It also creates barriers in taking Research and Development to full scale trials. The lack of strategic planning (restricted to strategic planning of demand) for a greater certainty to make investment decisions was found to result in lack of incentives, and recruitment or training of people in challenging times (Eagar & Boulton, 2010). The RTS does not come to the rescue either, as it is unclear what role the various elements of the rail industry can play in achieving the strategy and how can they contribute towards its success. More so, the lack of business strategy to support the technical becomes a barrier in itself (TSLG, 2012). This reflects in the lack of market knowledge and the business advantages of innovation are not always clear.

Narrowing down from a wider strategy, no product development strategy has been found to exist within the industry. The industry, with regards to the acceptance process, lacks an overall system authority and practical framework of leadership incentives for developing an innovation culture (Arthur D. Little, 2014).

As a summary, the barriers identified in the above discussion are as follows:

- Lack of holistic systems approach
- Lack of commercial business strategy
- Poor leadership
- Unclear organisational roles and responsibilities

4.3.2.2 Procurement and buyer dominance

Another barrier identified in the secondary data is the issues arising from buyer dominance and procurement in the UK rail industry. The Department of Business Innovation and Skills (BIS) (Department for Business Innovation and Skills, 2011), draws a wider picture of the procurement which includes the contracting frameworks and delivery lead times. They impact the clients as they do not get the best value for their investments, particularly because the rail industry in UK has few dominant customers (e.g. railway infrastructure owner). The major procurement programmes perceive unnecessary secrecy to enhance competition but it hampers SME participation due to low visibility of strengths and talents of UK supply chain. The framework contracts also tend to make investment in capability high risk cause of the low certainty on future works (Department for Business Innovation and Skills, 2011). This market imbalance which has dominance from a single buyer such as the railway infrastructure owner, restricts innovation. There is lack of incentives for suppliers to innovate when they are at mercy of a single buyer that also exercises influence over approvals and acceptance of innovations into the system (Eagar & Boulton, 2010) as can be seen with Network Rail.

The procurement process of a niche market of low risk, easy to implement innovations, when studied in detail has been found to be time consuming and challenging. The secondary data suggest that it is due to poorly promoted tender opportunities for start-ups, which are usually pushed to the bottom of the procurement list with a disconnect from the delivery teams (HackTrain, 2016). The acceptance process have been identified as time consuming and gaining access to testing facilities has been stated as impossible. The use of legacy systems restricts the industry to the use of old technologies and there is a lack of collaboration due to IP issues of SMEs which is not respected by larger companies (HackTrain, 2016).

4.3.2.3 Restrictive regulations, standards, processes and practices

The secondary data moderately highlights the barriers posed by restricted regulations and standards.
These restrictive regulations can be in terms of both technological and commercial regulations. Technological regulations such as safety and environment if too prescriptive in nature can act as a barrier (Eagar & Boulton, 2010). Cost and delays related to approvals and heavy penalties for non-compliance often drive risk aversion. Commercial regulations however can have a bigger impact than technological regulations, as they constraint investment timescales due to immediate short-term paybacks, as can be the case in short franchising period, often five years of Train Operating Companies (Eagar & Boulton, 2010).

Standards and product acceptance can add costs and are related to risk averse culture (due to high standards, inflexible implementations and reluctant participation in development) and can be highly questionable in terms of being fit for purpose. The Network Rail's acceptance process has also been found to be considerably difficult to understand and discouraged SMEs from brining innovative products to market as the processes of registration, audit and certification can be costly for SMEs and the effort for multiple registrations can be a high barrier to entry (Department for Business Innovation and Skills, 2011).

In addition to the restrictive regulations and standards, the secondary data further highlights the inaccessibility of industry data to external suppliers which is difficult for companies trying to break into the industry or for SMEs to access. The contractual agreements and non-disclosure agreements are characterised as strict, and constraints of data ownership as unreasonable, which thus restricts innovation. (HackTrain, 2016)

4.3.2.4 Weak innovation capabilities and implementation risks

The grey data identifies certain barriers in relation to the weakness in innovation capability such as the innovation process, cultural issues and the inability to conduct large scale research and feasibility demonstration in the industry (RSSB, 2010). The lack of a holistic system view (lack of joint actions by the industry value chain to reduce risk of innovating (Eagar & Boulton, 2010)) and limited time scales makes it difficult to commercially justify innovations traversing multiple stakeholders (benefits of the innovation can accrue to a party other than the originator

(Eagar & Boulton, 2010)) and control periods or franchises (limited franchise periods might lead to lack of incentives to invest in anything which does not have an immediate short-term payback (Eagar & Boulton, 2010)) (RSSB, 2010).

Another aspect of innovation capability highlighted in the secondary data is skills gaps in certain areas such as signalling and programme management, and owing to the lack of forward financial visibility, makes it difficult to plan and fund the required workforce and address specific skills gap such as large programmes and projects management skills, systems engineering skills, not training enough graduate engineers who also lack the right complimentary skills such as leadership and communications (Department for Business Innovation and Skills, 2011).

There is a critical need for effective communication between policy makers, supply chain, and major customers, as there is an appetite for engagement in dialogue at every stage of the innovation process (Department for Business Innovation and Skills, 2011). It also includes pre-procurement communication to enhance market and customer knowledge and aid investment decisions, detailed project planning. Communication and quality of dialogue was also cited as barriers since major buyers were not sufficient aware of the innovative and dynamic range of SMEs in the lower tiers of the supply chain.(Department for Business Innovation and Skills, 2011).

In addition, barriers related to risk averse culture, difficulty to access live rail for testing, and lack of clarity on testing facilities available and the range of tests, equipment and support they provide, were also identified in secondary data analysis. (Arthur D. Little, 2014)

In conclusion, the barriers identified in the above discussion are listed below:

- Weak innovation capabilities
- Innovation implementation risks
- Lack of strategic planning
- Skills and training
- Communication
- Processes, practices and trialling

4.3.2.5 Franchising system

One of the briefly touched issues related to the innovation in UK rail industry as derived from the secondary data analysis is that related to the franchising in TOC. The franchising model is identified to lack incentives for Train Operating Companies to innovate. The short franchising durations experience innovation in the first few years only as the business case for returns on investments is not profitable due to the finite franchising periods- often five years. It also highlights the appointment of a safety board as an innovation provider to be in contradiction to the fundamental characteristic of innovation which is about taking risks and having the freedom to fail. (HackTrain, 2016).

4.3.2.6 People and culture

The secondary data was found to very briefly touch upon the issue of people and culture, identifying the UK rail industry to have a risk adverse culture (where taking risks associated with innovation are not considered worth investing in, due to costs, strict regulations, lack of innovation risk management capabilities) without providing further details on the said issue. (Arthur D. Little, 2014).

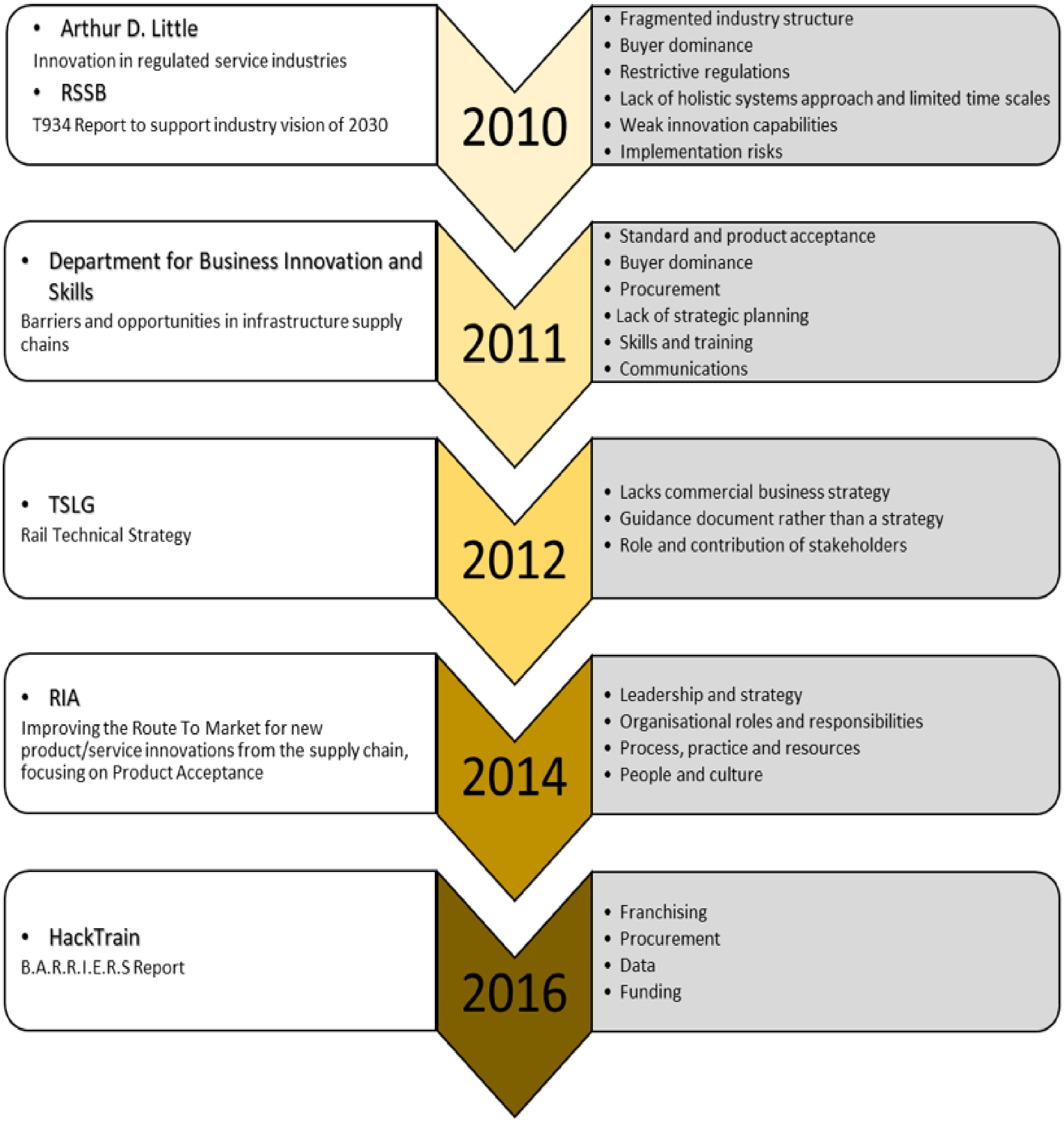
4.3.2.7 Funding

Another issue which is found briefly in the secondary data analysis is that of funding. Giving an insight into the funding system, the secondary data identifies the funding mechanism to be marred by poor accessibility, unproductive approaches to award funding and limitations due to restrictive specifications (such as eligibility, type of competition) of acquiring findings from various available sources in the UK rail industry (such as RSSB, innovate UK) (HackTrain, 2016) .

4.3.3 Conclusion of secondary findings

In conclusion, the secondary data forms a good base for exploring the barriers to innovation in the UK rail industry. Even though fragmented, the findings of the secondary data provide few pieces of the puzzle. The secondary data findings are focused mostly on the technical aspects of innovation and immediate elements of the innovation process. As such, there was a need to conduct a wider, updated and extensive research which aims at covering all the aspects of the innovation process and gathers views of most, if not all the stakeholders of the industry. The findings of the secondary data are summarises below in Table 8.

Table 8 - Secondary data findings



Based on the findings in Table 8, a conceptual model was created to link the findings with the innovation process to validate the alignment of primary findings with the industry perception and direction of removing barriers to innovation. Based on the works of Slater *et al.* (2014)and Dervitsiotis (2010), and taking the lead from the conceptual model of primary data findings in Figure 4.18, a similar conceptual model was developed for secondary data findings which is presented in Figure 4.19. On comparison the two figures highlight the gaps in knowledge of the industry in identifying the barriers to innovation. As can be seen Figure 4.18 extensively populated in comparison to Figure 4.19.

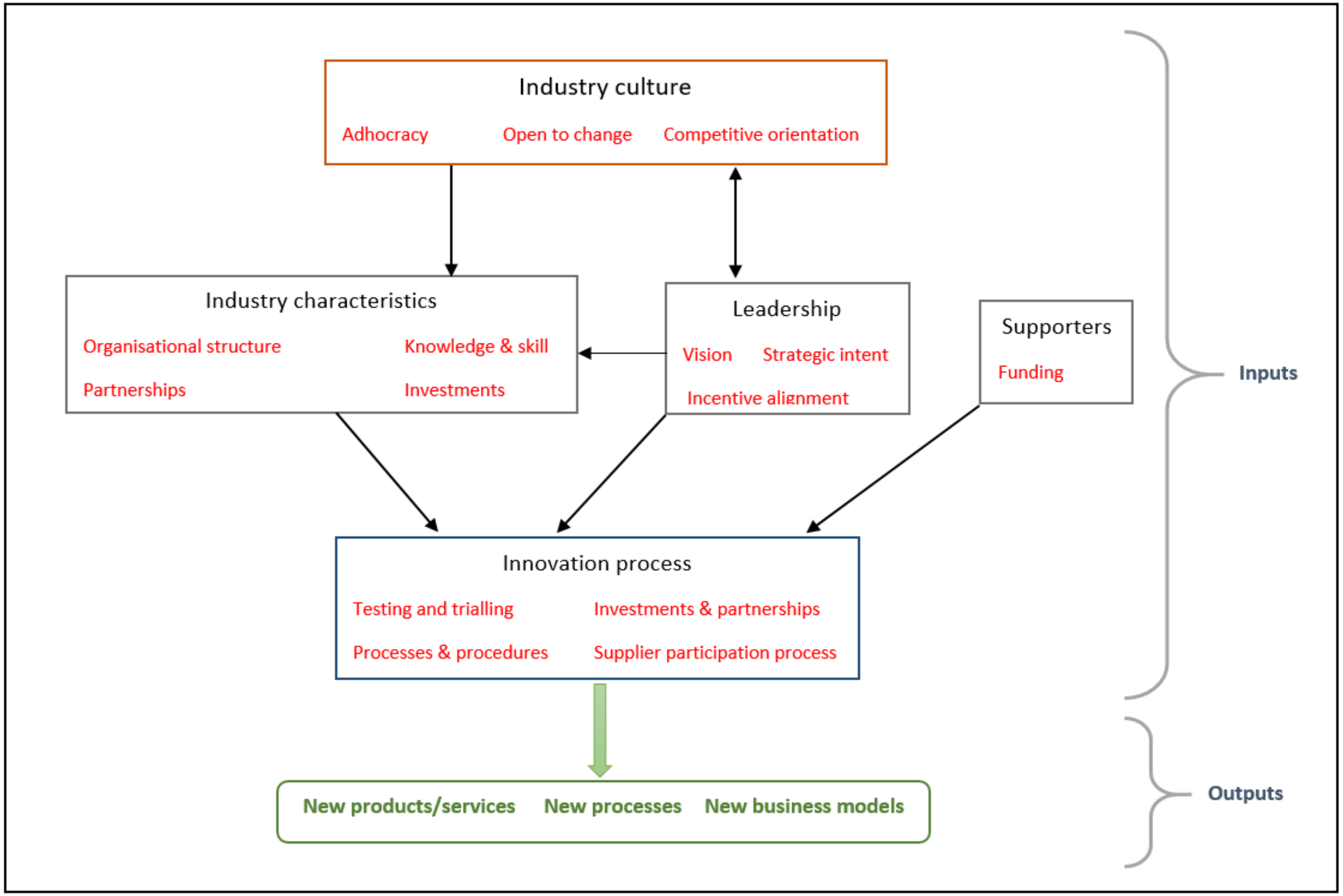


Figure 4.19- Conceptual model of secondary data findings (As adapted from (Dervitsiotis, 2010; Slater *et al.*, 2014))

4.4. *Findings conclusion*

This chapter has analysed the innovation scenario in the UK rail industry, from a multiple stakeholder perspective. Collecting data was the most challenging part of this research. The fragmented structure further increased the challenges as interviewing multiple stakeholders with varied job roles and experience was crucial to gain an overall view of the barriers to innovation. By conducting a thematic analysis of the collected data, six main themes pertaining to the barriers to innovation emerged: 1) fragmented structure of the industry, 2) innovation process, 3) franchising in TOC, 4) culture and people, 5) funding, and 6) external factors – government and media. Subsequently a survey was created, informed by the results of the thematic analysis, to validate the results from the wider industry and to remove any biases of researcher's interpretation.

In view of the research area of barriers to innovation, it was critical to conceptualize the interactions of the barriers with the innovation process as presented in Figure 4.18. As such, the six themes identified by thematic analysis were presented in terms of their impact on the characteristics of the key innovation input elements: 1) industry culture, 2) industry characteristics, 3) leadership, 4) supports of innovation, and 5) innovation process, as adapted from Dervitsiotis (2010) and Slater *et al.* (2014) and their interrelations in the innovation process. Therefore, this chapter not only analysed the barriers to innovation in terms of a multiple stakeholder view, but also established how and at what stages of innovation these barriers hampered innovation. Another crucial aspect established in this chapter was the validation of the direction of the primary data findings aimed at aiding industry to resolve the barriers to innovation. An analysis of the secondary data findings revealed that the research findings were aligned with the perception of the UK rail industry in becoming innovative and in terms of how it interacts with its stakeholders.

Having developed an understanding of the innovation scenario in the UK rail industry, through identifying the complex mix of barriers and their impact on the innovation inputs for desired value adding output, the next challenge that needs to be addressed is the development of recommendations to aid the industry to overcome the identified issues. The following chapter will therefore discuss the findings in light of the reviewed literature and the outputs of this chapter.

5. Discussion

5.1. Introduction

This chapter provides a comprehensive discussion of the research questions of this thesis. The chapter synthesises the reviewed literature referring to the phenomenon under investigation with the research findings, in order to answer the research questions. In doing so, the discussion critically analysis the findings of the research, and identifies the areas that support the extant literature, and the 'gaps' in knowledge.

The discussion builds upon the issues experienced in the UK rail industry that create barriers to innovation, as have been identified, analysed and presented extensively in Chapter 4. The use of thematic analysis to analyse qualitative data, in conjunction with the descriptive analysis of the quantitative data, provided a better understanding of the phenomenon under study, as it drew upon all the elements involved in innovation in the UK rail industry. The findings including the secondary data analysis, thus, provided an evidence based comprehensive understanding of innovation in a complex rail industry in the UK.

The chapter is presented in several subsections, in which the previously reviewed literature has been briefly restated, followed by a conceptual summarisation of the research findings. Subsequently, the research questions are discussed in light of the research findings, linked to the reviewed literature. The research questions are presented in three sections, starting from the specific elements in transportation, followed by the dominant factors influencing innovation, to the over governing elements of strategy.

Before commencing the discussion, a research overview has been provided which includes the conceptual models of the literature review and the findings of the research.

5.2. Research overview

Before focusing on the discussion of this research, a brief summary of the research so far is presented by means of conceptual models developed in the Literature Review and Findings chapters. The following section lays the foundation for synthesising and fitting the diverse research elements together.

5.2.1 Conceptual model of the literature reviewed

The literature review of this research as presented in chapter 2, draws vastly upon three main bodies of knowledge relevant to the issue under study, that is, 1) Strategy, 2) Innovation, and 3) Transportation. Each of these three areas of literature were critically reviewed and analysed in detail in order to better understand the issue under study and to identify research gap that has formulated this research. These disciplines have been extensively studied individually and in terms of their inter-connections according to various perspectives and research backgrounds. Similarly, for the purpose of this research these bodies of knowledge have been synthesised under the lens of Resource Based View (RBV). RBV lens enabled to detect the links between the bodies of literature and establish the theoretical boundaries of this research. In addition, the theory of change and leadership was explored as a supporter of successful value creation for stakeholders.

The following figure illustrates the three main bodies of literature synthesised under the lens of RBV. The conceptual model presented below in Figure 5.1, helps visualise the linkages and knowledge gaps which when addressed can lead to a sustainable competitive advantage in the UK rail industry.

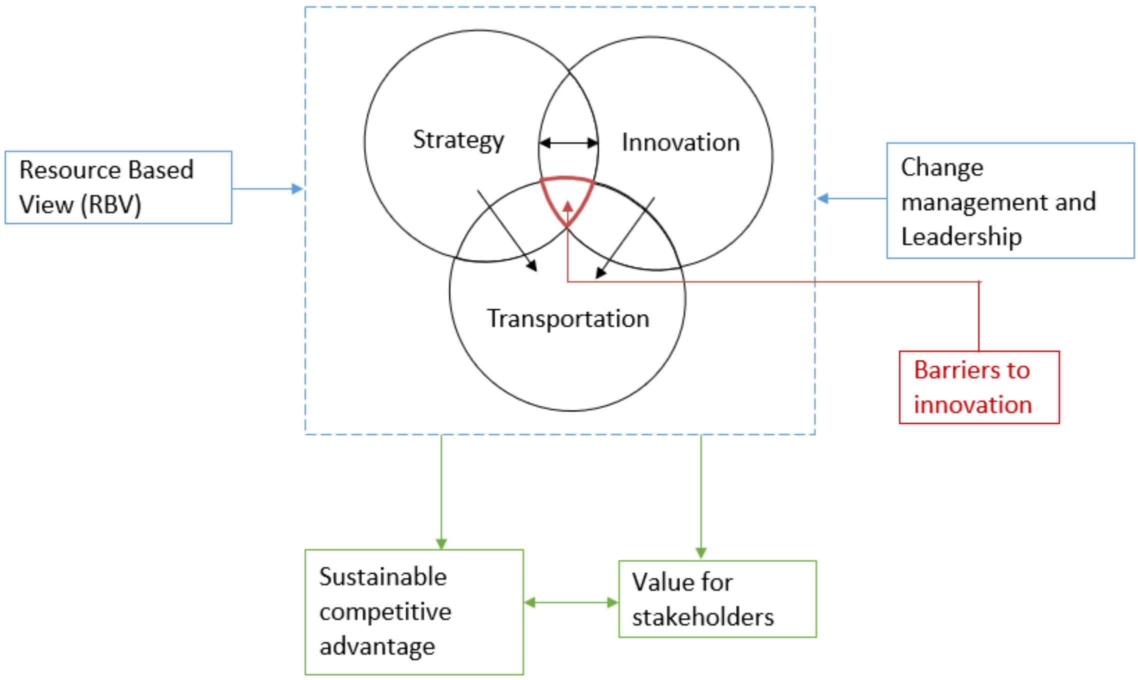


Figure 5.1 - Conceptual model of the reviewed literature

RBV sets the foundations on which innovations can be developed, and strategically managed to create and sustain competitive advantage. The main argument of RBV addresses the elementary question of why firms are different and how firms achieve and sustain competitive advantage by deploying their resources (Kostopoulos *et al.*, 2002). Irwin *et al.* (1998) argue that the resources of a firm are the determinants of its competitive advantage and financial performance. The resource-based view imposes that in strategic management the paramount sources and drivers of a firm's competitive advantage are mainly associated with the characteristics of their resources and capabilities. As such, each firm can be viewed as a unique bundle of tangible and intangible resources and capabilities (Wernerfelt, 1984). The sustainable competitive advantage of a firm is a result of resource selection, accumulation, and deployment by means of organisational capabilities and is based on a firm's resource heterogeneity (Kostopoulos *et al.*, 2002).

In order to gain competitive advantage, organisational resources and capabilities need to be matched with the opportunities and risks created by the external environment. This match has been defined as **strategy** (Grant, 1991). According to Chandler (1990), a corporate strategy is the determination of basic long term goals of an organisation, and adaption of route of action and deployment of resources required to achieve the goals (Chandler, 1990). With emerging technologies and market shifts, Mintzberg (2007) recognised strategy as 'a pattern in a stream of decisions'. Using the word pattern recognises the dynamic element of strategy as it takes a less certain view of strategy, suggesting that strategies may not always take a certain deliberately chosen path, and can emerge over time (Johnson *et al.,* 2017) while Porter (1996) emphasised on the uniqueness of chosen activities and the mix of value it delivers. A good strategy bears results when properly executed and the most challenging task for executives is the execution of strategy. Strategic management is the management of the integrated components of the three stages of the strategy process, which are, strategy development, strategy implementation, and strategy evaluation (Omalaja & Eruola, 2011). According to Ansoff and McDonnell (1990), strategic management is the systematic approach to the management of changing, which include, position the organisation by means of strategy and planning, managing problems by real time strategic responses, and systematic management of resistance during strategy implementation (Mainardes *et al.*, 2014). In strategic management, emphasise is laid on organisational analysis, decisions, and actions in strategic management, for creating and sustaining competitive advantage (Dess *et al.*, 2003). The competitive advantages enable an organisation to seize opportunities and minimise environmental threats (Mainardes *et al.*, 2014).

Innovation activities of an organisation significantly influence competition, which is based on inimitable resources and capabilities. These resources have been defined as productive assets of the firm through which activities are accomplished (Bakar & Ahmad, 2010). Gaining higher competitiveness by means of innovation means producing higher quality goods and services at lower costs as compared to the competitors (Urbancová, 2013). Organisations that are not able to introduce innovations on an ongoing basis risk lagging behind as the initiatives might be taken by other entities (Urbancová, 2013). Urbancová (2013) in her research found that the concept of innovation in large organisations not only influences inspection and change in internal environment, but also in the external environment. The internal environment of an organisation requires a suitable pre-set innovation culture (which is often characterised by the inconstant organisational structures), utilisation of specialists and temporary teams, the flexibility and speed to respond to new opportunities, in order to increase its innovation potential (Molina-Morales *et al.,* 2014). The characteristic features of such organisations thus include flexibility, openness to change, inclusion of information and resources in the external environment, anticipation, creativity, and experimentation and informal communication (Urbancová, 2013). Improvements in performance depend widely on innovation, and an effective innovation requires a strategic approach. In today's rapidly changing environment, an innovation strategy must enable an organisation to learn from other industries, influenced by internal resources and external capabilities of suppliers, universities, individuals and organisations, to achieve its corporate goals (Davies *et al.*, 2014). Dodgson *et al.* (2008) argue the significance of external analysis being crafted alongside a firm's understanding of its internal resources and capabilities, as it enables the effective deployment of firm's internal resources and capabilities in delivering a firm's value proposition. An innovation strategy enables and guides decisions on the use and deployment of resources to meet a firm's innovation objectives (Pisano, 2015), thereby delivering value and building competitive advantage (Dodgson *et al.*, 2008).

RBV enables the production of **innovation** outputs of increased value and by implementing innovations, enables a firm to establish new 'stocks' of assets that the competitors will find difficult to replicate quickly (Kostopoulos *et al.*, 2002). According to Kostopoulos *et al.* (2002), the basic fundamental of resources based research of innovation is that a firm's resources and capabilities are the underlying determining factors of a firm's capacity to innovate. As such, a firm's resources (cf. (Kostopoulos *et al.*, 2002) (Tahera *et al.*, 2012) (Abualqumboz *et al.*, 2017)) are transformed by its capabilities (cf. (Kostopoulos *et al.*, 2002) (Drucker, 2014) (Teece *et al.*, 1997)) to produce innovative forms of competitive advantage (Kostopoulos *et al.*, 2002). The strategic management of innovation is a crucial part of firm's strategy, and is a major contributing factor to a firm's competitive advantage (Keupp *et al.*, 2011; Porter, 1985). Innovation management is the management of entire innovation process from idea generation through to development and commercialisation, including strategic and operational issues (Ojasalo, 2008). McCosh *et al.* (1998) suggest that for successful management, the company in which the innovation is taking place must be very supportive of innovation in their actions, words and examples that they set. Maintaining a close relation with the customers can enable a firm to determine the future needs and best solutions for the customers (McCosh *et al.*, 1998; Ojasalo, 2008). Another key factor identified in innovation management is the innovation culture. It involves appreciable freedom of action, resources to educate the employees about new technologies, and using teams of highly skilled employees (McCosh *et al.*, 1998; Ojasalo, 2008).

The global market place is compelling every industry to transform itself into a customer-oriented and service-focused business (Chapman *et al.*, 2003). Busse and Wallenburg (2011) identified three trends that appear to have increased the need for innovation in logistics service providers. These trends are, firstly, the need to deliver sophisticated services which require more innovation, secondly globalisation and consolidation increases competition and the pressure to innovate, and thirdly deregulation which increases possibility and pressure to innovate by increasing competition for cost and quality (Busse & Wallenburg, 2011). EuropeanCommission (2011) stated **transportation** as a key enabler of economic growth and job creation. It recognised that the transportation faces new challenges while the old challenges remain. Issues including, providing better services to the customers to meet their growing desire to travel, transporting goods while preparing for resources and environmental constraints were highlighted in the report (EuropeanCommission, 2011). A study conducted in 2005 on the innovation strategy in Cross rail (Dodgson *et al.*, 2015), highlights the challenges faced in implementing innovation strategies in large transportation projects. Van Marrewijk *et al.* (2008) stated that megaprojects such as railways are associated with risk and uncertainty that lead to avoidance of innovation (Van Marrewijk *et al.*, 2008). There are no examples in literature of mega projects as reviewed by Davies *et al.* (2014), of organisations, contractors, clients or sponsors developing deliberate strategies and processes to design and implement innovation. Defining strategy as a top down approach, Dodgson *et al.* (2015) identified that it reflects the leadership of an organisation. In order to implement a strategy successfully it is crucial to equip the organisation and supply chain with the necessary knowledge, processes and incentives to generate innovation and encourage collaboration. Thus, building the innovative capacity, equips the organisation to deal with changing times and unforeseen circumstances (Dodgson *et al.*, 2015). The right mix of strategic and operational expertise which is open to new ideas determines the successful implementation of innovation strategy (Dodgson *et al.*, 2015). The strategies need to be continuously analysed and developed in order to stimulate economic growth and stability. F.R.David (2011) suggested that an analysis can be performed to identify the competitive/industry performance, to enable pairing of suitable strategies with the industry structure (F.R.David, 2011). It may also help to prepare for unforeseen circumstances by bringing to light appropriate and cost effective measures that can be taken in such times (Porter, 1980). This in turn can help creative and perhaps more importantly maintain competitive advantage (F.R.David, 2011). As established by Porter (1985), gaining a sustainable competitive advantage is the only way of achieving superior performance.

Innovation enables to transform existing products and services, enhancing their value (in tangible and intangible form). The accumulation and combining of resources through technical processes, that have **value** creating features is not sufficient. It is critical to have a network of **stakeholders** as resource providers that help the firms achieve a unique competitive position in the industry (Verbeke & Tung, 2013). Interactions with the key stakeholders enhances innovativeness and adds to the success of the new launched product/service (Smirnova *et al.*, 2009). In transportation, innovations that bring workers and firms together can lead to production cost savings and/or technological advantages, thereby lowering input costs, improving communications between firms, reduce labour market frictions and improving work efficiency (Gibbons & Machin, 2005). A firm's performance greatly depends on its innovation capability (Odeh *et al.*, 2014). Innovation enables higher value creation for the stakeholders of firm, which are the main drivers of a firm's business.

Globalisation has put enormous pressure on business organisations to **change** (Hechanova *et al.*, 2018), with technology being the key factor of revolutionising the way organisations are run for greater efficiency, systems streamlining, processes and structures (Hechanova & Cementina-Olpoc, 2013). Change programmes often fail due to poor management such as poor planning, monitoring and control (Gill, 2002). According to the American Management Association survey (Gill, 2002), the keys to successful change are first and foremost **leadership**, followed by corporate values and communication (Gill, 2002). Change is orchestrated by the leader of the organisation or the change agents authorised to facilitate the change (Quinn *et al.*, 2006). Al-Ali *et al.* (2017) argue that in addition to leadership or change agents, change is not possible without the organisational culture and the commitment of those involved in the change process. Organisations in which goals are achieved, the change leaders exhibit task behaviours and also adopt behaviours that make employees more comfortable and receptive of change. These transactional and transformational leadership styles ensure productivity and effective change management, thus, enabling the leaders to act both as supports of organisational change and as change-agents (Al-Ali *et al.*, 2017). In addition, transformational leaders stimulate their employees to think outside the box and find innovate solutions in their work by addressing old problems in new ways (Kuipers & Groeneveld, 2016).

5.2.1.1 Conclusion

Having summarised the main bodies of knowledge, concepts and ideas upon which this research is built, the role of innovation has clearly emerged to gain sustainable competitive advantage. Innovation forms a key element of the strategy of an organisation as an enabler of change and value creation. A robust strategy clearly defines the vision and objectives of an organisation, and lays the direction for achieving long term goals in response to the opportunities and risks created by the dynamic external environment. It enables to identify, exploit and replenish organisational resources and capabilities in order to gain advantage over competitors, and create value for all stakeholders. Innovation enables the creation of new stocks of assets for an organisation that are valuable, rare, and hard to imitate by the competitors. Such a resource/capability enables a firm to implement strategies that allows the firm to exploit opportunities, improve effectiveness and efficiency, and to mitigate external risks (Brem *et al.*, 2016). As such, this research aims at supporting innovation in the UK rail industry, in order to deliver customer specific solutions, create value for stakeholders, and to gain sustainable competitive advantage in domestic and international markets. In light of the reviewed literature, this research systematically reviewed the innovation scenario in the UK rail industry to identify the barriers to innovation.

The literature review chapter analysed and presented the main bodies of literature that lay the foundation for development of this thesis by identifying knowledge gaps. As such, it facilitated the design and justification, of the theoretically-driven development, of the research questions.

5.2.2 *Conceptual model of the findings*

To address the research questions, the research design of this study includes qualitative and quantitate approaches to data collection. The qualitative data was collected by means of 43 unstructured and semi structured open interviews with a range of railway industry professionals, and quantitative data was collected via a survey of 57 responses. In addition secondary data was derived from the available industry reports on barriers to innovation as published by the UK rail industry. These reports were collated and span the period from 2010-2016, to form an integral part of the findings chapter as it throws light on the perceived aim of the industry and its interactions with its stakeholders.

The interviewees for the qualitative data were very carefully selected via an extensive exercise of conducting a stakeholder analysis to identify the stakeholders involved at various stages of the innovation process, followed by the identification of the organisations under various stakeholder categories. For example, for the stakeholder - train operator, organisations such as Virgin Trains and First Trans Pennine were listed. Similarly, various other organisations were identified using the stakeholder analysis along with the understanding of the UK rail industry structure. The rail industry structure was taken into consideration in order to get an overall view of the innovation landscape from various perspectives. An array of professionals ranging from technical bodies such as engineers to senior management such as directors were interviewed for this research. . In order to validate the results and find possible solutions the survey questionnaire for the quantitative data was based on the qualitative data results of the research. The quantitative data also served as means to eliminate the researcher's personal interpretation of the qualitative data, and present updated results as perceived by the wider industry. The analysis of the secondary data highlights the gaps in knowledge and the need for an extensive research done via the primary data analysis. It reveals the industry aims and vision in terms of innovation and its interactions with its stakeholders. The secondary data enabled to validate the direction of investigation aimed to address the innovation issues faced by the UK rail industry.

The interviews were analysed using thematic analysis (Braun & Clarke, 2006), which revealed themes that presented the innovation landscape of the industry, these are: 1) **structure of industry**, 2) **franchising system**, 3) **barriers along the innovation process**, 4) **culture and people**, 5) **funding**, 6) **external barriers-political/government hindrances, and role of media**. The findings revealed that the identified themes create barriers that hamper innovation in the UK rail industry. The qualitative data analysis, revealed that the identified barriers to innovation varied with the nature of the stakeholder with respect to their job role and expertise. The innovators mostly faced barriers related to funding, regulation and standards, and breaking into the industry. Wider barriers such as lack of collaboration mechanisms, fragmented structure of the industry were identified by middle management. The core barriers such as the lack of strategy and poor markets were identified by the directors who had an overall view of the business. As such, conducting a stakeholder analysis to identify the interviewees with diverse experience levels within an organisation enabled the researcher to capture a multi perspective view of the innovation landscape in the UK rail industry. As identified and analysed in the literature review, the analysis of the findings revealed strong inter dependency and interconnections among the identified themes. The conceptual model presented fellow in Figure 5.2 helps visualise the linkages and influences of the identified barriers to innovation which when addressed can lead to a sustainable competitive advantage in the UK rail industry.

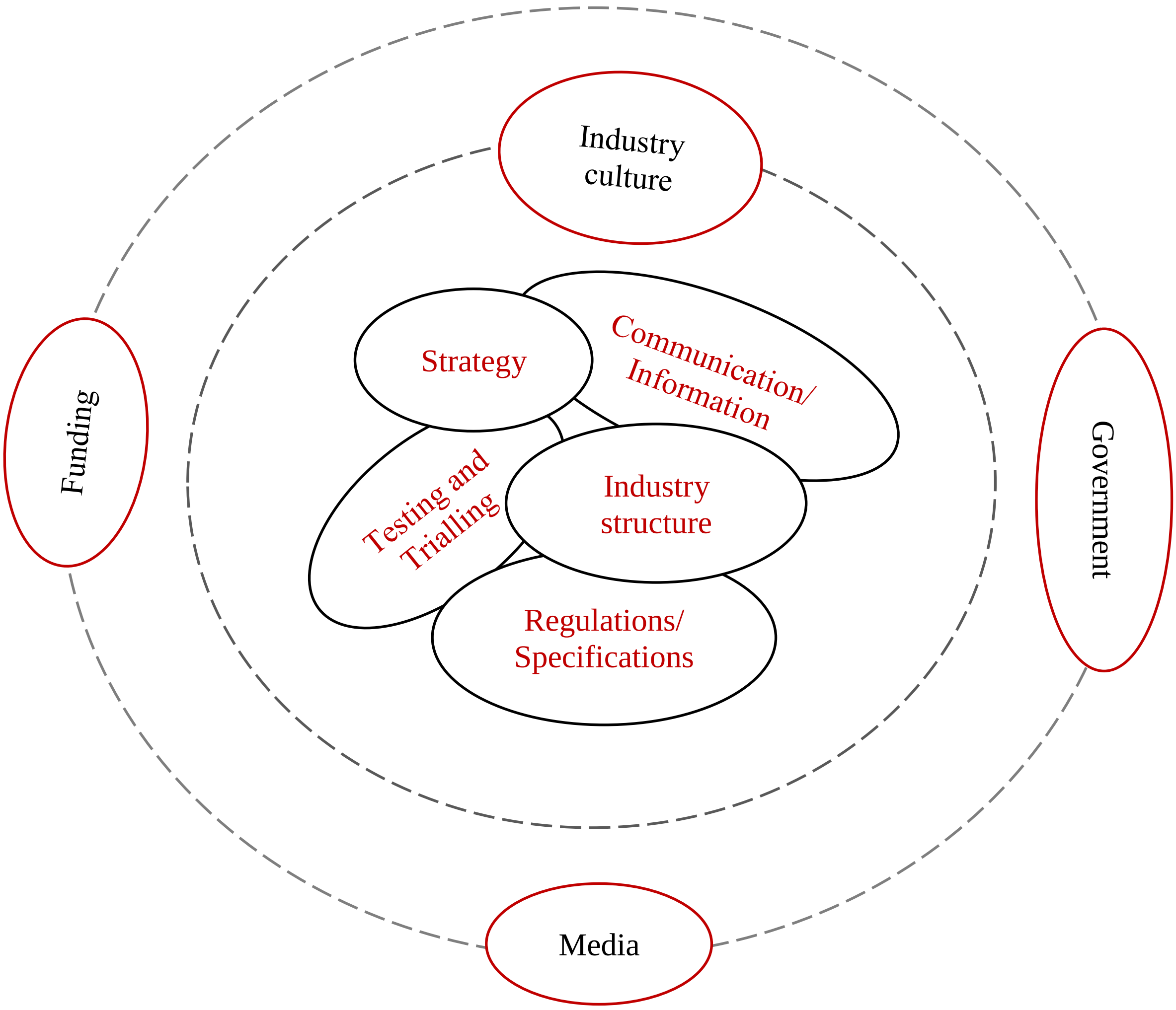


Figure 5.2 - Conceptual model of the findings

5.2.2.1 Conclusion

As evident from Figure 5.2, the UK rail industry faces barriers to innovation, grouped into three areas of influence, as predicted by the literature review. In continuation with the three bodies of knowledge reviewed on the literature, the UK rail industry at the core faces barriers to innovation due to the lack of a robust innovation strategy and other barriers emerging from it. These are further influenced by the innovation culture prevailing within the industry.

Industry specific factors of funding, and government and media influence, were then found to impact the overall innovation landscape in the UK rail industry.

All the elements presented in this section, are further discussed within this chapter via specific research questions that aim at identifying the barriers, with their sources and impact, on innovation.

Having summarised the literature upon which this research has been built and the findings, the following section discusses them in light of the reviewed literature, in order to answer the research questions.

5.3. Research questions

Having revisited and discussed the reviewed literature and the findings of this research, this section consists of their synthesis in order to answer the research questions. This research consists of three main questions pertaining to transportation, innovation and strategy in line with the conceptual model of the reviewed literature presented in Figure 5.1, and the respective sub research questions in accordance with the conceptual model of the findings presented in Figure 5.2. Before starting the discussion, a visual presentation of the structure of this section, as per the research and sub research questions, is presented in Figure 5.3.

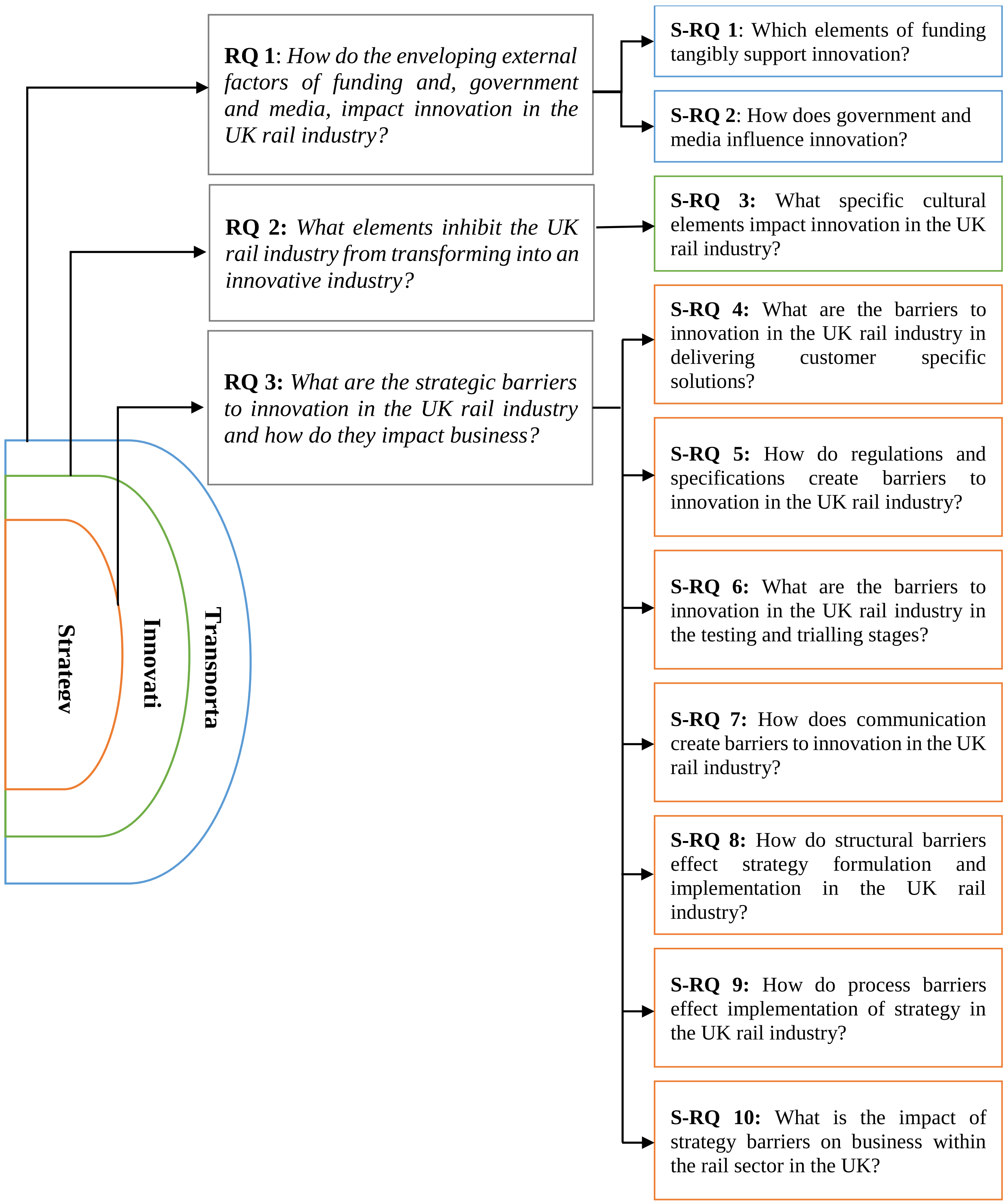


Figure 5.3 - Structure of discussions

5.3.1 RQ 1: How do the enveloping external factors of funding and, government and media, impact innovation in the UK rail industry?

As identified by the reviewed literature, various factors impact innovation (c.f (Madrid-Guijarro *et al.*, 2009) (Ross *et al.*, 2012) (Orcutt & AlKadri, 2009a; Orcutt & AlKadri, 2009b)), with varying influence. The findings confirm the interrelations and influences of these factors. However, two factors stood out to have an overall impact on the entire industry, irrespective of the local characteristic of the stakeholders. These are funding and the role of government and media. The findings revealed that these overarching factor persist across the innovation chain fuelling and/or contributing to other emerging barriers. In order to study the influence of these external factors two sub research questions have been formed to discuss each of these factor individually. These are discussed below:

5.3.1.1 S-RQ 1: Which elements of funding tangibly support innovation?

As indicated by the literature review and confirmed by the data analysis of the findings of this research, funding forms the fuel for innovation. The common theme in the extant literature spanning over decades, strongly suggests that financial resources are key supporters of critical activities of innovation (c.f (Moore & Garnsey, 1993)), including experimentation, idea generation, testing, prototyping, commercialization, customer surveys, and collaboration (Gibbert *et al.*, 2014).

According to the literature, the financial resources of a firm are found to support its innovation activities (Davenport, 2013) (c.f (Branscomb & Auerswald, 2002)), whereas the lack of it can limit the level of innovation of a firm (Archibugi *et al.*, 2013). Based on the findings of this research, there is an overall lack of funding in the UK rail industry, which limits innovation, as mentioned by IO13: '*We are funded to maintain the railway; we are funded to do a limited amount of enhancement*'. In addition, as stated by G38: '*Funding, well the amount of investment of the rail sector as a whole in innovation is we reckon about 0.5% of turnover. The UK average is about 1.7% so I think it is at least three times lower than the average, and the railway is quite a technical sector so you would expect it to be above average rather than three times below average and also it is much lower than the investment levels of other countries for example Germany and China*', and IO15: '*Because a lot of them are saying you want us to invest our resources in addressing your challenges, so we would expect you to fund in part not necessarily the full amount of money to come up with those ideas. But the problem is we don't have that funding ourselves*'. This forms an issue especially in higher Technology

Readiness Levels (TRL), which are associated with testing and trialling in the concerned environment, in order to gain compliance as per industry standards, and manufacturing and commercialisation, with continuous monitoring whilst in market to establish continuous safety and compliance. As identified in the literature review, innovation activities in many cases requires a prior investment in highly sophisticated technical equipment which raises the possibility of producing unique, diverse and high quality products, which results in an increased value for the firm (Kostopoulos *et al.*, 2002). Higher TRL levels are associated with high costs, and can prove to be prohibitive for SMEs. Throwing light on the costs associated with developing innovation, C7 explained: '*You have to fund it all as the innovator from the idea to the development cost to prototype to product manufacturing to installation all the way through till the end of the trial installation. And at the end of trial installation they decide they don't want it then you pay the costs of its removal as well and the reinstatement of anything that you would have changed*'. As mentioned in the findings, innovation struggles to pass through higher TRL levels due to lack of funding, cultural barriers, gaining access to tracks for trialling, and the nature of the industry standards and specifications. For example, RS24 while explaining the funding scenario said: '*[...] the problem then becomes let's say you have got to TRL 6 and you have got a prototype that does whatever the challenge was, then the problem is the lack of funding to take it onto the next stage and commercialise it*'.

The literature review strongly suggests that financial resources determine the speed of development of innovation (Archibugi *et al.*, 2013) and help build an appetite and tolerance for risk (Dodgson *et al.*, 2015). The findings of this research however, record that the funding does not fully address the risk averse nature of the UK rail industry. In addition, the current funding scenario and funding mechanisms in the industry were found to slow down the innovation process and contribute to the associated risks. The fragmented structure of the industry, and the processes involved in securing funding were strongly found to be associated with the speed of innovation. As TOC26 said: '*[...] but I think also some of the funding situation is a barrier. So you know the time taken to decide and secure funding for a given project and again you get to the point where and then who is delivering it for you*'. And as M25 explained: '*It slows you down because once the application goes in you have to wait for I don't know how long, if it is six months well that is half of the overall project time. Fifty percent of the project time is waiting for approvals, so you are delaying yourself by a huge amount in the grand scheme of things*'. The funding scenario in the UK rail industry also creates barriers in terms of the risks involved, which arises from the cultural barriers within the industry and from the fragmented structure of the industry. The complex network of a large number of stakeholders increases risks and hinders collaboration as IO15 said: '*So basically the problem is that it is more related to funding, I mean even though we want to do much our hands are tied because of funding and because of the nature of the industry. So safety critical you can't risk*'. Funding also increases risks when innovation is self-funded. The findings of this research found two main reasons for the adoption of self-funding: 1) the lack of funding and the complex terms associated with various funding options. For example, I2 while explaining the experienced funding barriers of requiring upfront investment by the innovator said: '*But that is more difficult because that means although you are getting a grant, it means you are getting your money back eventually but you haven't got any money upfront. You know you can go to a bank […] unless your company has got a track record, if you are an innovator where are you going to get £100,000 from. They first thing the bank will say is that give me the deeds of your house [...] but it certainly is a problem from the point of view of risk. As consequently there is no way I will put my house on the line, not now when I have got to this age*'. And 2) the IP issues associated with using external funding. For example, M25 said: '*I think the reason for that is because once you got to external funding you will have to declare what you are working on, which from an IP perspective isn't necessarily the best*'. This is reflected by Transaction-costs Economics and Agency literature, which reports that a firm's internally generated funds are more favourable to a firm's Research and Development (R&D) activities and investments (c.f (Camarero *et al.*, 2011)) than external funds. Kostopoulos *et al.* (2002), identified that this is because there is a risk of competitors gaining information on R&D projects and the firm losing control over their innovation due to the information asymmetries that exist between firm and the external capital market (Kostopoulos *et al.*, 2002).

The literature review of this research has extensively discussed the role of resources such as financial resources in order to gain competitive advantage. As discussed, RBV strongly emphasis that a firm's resources when worked upon using firm's capabilities, have the ability to transform into competitive advantage for the firm. Bakar and Ahmad (2010) in their research state that intangible assets are found to contribute more than tangible assets in creating value. However, the funding in the UK rail industry faces capability barriers in terms of leadership, and knowledge and skill in order to tangibly support innovation. An example found in findings as stated by TOC36 while describing the attitude of the leadership is as follows: '*one of my directors who I report in to, when I told him about TOC 16 he said "how big is the pot" and I said £4M, and he said – well I was expecting him to say "okay what ideas do you think we* *might come up with". And what he said was "okay get me two million pounds of it"*'. Funding also fails to generate optimum results due to the lack of skill and knowledge, especially for the SMEs, to produce successful funding applications. When competing against established firms, the SMEs have a higher probability of being unsuccessful in their funding applications. For example, I1 said: '*in the UK company like […] they got whole department of people who have spent their whole life doing funding and when I have applied for funding I have barely been able to meet the deadline, I couldn't complete it. But how can I compete with that if somebody is being paid to do nothing but 6 months looking at one funding report. They can work 30-page report consultancy level and do that and me I am struggling at the last few minutes trying to get the last few pages in, then you got no chance*'.

Another key requirement, as discussed extensively in the literature review, for a resources (such as financial resources as being discussed in this section) to deliver tangibly results is its strategic management. The findings in contrast reveal that the funding scenario in the UK rail industry is more concentrated on short-term returns, owing to the short funding cycles and lack of overall funding. The short operational cycles further hamper funding from producing tangible results due to the poor-business case arising from it (c.f (Herzlinger, 2006)). The critical role of strategy in making available the resources and exploiting them to gain competitive advantage as found in the findings of this research is highlighted by RS24 in the following example: When comparing UK rail industry with other transportation sectors RS24 said: '*if you look at the other sectors automotive and aerospace they have done that superbly well and their strategies have been consistent for about the last five plus years and they have had all of the industry singing on the same hymn sheet and they have consistently made incremental cases for funding against their overall strategy*'.

Conclusion

In conclusion, having discussed the findings of this research in light of the reviewed literature, for funding to tangibly support innovation, three elements are required. For funding to become a resource for gaining competitive advantage, it first needs to be well specified in the strategy, followed by being strategically managed as a resource to satisfy the overall strategy, and supported by the capabilities to ensure its successful exploitation and replenishment to support innovation. A perfect example to demonstrate these three elements of funding, can be found in the findings of this research as stated by TF11. TF11 was strongly associated with the world class rail testing and trialling facility called the Transport Technology

Centre Inc. (TTCI) in Colorado, who had tried to expand their business to UK. However due to the barriers to innovation, the organisation was not successful in expanding to UK market. TF11 explained the role of funding as follows: '*one big benefit we had is facilities that you mentioned the TTCI the facility itself was created in 1971 by the united states congress that was funded by the US Congress to be established as the high-speed ground test centre. […] and the feds put in money to put together this facility which includes all of the track age that we have around about 50 miles of track on site we have full scale laboratory building here. So that was sort of already there when the AAR (Association of American Railroads) walked in 1982 and said that we would like to take over the operations of the facility because in 1982 the government had decided to close the place down. […] if it were true that this place did not exist to government funding I very much doubt whether we be investing that kind of money ourselves in terms of an industry a private industry so I guess what I'm trying to get at is there should be some consideration given to government funding to provide the I guess the stability and sustainability to do innovation*'. As can be seen from the above example, funding when envisioned in the overall strategy by the government, laid down the foundations of a world class testing facility, which when strategically managed by the concerned rail association, paved the way for further investments over time, while mitigating risks as perceived by investors of investing in private sector. The capabilities of the industry enabled the continuous replenishment of the financial resource by transforming the initial funding into a continuous source of funding used for world class Research & Development, and testing and trialling of innovation. As such, in this case, the three elements of strategy, strategical management of the funding resource, and its exploitation via the industry capabilities, tangibly supported innovation by means of establishing a world class research and testing facility to develop innovations.

A conceptual model adapted from Covey (1989), has been developed to present the influence of funding on innovation in the UK rail industry. It is presented below in Figure 5.4.

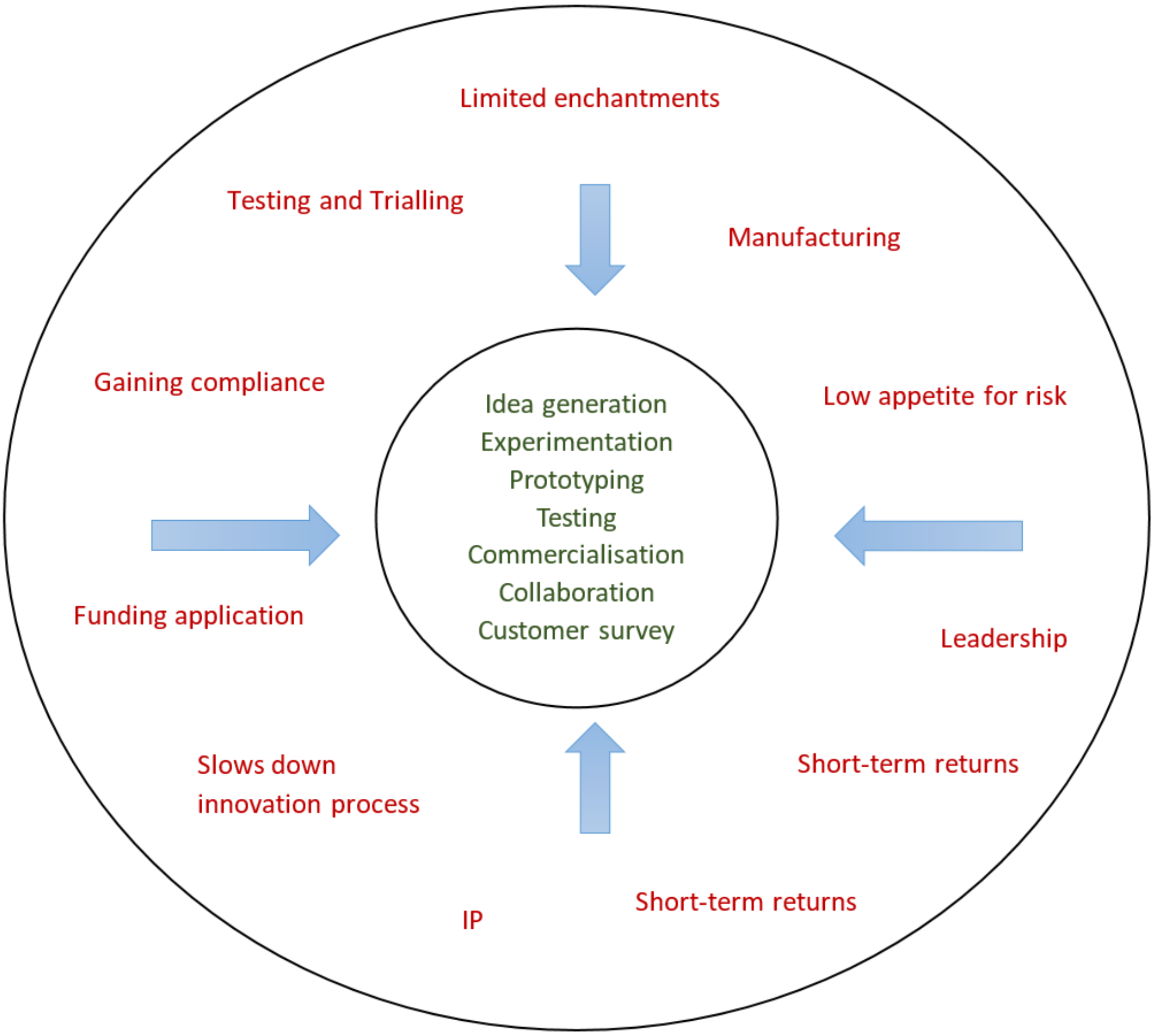


Figure 5.4 - Conceptual model of how funding impacts innovation (Adapted from Covey (1989))

In Figure 5.4 the inner circle represents the circle of influence that is, how funding can influence innovation. The outer circle represents the circle of concern, which is how the funding in the UK rail industry is currently influencing innovation. As shown in Figure 5.4, in the current rail industry, the circle of concern is bigger than the circle of influence. As stated by Covey (1989) in order to influence change, efforts must be focused on the things that can be influenced. By doing so the circle of influence will start to increase, increasing the effectivity and power of funding.

5.3.1.2 S-RQ 2: How does government and media influence innovation?

The literature review of this research indicates that political powers, irrespective of having a financial stake in an organisation, have a power to influence events that can have an impact on an organisation (c.f (Wang, 2018)). In return, innovation supports the main role of the government in helping to co-create a society that improves the life of its citizens and create markets for business to compete and prosper (Verbeke & Tung, 2013).

However, when reviewing innovation, it was found that a number of studies have shown that the barriers to innovation are mostly related to government policies, in addition to costs, human resources, organisational structure and flow of information (Madrid-Guijarro *et al.*, 2009). Similarly, lack of government support was recorded as a barrier to innovation in Spanish manufacturing SMEs by (Madrid-Guijarro *et al.*, 2009). The findings of this research also record barrier to innovation due to the lack of government engagement/interest. As TOC30 said: 'a*ctually in the government I think they lack vision*', and M4 said: '*You can't without having an overacting body, and you know regulators if you like the government or regulator probably don't like to get involved*'. This creates barriers especially when the industry structure is fragmented and complex, as revealed in Chapter Four - findings. Having various different reporting bodies, aligning of strategies becomes challenging and gives rise to lack of direction for the whole industry. In a study of innovation in UK logistic services Mena *et al.* (2007) found that due to the economic growth, the logistics chains are growing longer and more complex, decreasing visibility and increasing risks. According to the findings of this research, in the UK rail industry this complex network impacts funding as along with the lack of structure, vision and direction, bureaucracy prevails in the industry and some investments are made according to political priorities. The current political situation in terms of Brexit also creates uncertainties in the business.

In terms of branding and positive promotion, media can have a big impact on the innovation scenario in the UK rail industry. Unfortunately, media plays a negative role in the promotion of innovation in the UK rail industry. The findings suggest that the industry lacks positive media presence which creates nervousness about bad publicity among the management. This demotivates them and creating an environment which does not allow risk taking to innovate. As conveyed by C7: '*But the failures get spoken about than successes'*, there is an urgent need to highlight the UK railway industry's success stories, as they are not advertised/communicated as extensively as there is a need for. As such, for potential innovators and investors it creates an image of an unprofitable and risky business venture, thus, hampering innovation.

Conclusion

In conclusion, the government and media are found to negatively influence innovation in the UK rail industry; however, if addressed, these factors have the potential to positively boost innovation as suggested by the reviewed literature. In light of the above discussion, the main influence of the government was recorded in the funding area, as section 5.3.1.1 reveals that there is an overall lack of funding in the UK rail sector, and a lack of vision/direction from the government to implement a robust industry strategy. Negative media presence further creates barriers to innovation by fuelling the risk-averse nature of the industry as identified in the findings sub-section 4.2.2.6, demotivating the management, and limiting entry of potential innovators and investors as it creates an image of the UK rail industry as an unprofitable and risky business venture. Figure 5.5, below presents a circle of influence and circle of concern model to summarise the discussion of this section.

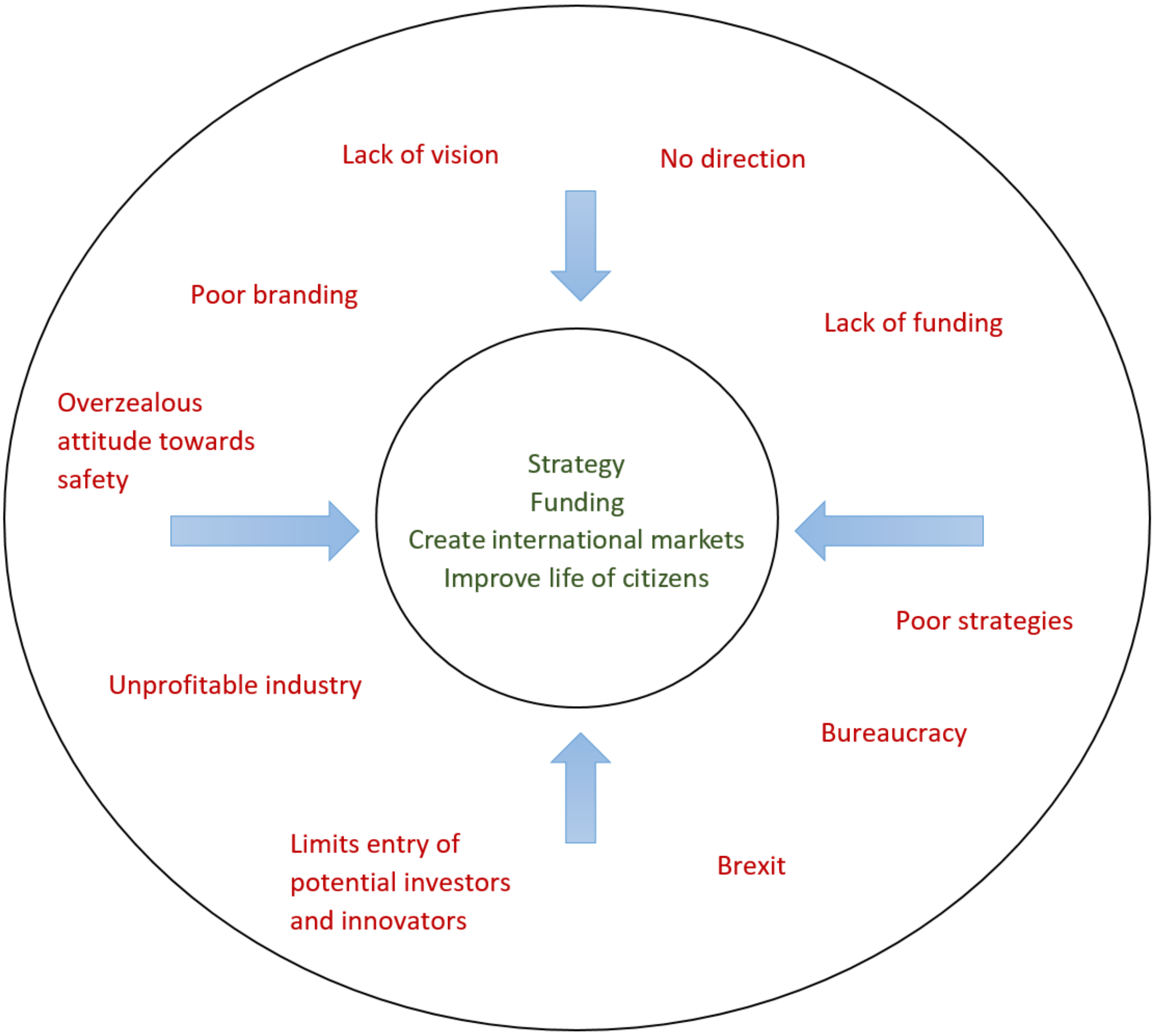


Figure 5.5 - Conceptual model of how government and media influence innovation (Adapted from Covey (1989))

As shown in Figure 5.5, the government and media negatively influence innovation in the UK rail industry. The inner circle represents the potential influence government and media can have on innovation, and the outer circle presents the concerns raised by government and media that form a barrier to innovation.

5.3.1.3 Overview of the first research question RQ 1

The above discussions in section 5.3.1.1 and 5.3.1.2, discussed the role of funding and the government having an overarching influence on innovations in the UK rail industry. The key revelations of the discussion can be summarised as: the lack of funding inhibits innovation as it caps the ambition of innovation, provides very little room for taking risks, increases failure risks, negatively impact innovation development and slows down processes. The findings suggest that there is a lack of internal funding within the industry, and as such, it mostly depends on funding from the government. However, the bureaucracy and political agendas create an uncertainty pertaining to funding. It is also revealed that the industry needs more involvement from the government in terms of establishing a direction for the rail in UK. The lack of an on overall strategic vision makes it difficult to align the strategies of a large number of stakeholders. Negative media presence further creates barriers to innovation by fuelling the risk-averse nature of the industry.

Having discussed the overshadowing factors that impact innovation in the UK rail industry, the next step is to study the middle level factors that impact innovation.

5.3.2 RQ 2: What elements inhibit the UK rail industry from transforming into an innovative industry?

Beliz Ozorhon *et al.* (2014) argues that a conservative environment requires a cultural change for the successful diffusion of innovation, which is brought about by teamwork and mutual trust within the partners. For an organisation to gain competitive advantage, and produce innovation, Apsalone (2017) emphasised that the organisational purpose must reflect within its employees. Kendra and Wachtendorf (2003) further added the importance of creating anenvironment that encourages new ideas and new ways of achieving goals, and flexibility for experimentation and for adapting to the external and internal changes. In addition Tyas Indah Twi *et al.* (2018) highlighted the need for a continuous feedback loop of learning. These are reflected in the culture of an organisation. Studies have suggested a strong link between the capacity to innovate, and long-term thinking, risk-taking abilities and individual responsibility (Apsalone, 2017); and the decision making processes and the ability to adjust to external changes is strongly impacted by organisational culture (Throsby, 2001).

Thus, the following sub research question discusses the cultural elements that impact innovation in the UK rail industry.

5.3.2.1 S-RQ 3: What specific cultural elements impact innovation in UK rail industry?

The literature review of this research, extensively discussed the cultural elements that impact innovation, in terms of strategic management of innovation, gaining sustainable competitive advantage and creating value through innovation, and the barriers it creates to innovation. The findings also explored the culture and people in the UK rail industry and how it influences innovation.

Molina-Morales *et al.* (2014) argues that internal environment of an organisation requires a suitable pre-set innovation culture, utilisation of specialists and temporary teams, and the flexibility and speed to respond to new opportunities, in order to increase its innovation potential. The characteristic features of such organisations as suggested by Urbancová (2013) thus, include flexibility, openness to change, inclusion of information and resources in the external environment, anticipation, creativity, and experimentation and informal communication. From the secondary data analysis of this research, Arthur D. Little (2014) in the study of improving route to market for new product/service innovations briefly touched upon the impact of culture on innovation in the UK rail industry and suggested that the UK rail industry to have a risk adverse culture where taking risks associated with innovation were are not considered worth investing in, due to costs, strict regulations, and lack of innovation risk management capabilities. The primary data findings of this research also suggest, as said by C19: '*the rail industry is a very conservative industry, it is also a very old industry so there is they have a lot of cultural barriers not invented here, we tried that it didn't work*'.

According to Ojasalo (2008) and McCosh *et al.* (1998) innovation culture forms a key element of strategical innovation management (c.f (Apsalone, 2017) (Tyas Indah Twi *et al.*, 2018)), and it involves appreciable freedom of action, resources to educate the employees about new technologies, and using teams of highly skilled employees. The findings however, suggest that the industry is paralysed by, as stated by TOC36: '*we have always done this way*' culture. This presents a barrier to innovation as it eliminates the probability of entertaining new ideas, taking risks to develop it, and accepting that failures are a part of the innovation process. Over all the industry was found to have a: G38: '*very low appetite for risk*'. The failures of the past and the media coverage it received contributes to the risk-averse culture of the industry, as it builds an overzealous attitude towards safety among the management. The prevailing culture struggles to cope with the recent shift to innovation as said by TOC27: '*That speed of change is just not something that we in the rail industry have had to face*'. This risk-averse nature and overzealous attitude towards safety further adds time and costs to innovation processes. Another impact of the current industry culture is the reluctance of the industry to adopt innovation developed in other environments, as stated by: C19: '*so there is they have a lot of cultural barriers - not invented here*' and TOC27: '*are very negative in people have traditionally had quite closed minds to if it's not invented here*'.

Dougherty (1992) stated that organisational culture is a major barrier to innovation. Similarly, Al-Ali *et al.* (2017) argued that in addition to leadership or change agents, change is not possible without the organisational culture and the commitment of those involved in the change process. But as concluded by the findings of this research the safety critical culture is so deeply engraved in UK rail industry that it has become an automatic reaction to innovation proposals, without fully considering the benefit of innovation. The leadership (c.f (Beliz Ozorhon *et al.*, 2014)), in light of the culture in addition to the negative media coverage, the fragmented industry structure, and the franchising durations was recorded to be unwilling to take risks and commit, especially when returns on investments could not be proven due to limited operational time frames. With the directors deciding down to the very granular levels without giving the staff the freedom to find and apply innovative ideas and solutions, gives rise to the TOC36: '*what is in there for me*' attitude and inhibits the development of an overall organisational culture of innovation. The conservative, and safety critical culture of the industry also influences the middle management as TOC36: '*The middle management who have always done their job in a certain way for ten, fifteen, twenty years […] can't understand how to change to and are not bought into innovation at all*'.

Conclusion

In conclusion, the culture in the UK rail industry was found to negatively impact innovation. The specific cultural element that influence innovation in the UK rail industry are the conservative, safety critical, and risk averse nature of the industry. Such a culture manifests itself strongly among the key enablers of change, that is, the leadership. As argued in the literature, the culture of an organisation can be an enabler of innovation, as organisations with an innovative culture are found to create loyalty arising from employee engagement to fulfil the organisations goals and performance (Urbancová, 2013). However, the findings of this research reveal that the leadership in the UK rail industry displays an overzealous attitude towards safety. Thus, failing to understand the true benefit of innovation. Other external influences such as the negative media coverage the past failures have received, further discourages the leadership. With very little room for failure, the leadership is pushed to make decisions to the very granular levels, limiting creativity and innovation among the employees, which builds a 'what is there for me' culture among the employees. As such, the industry fails to fully exploit its employees as a valuable resource to a firm for gaining sustained competitive advantage, who are always open to opportunities from competitive firms in order to improve their overall wellbeing (Verbeke & Tung, 2013). Therefore, firms should make a conscious effort to deliver ethically appropriate benefit packages to employees (Hosmer & Kiewitz, 2005) as reward to recognise and encourage the innovation culture in a firm. Figure 5.6 below presents the potential influence that culture can have on innovation and the concerns that cause a barrier to innovation as identified in the UK rail industry.

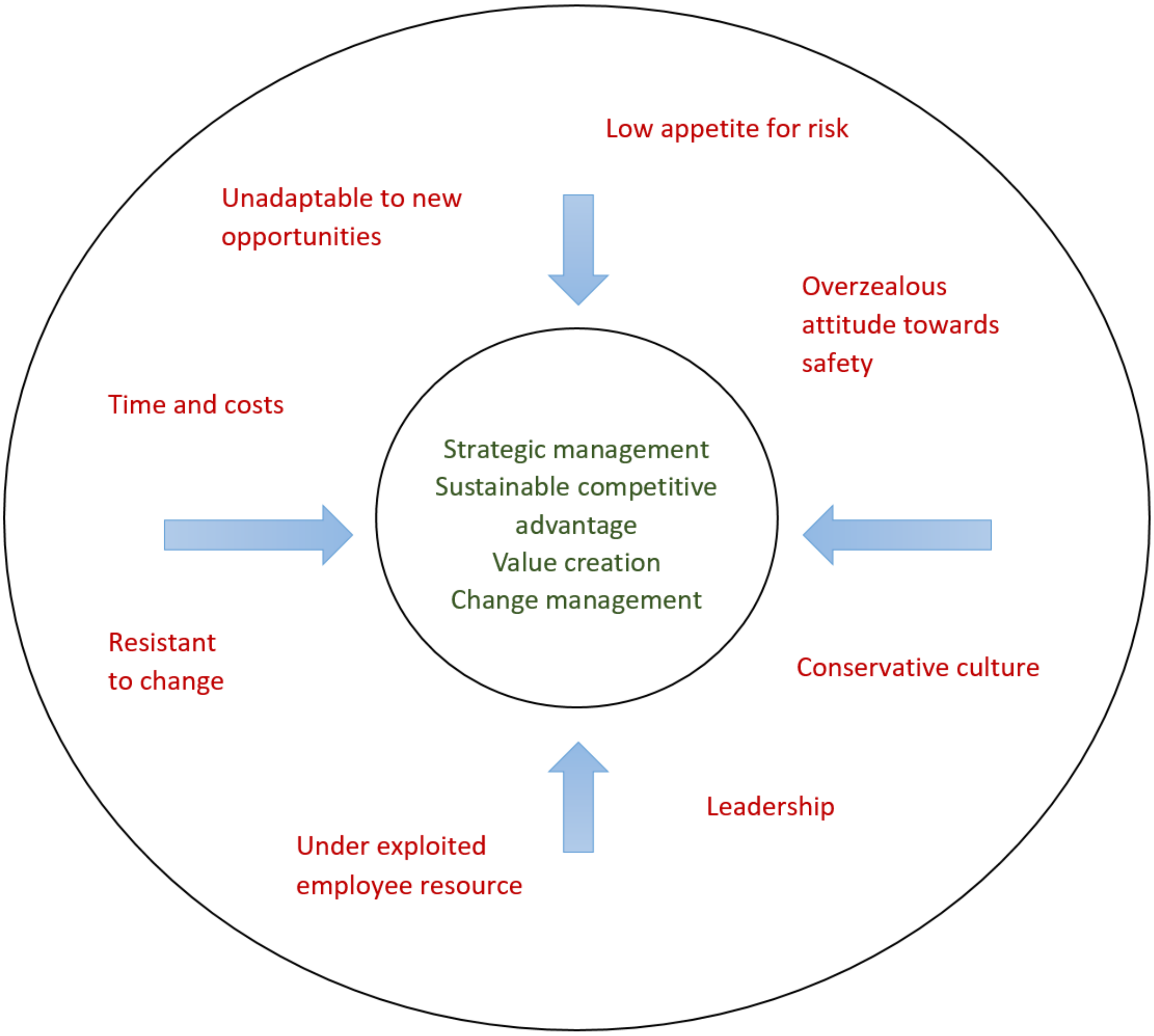


Figure 5.6 - Conceptual model of impact of culture on innovation (Adapted from Covey (1989))

As is evident from Figure 5.6, the inner circle of influence is smaller than the outer circle of concern, thus, suggesting that the culture in the UK rail industry has more negative impact on innovation as deduced from the findings in Chapter Four, than its perceived positive impact as identified in the literature review of this research. In order to bring about an effective change, the industry culture needs to increase its potential influence to address the identified concerns, resulting in accelerated innovation.

5.3.2.2 Overview of second research question RQ 2

The discussion presented above in 5.3.2.1, confirms the role of organisational culture as an enablers of transforming an organisation by supporting innovation. In the UK rail industry, culture strongly inhibits innovation as the findings recorded a poor innovation culture within the industry. The key cultural elements revealed that inhibit innovation are the conservative nature and an overzealous attitude towards safety, that creates resistance to change. A poor innovation culture thus, cripples the leadership by discouraging them and as a result, the human resources of an organisation remain underexploited.

The next section now moves to discussing the issues hampering innovation, which lie at the core of the UK rail industry.

5.3.3 RQ 3: What are the strategic barriers to innovation in the UK rail industry and how do they impact business?

The literature identified strategy as a long term direction of an organisation (Johnson *et al.*, 2017). Omalaja and Eruola (2011)expanded the scope of strategy and defined it as the pattern of decisions, that conclude and review its purpose, goals, objectives, formulate its policies and plans for achieving these goals and defines the businesses the company is going to pursue and the kind of human and economic organisation it is or intends to be, and the kind of economic and non-economic value it intends to create for its stakeholders (Omalaja & Eruola, 2011). Again, an innovation strategy must have clearly defined goals and objectives and defined strategic areas of focus which tie into broader business goals (Cooper & Edgett, 2009). Inter organisational actions when aligned strategically, tactically, and operationally, lead to innovative products, which are commonly characterized as being novel, valuable, and frequently introduced (Kim *et al.*, 2015). As such, strategy impacts a wider range of factors leading up to innovation. In order to facilitate a thorough discussion, seven sub-research questions are discussed to cover the various aspects as identified by the findings in the UK rail industry, which are influenced by strategy, and create barriers to innovation.

5.3.3.1 S-RQ 4: What are the barriers to innovation in the UK rail industry in delivering customer specific solutions?

The main barrier to innovation as identified in the findings of this research, is the lack of vision and strategy within the industry. The reviewed literature, indicates that in the current dynamic markets, ongoing success typically requires innovation and change (Sull *et al.*, 2018). Improvements in performance depend widely on innovation, and an effective innovation requires a strategic approach. As characterised by Dodgson *et al.* (2015), an effective innovation strategy consists of a systematic way of decision making and efforts in order to improve innovation within and across organisations. Similarly, Cooper and Edgett (2009) argue that an innovation strategy must have clearly defined goals and objectives and defined strategic areas of focus which tie into broader business goals. However, the findings reveal, as stated by TOC18: '*there doesn't seem to be any great overall strategic plan*'. The qualitative result is supported by the survey results, which found that approximately 90% of the participants answered 'no' to whether there exists a robust innovation strategy within the industry. The lack of a strategic vision in a dynamic market, hampers innovation, as the industry fail to identify, exploit and replenish its strategic resources (c.f (Kim *et al.*, 2015)).

Various other barriers stem from the lack of an overall business strategy. With no systemic and strategic means of identifying the challenges faced by the industry, the findings suggest that there is a lack of understanding of the problems faced by the industry. For example, TOC23 said: '*So I think selling what the industry is about, where the industry is going, and what the industry actually needs and some of that is stuff that they don't even know what it needs*'. The poor understanding of the problem can lead to the delivery of poor solutions, as stated by C7: '*In many ways it was us saying we believe you want this, we think you want that. And if they agree fine and if you don't get any response then you have to make judgement*'. Further barriers are created due to the poor communication of innovation needs of the industry (c.f (Ulijn, 2000)). According to the American Management Association survey (Gill, 2002), the keys to successful change are first and foremost leadership, followed by corporate values and communication (Gill, 2002). However, in the UK rail industry: RS24: '*clients don't make clear to the innovation fraternity what their challenges are*'.

Defining in the context of product lifecycle, such as in railways where vehicles and other infrastructure has a life span of 40 years or more, Cooper and Edgett (2010) define innovation strategy as a long-term commitment. Gaining higher competitiveness by means of innovation means producing higher quality goods and services at lower costs as compared to the competitors (Urbancová, 2013). Whereas, the findings record that innovation in the UK rail industry is based on short-term return, and are reactive in nature. As mentioned by TOC34: '*Why would you plough money into something if you couldn't see a pay back, so that's been lost to a large extent and because everything has to have a commercial case there isn't really a great deal of R&D*'. This lack of R&D negatively impacts innovation as Zemplinerová (2010) argue that the expenditure on research, development and introduction of innovation are the determining factors of gaining a dominant market share (Urbancová, 2013).

Developing successful technological innovation is fundamental to creating and sustaining an organisation's competitive advantage (Martín-de Castro *et al.*, 2013). In light of the previous discussions on the role of funding, government and media, and culture, the industry was found to concentrate most of its resources on safety. This creates a barrier as: C19: '*Why are we spending money on making rail safer, when if we spent that same money on making it more attractive, more innovative, more customer friendly we would save loads of lives because we would get people off the road and onto the train*'. This disconnect from the customer jeopardises gaining competitive advantage, as by offering innovative solutions to customer problems, a firm earns their loyalty, purchase intent, positive attitude and minimised scepticism regarding the quality and ethical issues related to the product/service (Verbeke & Tung, 2013). Stakeholder theory states that treating stakeholders well and taking care of their interests helps a firm to create value along a number of dimensions and therefore enhances performance (Freeman *et al.*, 2007) (c.f (Juntunen *et al.*, 2018)). It supports the idea that stakeholders depend on the firm and on other stakeholders to satisfy their own interests (Harrison & Wicks, 2013).

Lastly, the findings reveal that innovation is mostly interpreted as technical and radical: TOC22: '*and when you probe them on this you find that they are always thinking about that radical change*', resulting in loss of other innovation opportunities. However, the current competitive environment demands organisations to have multiplicative levels of improvement in business performance. According to Davenport (2013), a business should be viewed in terms of its key processes and innovative technologies and organisational resources should be employed to improve them. As the OECD (2018) definition states, the innovation process involves both the product innovation and process innovation. Successful companies overcome the traditional understanding that a trade-off exits between customer value creation (via product innovation) and cost control (via process innovation). It has been recognised that organisations need to be aware of both of these innovations and invest in different innovation activities simultaneously, in order to improve the current services and reduce the costs of delivering these services (Wagner, 2008). Drejer (2002) summarised the activities of strategically managing innovation into: technical integration, the process of innovation, strategic technology planning, organisational change, and business development (Ojasalo, 2008). As such, the Rail Technical Strategy falls short of being a strategy and as the findings reveal, the document is widely criticised as: TOC36: '*I would honestly say that the RTS at the moment is an advisory document at best. It is there, out there to try and influence what we do; I wouldn't say it governs what we do at all*'. Also: G38: '*It's the business side of things that has not fully bought into this*'. This lack of a business strategy to support the Rail Technical Strategy results in short-sightedness: M16: '*what's the market going to require in the next ten years*' of the industry owing to the lack of an overall strategy. Thus, when considered along with the fragmented structure, lack of communication and short operational periods, there is a lack of relationship development for long term strategic planning and development.

Conclusion

In conclusion, the barriers to innovation to delivery customer specific solutions, in the UK rail industry are due to the lack of an overall strategy, and other barriers stemming from it, which includes, poor identification of challenges and opportunities, poor identification and exploitation of innovation resources and capabilities, disconnect from stakeholders which prevents optimal value creation, and replenishment of industry resources and capabilities, and poor understanding of the benefits of innovation. A conceptual model has been developed to present this discussion in Figure 5.7 and **Error! Reference source not found.** below:

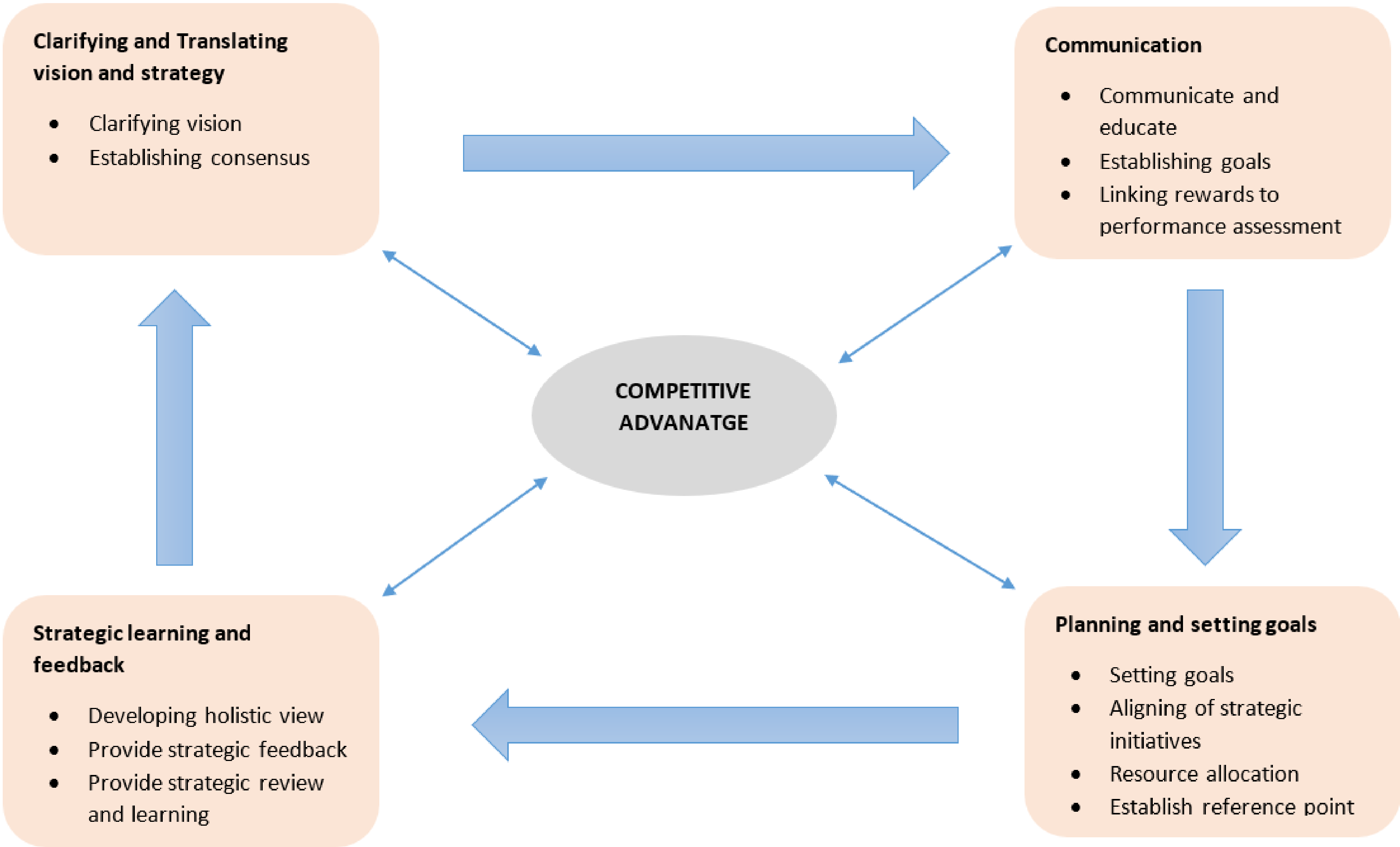

Clarifying and Translating vision and strategy
Clarifying vision
Establishing consensus
Communication
Communicate and educate
Establishing goals
Linking rewards to performance assessment
COMPETITIVE ADVANATGE
Strategic learning and feedback
Developing holistic view
Provide strategic feedback
Provide strategic review and learning
Planning and setting goals
Setting goals
Aligning of strategic initiatives
Resource allocation
Establish reference point

Figure 5.7 – Balanced scoreboard approach to strategical barriers to innovation (Adapted from (Manica *et al.*, 2017))

Figure 5.7 presents a balanced scorecard approach to present the discussions of this section. In the current market of increased competition, it is necessary to take into account other aspects of performance in addition to financial measures (Kaplan & Norton, 2005), in order to measure organisational performance (Hakkak & Ghodsi, 2015). In the modern system of management, balanced scorecard is a comprehensive system of performance evaluation that enables organizations to make clear their vision and strategy and turn it into action (Hakkak & Ghodsi, 2015). As identified in the discussion above, poor management of these four stages presented in Figure 5.7 create barriers to delivering customer specific solutions in the UK rail industry.

According to **Error! Reference source not found.**, deliver customer specific solutions it is necessary to: 1) identify customer needs, 2) identify how best to create value, 3) the core competences required for it, and 4) implement feedback and organisational learning to modify and adapt strategic goals (Rothaermel, 2013). The UK rail industry experiences barriers in these four stages, which when addressed can enable gaining sustained competitive advantage.

5.3.3.2 S-RQ 5: How do regulations and specifications create barriers to innovation in the UK rail industry?

Both the literature review and the findings of this research identify barriers to innovation due to regulations and specifications (c.f (Blind, 2012)). As discussed in the earlier sections, the UK rail industry has a dominant safety culture, which makes it highly regulated. This stifles innovation especially in the current rapidly evolving technology era. For example, TOC30: '*it is very highly regulated so that I think also is something that stifles innovation when it is too regulated and I mean if you look at the digital information screen, […] you know that technology moves very quickly*'. The complex mix of a lack of direction, a risk-averse culture, lack of support from government, and continuous scrutiny by the media, pushes the industry to adhere to the strict standards of the past, with very little flexibility for change. TOC34 described the barrier as: '*I think this is a really big issue in the UK Rail Industry is the constraints of these overzealous national standards and this overzealous approach to safety*'. The processes and procedures were found to be significantly influenced by the success gained pre-privatisation which impacts the overall innovative mind-set of the work force in the industry as: TOC27: '*I think the mind-set in many functions within railway companies and Network Rail is not necessarily that innovative because there are many processes and procedures that haven't changed I would actually say in generations*'.

The regulations and standards significantly impact SMEs. This is due to the costs associated with gaining compliance and due to the lack of SME engagement mechanisms in place. The barriers increase in case of radical innovations, as the standards and specification may not be able to accommodate the innovations. As stated by RS24: '*so if the specification for procurement has been written based upon the knowledge of what is possible "today", then if you have got something that is better than "today's" capability then it may not be procurable through that route*'. In a similar example recorded in the findings, the industry worked with the innovator to help create new standards, however, this can prove to be challenging for SMEs as: C7: '*Because existing specifications were for concrete and our product was completely different from that. So we had to then do the whole product comparison scenario as well*', due to the costs and time associated with the process. The findings also reveal that there a lack of standardisation of the processes and procedures which often results in work duplication. A supporting statement provided by one of the interviewees is as following: I2: '*I think as there should be more standardisation. Because duplication of approaches is wasteful*'. Another way the regulations and standards create barriers, especially for SMEs, is due to the industry culture and processes involved. The start-ups and SMEs are not resource rich organisations. As such, the costs and time associated with going through the leadership which is greatly influenced by the risk-averse safety critical culture prevailing within the industry, the legal teams, and constant moving of employees, in order to gain compliance with rigid standards, can discourage potential innovators for entering the UK rail industry.

The process and procedures of gaining compliance in the industry were found to be opaque and intimidating. This creates barriers to entry for potential innovators and investors as RS24 said: *'[…] if they say well its quite opaque and uncertain then guess what, the investor goes and spends his money somewhere else*'. Also, as discussed in the findings sub-section (fragmentation & large number of stakeholders), the UK rail industry consists of a complex network of a large number of stakeholders. As such, regulations and specifications, become increasingly challenging to conform to in terms of the time involved in navigating through numerous processes involved. The acceptance process in particular, has received large criticism for creating barriers to innovation. I2 described the acceptance process as: '*All sorts of acceptance processes of Network Rail who he says are an absolute nightmare, nobody knows what they are doing*'. The acceptance process was found to be bureaucratic and lengthy which makes it difficult to bring about changes. Another aspect captured in the findings is that due to the challenges of gaining acceptance, only few suppliers are successful. This can result in a monopoly situation which limits competition. The acceptance process also suffers at the hand of large number of stakeholders involved. The consequences of a long supply chain with varied interests and dominated by the safety-critical culture, are best described in the following statement by TOC36: ‘*around getting our directors to buy into things, getting our frontline to be engaged on things we want to do and then all of a sudden you have got to go and get approval from Network Rail or RSSB or ORR or ATOC or any number of other people who claim to have a holding power over it. And all of a sudden you have brick wall, after brick wall, after brick wall to overcome and you never get anything done*’.

Conclusion

In conclusion, the regulations and specifications create barriers to innovation mainly due to the complexity they add to the innovation process. Influenced by the cultural barriers, the standards and specification provide very less flexibility to accommodate change. As such, radical innovations that do not have pre-set standards and specifications in the industry require an extensive exercise of testing, reporting and documentation, which can be prohibitive for innovators in terms of the associated costs and time. The large number of stakeholders involved further complicates the process in gaining product acceptance, as navigating through the complex network of stakeholders can be very challenging and time consuming. Standards and regulation particularly create barriers for resource deficient SMEs and start-ups which form a considerable portion of the innovation generators in the UK rail industry. Figure 5.8 below presents a conceptual model of the above discussion:

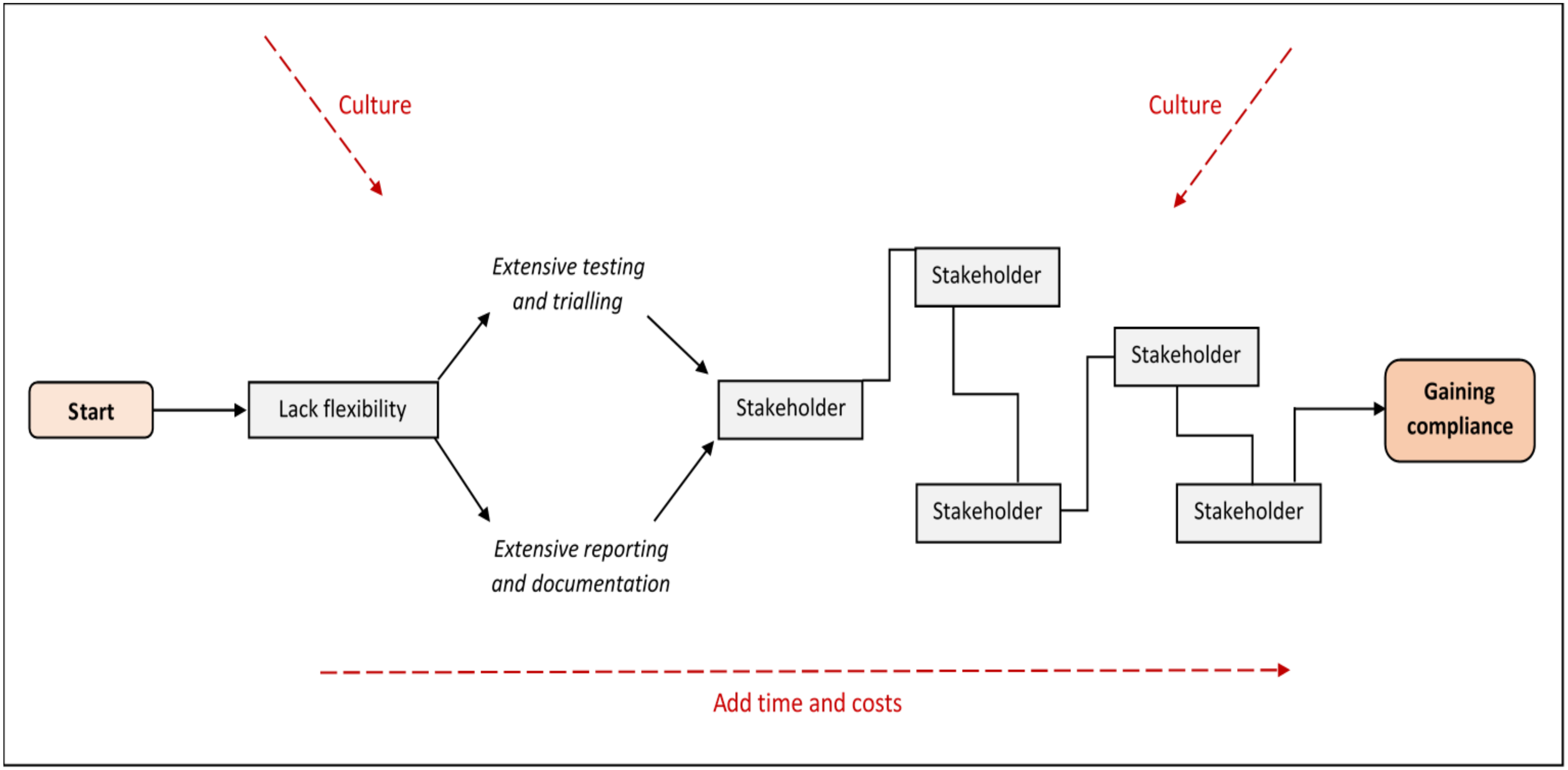


Figure 5.8 - Conceptual model of barriers to innovation due to regulations and specifications

As evident from Figure 5.8, regulations and specifications add complexity to process of innovation. Influenced by the safety critical, risk-averse culture of the industry, rigidity in the standards and regulations add risk in terms of time and cost to the innovation process.

5.3.3.3 S-RQ 6: What are the barriers to innovation in the UK rail industry in the testing and trialling stages?

The literature review of this research, under the lens of RBV, identified technical resources as key contributors of gaining competitive advantage. Testing is an essential part of both the technology development process and the product development process (Tahera *et al.*, 2012). Testing at an early stage determines the feasibility of the concept (Lévárdy *et al.*, 2004). Using upfront analysis at the concept stage can help reduce the Product Development cycle time (Tahera *et al.*, 2012; Wilkinson, 2007). For example, tools such as, QFD (quality function development) are used to translate customer needs to engineering details. These details form the inputs for the FMEA (failure mode and affects analysis). Along with data of previous products, the FMEA helps identify potential failures (Tahera *et al.*, 2012). The findings suggest that the UK rail industry faces barriers to innovation in the testing and trialling stages, particularly in the intermediate stages of taking innovation from lab to track, as expressed by M8 said: '*But in general taking it from that laboratory stage to final product approvals requires some kind of intermediate test and that particularly within rail can be quite hard*'.

To begin with, the innovators face barriers to testing and trialling, in terms of the lack of information about testing facilities. This includes the locations of testing facilities in UK, the equipment and types of testes they offer, and their availability. Secondly, the findings reveal that the testing facilities are not sufficient in meeting the testing demands of the industry. For example, an interviewee, I2, described one of the largest testing sites in UK as: '*I have to say I think Long Marston was a bit of what is the word, bit amateurish*'. Significant percentage of the analysed data, recommended the need for a centralised testing facility and/or a realistic test lab that can enable innovators to test and plan ahead for the future. This could enable pilot testing in a risk free environment, which can eliminate issues in the initial stages of the innovation process, thus saving time and money. Another barrier to testing and trialling, identified by the findings, is the costs associated with the process, which can be particularly a barrier for SMEs as: C7: '*But I mean it could be prohibitive. There was a lot of test work involved in it*'. Most of the testing facilities are privately run. As such there can be long waiting times which results in additional costs for the innovator. Similarly, barriers arise in the trialling stages, as access to live rail can prove to be challenging owing to the safety issues and the full capacity of the network. Therefore, as stated by M8: '*you're relying on the goodwill of the customer to give you that live rail'*.

Additional barriers surface in the higher Technical Readiness Levels (TRL). The literature of this research argues that at the later stages, focus is on reliability, product performance, and requirements verification. By this stage there are more physical objects and virtual models are detailed (Tahera *et al.*, 2012). Engineers believe that at this stage since both virtual and physical testing is an option, intelligent integration of the two is required for high fidelity testing and to save time and costs. Virtual testing drives physical testing at these later stages (Tahera *et al.*, 2012). Tahera *et al.* (2012) believe that it makes the physical testing more focused as the boundaries are set by virtual testing (Tahera *et al.*, 2012). Despite the advantages, the primary data suggests that in the UK rail industry there is very little faith in simulations and virtual testing. In addition, test results from other environments and test facilities outside UK are also not widely accepted. This can lead to work duplication and under exploitation of the current available innovations. One of the examples given by an interviewee C19, to explain this is as follows: '*So basically if we provide the test certificate with our ION17050 stamp on in the Netherlands no more testing is needed. If we give the same thing to Network Rail they still have to do their tests on it*'.

The findings captured an interesting perspective on barriers to testing and trialling, of the acceptance bodies. According to this perspective, the barriers to testing and trialling in order to gain compliance are mostly due to the lack of evidence from the applicant's side. As IO31 said: '*You know if they come to the table with everything that is required it didn't take the engineer as long to you know go through it and approve but it would if he keeps having to go backwards and forwards*'. However, it should be noted that accepting bodies only get involved at higher TRL levels, that is, TRL 7 onwards. This creates further barriers for the innovator as there is a lack of engagement, feedback and guidance to develop the product to industry requirements. This lack of customer engagement and feedback further increases the risks associated with testing and trialling.

In addition, the quantitative data analysis revealed that a number of participants were unable to comment on the barriers to testing and trialling. This can reveal two things: 1) the respondents did not have enough knowledge about the testing and trialling process, and 2) respondents did not have enough knowledge to comment on the testing and trialling in the UK rail industry as a barrier to innovation because: a) if the respondents were innovators, the results show that they have not reached the testing and trialling stages in their innovation development and/or do not have enough information about this key stage of innovation development, and b) if the respondents were not innovators rather industry experts, then being involved in the innovation process requires enough knowledge about all the stages of innovation development which the results found were lacking. In both the cases, it has the potential to create more barriers to innovation.

Conclusion

In conclusions, the main barriers to innovation in the UK rail industry in the testing and trialling stages were found to be due to lack of desired testing facilities and the costs associated with it. Further the lack of information on testing facilities in terms of the equipment and tests they offer and their availability, and the lack of commitment form the customer adds more barriers to testing and trialling. Virtual testing and test results from other environments were also found to be not readily accepted which again adds to the costs and reliability of the product. Compared to other industries the testing and trialling capability of UK rail industry were found to be unsatisfactory. Following example taken from the findings of this research, best summarises the statement: Highlighting the need for urgent intervention in testing and trialling scenario in UK rail, interviewee I2 compared the UK rail industry with other high technology sectors and stated: '*I am surprised that I haven't come across within the rail industry the same degree of testing facilities that there are associated with Defence and Aerospace. And bearing in mind that rail industry is going for 200 years and Defence and aerospace certainly 100 years old*'.

Figure 5.9 below presents a conceptual model of the barriers to innovation in the testing and trialling stages as discussed above.

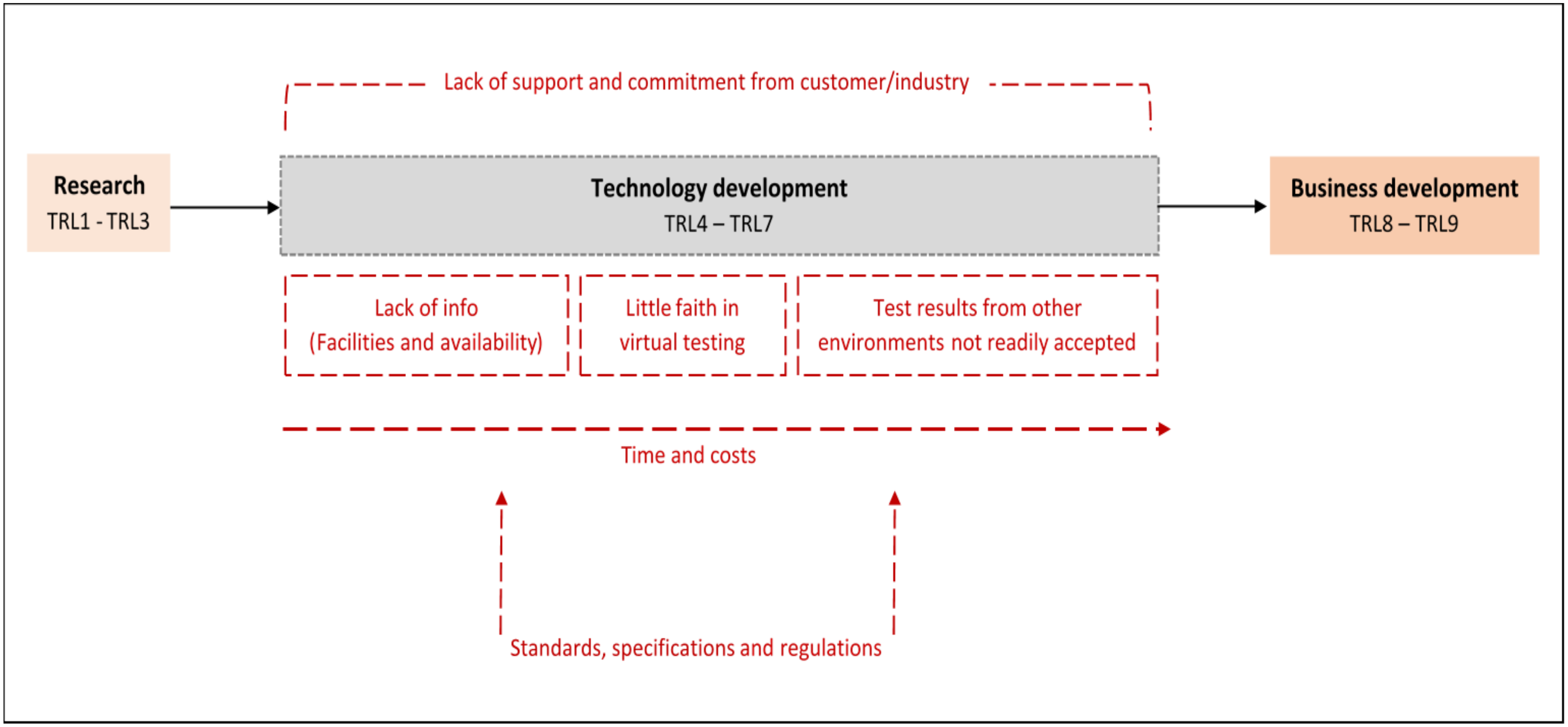


Figure 5.9 - Conceptual model of barriers to innovation in the testing and trialling stages

As presented in Figure 5.9, barriers to testing and trialling occur in the technology development stage between TRL4 and TRL7 (Parliment, 2009). These barriers as identified in the above discussion are mostly due to the lack of information of on tests and equipment offered by the testing facility and their availability, lack of faith in virtual testing, and test results not being readily accept of tested in other environments. This increases risks to innovation in terms of time and costs. In addition, the testing and trialling stages are significantly influenced by the lack of commitment and support from the industry, and as discussed in the previous question, the rigid standards specifications and regulations, which create further barriers to innovation.

5.3.3.4 S-RQ 7: How does communication create barriers to innovation in the UK rail industry?

According to the American Management Association survey (Gill, 2002), the keys to successful change are primarily leadership, followed by corporate values and communication (Gill, 2002) (c.f (Angela-Eliza & Valentina, 2018)). In the UK rail industry, certain communication barriers hamper innovation. The findings revealed that the industry is disconnected from the end users, preventing the industry from producing customer specific solutions. For example: C19: '*That organisation is three or four stages detached from the users of the trains, so the innovation that it comes up with are almost certainly not going to be aimed making the rail experience better which should be the end result'*. Similar disconnect has been found to exist between the stakeholders involved in the innovation process. The industry recognises the need for long terms relationships to be established to be able to be more strategic and open to bringing about change in the long-term future. This in turn can provide suppliers with future visibility, which can reduce risks by providing business stability and long term planning. Poor communication among the stakeholders involved in the innovation process leads to the lack of information in various areas of the innovation process. The lack of information creates barriers firstly, as the innovation needs of the industry are not conveyed to the innovation community. Subsequently, there is lack of data on product performance. This includes performance data of already existing systems and components, which the new technology is trying to interact with. Collecting such background information before testing and trialling can add significant costs and time to the innovation process, especially of the SME. It creates barriers such as stated by C7: '*We don't have masses and masses of data on that. So a lot of data we have to extract, expedite and conduct tests to understand the performance of the material. And therefore some of the costing data has to be expedited as well. We don't have* *actually data to say this is how much it will cost*'. In addition, lack of information and communication creates networking barriers, as the innovators were recorded to struggle with finding the right contacts within the industry. The poor communication can also lead to work duplication as the findings of this research suggest that the work done by various organisational groups is not well communicated. Thus, resulting re-doing what has already been done before. For the SMEs, communication gaps create barriers due to the lack of guidance and feedback from the industry on innovation development.

Conclusion

In conclusion, communication creates barriers to innovation in the UK rail industry mainly due to the lack of communication of industry needs to the innovation fraternity. As a result of which further barriers are created in the innovation process, which include lack of guidance and feedback for product development, and work duplication as the work of various industry organisations is not widely communicated. Lack of communications also hinders long term planning and creation of long term strategic relationships within the industry stakeholders. Macdonald (1995) argues that it is crucial to collaborate with the customers, to in-cooperate customer's understanding of challenges, success factors etc. that enables knowledge acquisition (Macdonald, 1995). Efficient communicating can therefore, prevent loss of opportunities and enable to fill the gaps between the industry stakeholders, and innovation process stages helping streamline innovation in the UK rail industry. A conceptual model of the above discussion has been presented in Figure 5.10 below:

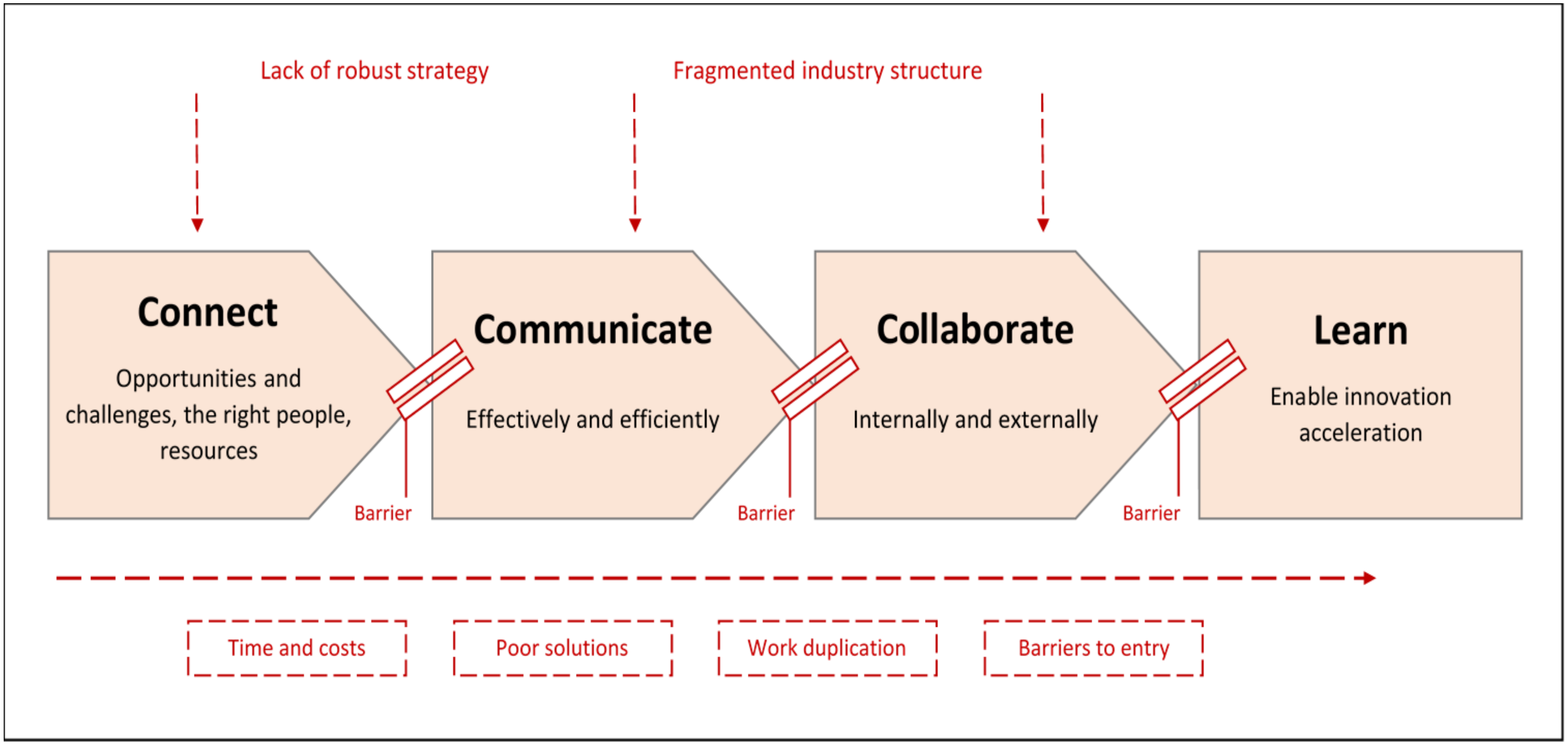


Figure 5.10 - Conceptual model of barriers to innovation due to poor communication (Adapted from (CiscoSystems, 2011))

Figure 5.10 presents the communication barriers to innovation in the UK rail industry. As discussed above, poor communication hinders communication of challenges and opportunities that the industry experiences, which results in poor industry solutions. This is also influenced by the lack of robust strategy active in the industry (as discussed in Chapter Four), which fails to establish a vision for the industry which when effectively communicated can aid effective collaborations, and speed up innovation by removing roadblocks such that include, work duplication, lack of support and commitment from the industry for innovators/SMEs. Establishing and communication an effective process can help minimise innovation risks associated with time and costs, prevent work duplication, encourage investors and innovators to bring business into the industry, and create value for customers and other stakeholders.

5.3.3.5 S-RQ 8: How do structural barriers effect strategy formulation and implementation in the UK rail industry?

The findings of this research largely suggested the rail industry structure to be complex and haphazard. It significantly impacts the innovation landscape of the UK rail industry by being the source of various barriers emerging due to its complicated structure. The below quote by a senior engineer TOC18, gives a glimpse of the frustration arising due to the fragmented structure among the industry experts: '*People often say to me well why it is so hard to do innovation in the rail industry; it's because it is bloody fragmented that's why*'. The structure of the industry (c.f (Teece, 1996)) plays a vital role as it impacts a firms profit margins and productivity significantly (Karabag & Berggren, 2014). The industry structure greatly influences formulation and implementation of its strategy. This is mainly because the industry comprises of a large number of stakeholders with an unclear hierarchical structure. The findings suggest that it is not clear as to who is the leader or the driving force that has the vision to drive the industry forward towards being an innovative industry. The industry structure has also been repeatedly described as too complex, rigid, and lacking a guiding vision and a decision making process. It creates barriers to long-term strategy formulation as owing to the other factors, such as franchising periods and control periods; the stakeholders prioritise making temporary profits for themselves in the given set periods as long term investments make for poor business cases. This has led to the stakeholders not being used to engaging as an industry and working in silos, thus creating cultural barriers.

Thus, the implementation of strategy in such a structure become challenging. This lack of authority leads to a long chain of stakeholders to be convinced for the success of a project, adding time and costs. As is evident from one of the interviews as stated by M16: *'So you have got to bring together the technology, the manufacturer, the rolling stock operator and the track owner to be able to do real testing on the railway and that is very difficult, it gets very contractual, it is protracted in timescales'*. Without a clear strategy to lay out a direction for the industry, the varying interest of the stakeholders takes precedence and pulls the industry in varied directions. As discussed in section 4.2.2.1 the barriers created by the fragmented structure of the industry (structural barriers), the varying interests of the shareholders do not aid innovation as it does not aid aligning of their respective strategies. Again, due to the fragmented structure of the industry different components of a project can be controlled by a number of stakeholders. This significantly impacts investments and creates interdependencies amongst the stakeholders. It can add further risks to innovations as said by TOC22 said: '*And so we rely on them to be innovative and we suffer if they are not innovative*'.

The ambiguity around who determines the future requirements of the industry restricts the various stakeholders to better channel their efforts and investments. With a lack of future vision and disconnect between the stakeholders, this haphazard structure makes it difficult to streamline innovation processes. It also raises barriers to entry for small companies, as finding the right contacts can be challenging. This disconnect with the grass root levels of innovators/SMEs also leads to issues such as the one stated by M16: *'so those sort of big picture items are very clear. But you are right the smaller needs are not so clear because there is nobody pulling it together'*.

Conclusion

Structural barriers effect strategy formulation and implementation, due to the fragmented structure of the industry, where there is disconnect with the root level of innovators, and other stakeholders within the industry that are involved in the innovation process. The short operational and control periods inhibit the industry from developing long-term strategies as long-term business cases do not prove to be profitable for significant stakeholders involved. Without an overarching vision and direction, the varied interests of the stakeholders create barriers to collaboration and pushes them to work in silos. These cultural barriers arising due to the fragmentation of the industry further makes implementation of an overall industry strategy challenging. A conceptual model presents the discussion below in Figure 5.11.

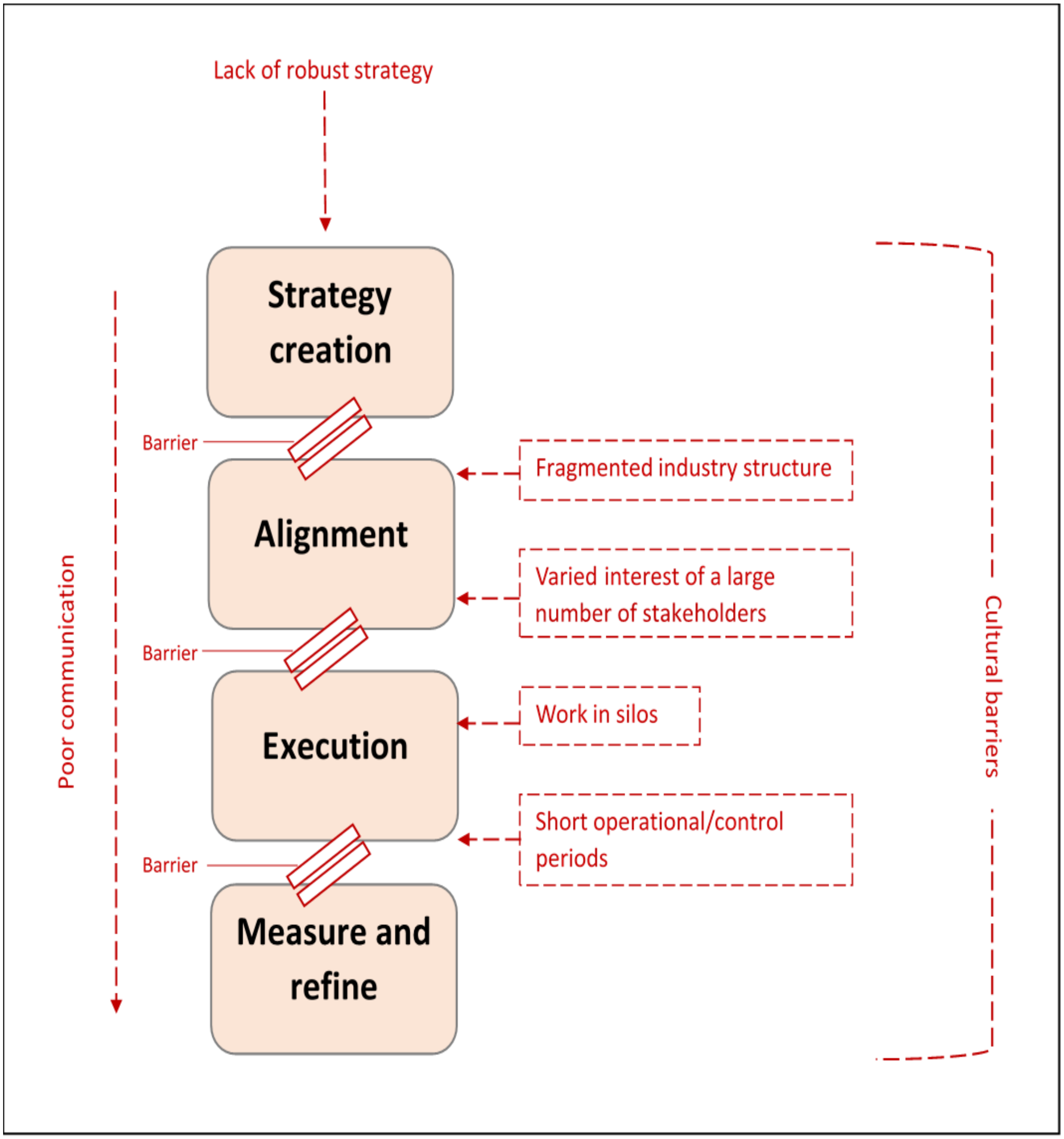


Figure 5.11 - Conceptual model of effect of structural barriers on strategy

Figure 5.11 presents how structural barriers effect strategy formulation and execution. As evident, the main barriers occur in strategy alignment and execution stages. The fragmented structure of the industry, and as influenced by the previously discussed factors that is, lack of robust strategy, poor communication, and cultural barriers, create barriers as the interests of the stakeholders are varied and not aligned. This also leads to collaboration barriers as the industry is found to work in silos. Short operational and control periods further hamper execution of strategy.

5.3.3.6 S-RQ 9: How do process barriers effect implementation of strategy in the UK rail industry?

The findings of this research revealed that most of the procedural barriers are created due to the complex fragmented structure of the industry. These procedural barriers were found to slow down the innovation process. Procedural barriers effect implementation of strategy mostly due to communication barriers. As the findings suggest, the large number of stakeholders working in a complex network, makes effective communication challenging. This disconnect between the organisations can result in loss of opportunities. An example is disconnect between the academic groups and the industry which can have significant impact on Research and Development, as stated by M21: '*you realise the R&D that is when I think academia can also have an input and for whatever reason it doesn't in my opinion*'. Communication barriers are also associated with the industry groups. The research reveals that there is also a lack of communication between the various industry groups and the wider industry. As stated by an interviewee TOC22: '*I think in our efforts as an industry to create collaborative forums we have created a very complex environment. So knowing where you should go to find out about industry expertise is quite difficult*'. Improving communication about the work being done by the various industry groups can help improve their productivity and identify new opportunities.

Another way the procedural barriers effect implementation of the strategy is the operating nature of the industry. The UK rail industry is found to have a contractual/project based operating nature which make it challenging to innovate as failures and delays add costs to the project. The complex fragmented structure gives rise to large number of contractual interfaces which causes delays. Procurement issue also arise from the complexity of the procedures as TOC36 said: '*I have a feeling that we are reluctant to procure from new suppliers because we have made that process take so long*'. The complex procedures and the lack of information makes breaking into the industry and SME engagement very difficult. Due to communication barriers the roles and responsibilities of the large number of governing bodies and steering groups are not being well communicated, which further hampers innovation.

Conclusion

In conclusion, the procedural barriers effect implementation of strategy mainly by increasing the complexity within the systems, making it difficult for potential innovators to break into the industry. The complex procedures in conjunction with the fragmented structure of the industry make effective communication challenging. This further effects implementation of strategy as it creates communication gaps between the stakeholders involved in the innovation process. Similarly, it hampers productivity of the various industry groups dedicated to resolving various industry problems, as their work is not widely communicated. Lastly, the complex procedures increase risks to innovation as they add time and costs to innovation. It also effects procurement as procuring from new suppliers can prove to be a complex expensive process. The discussion has been summarised in a conceptual model presented below in Figure 5.12:

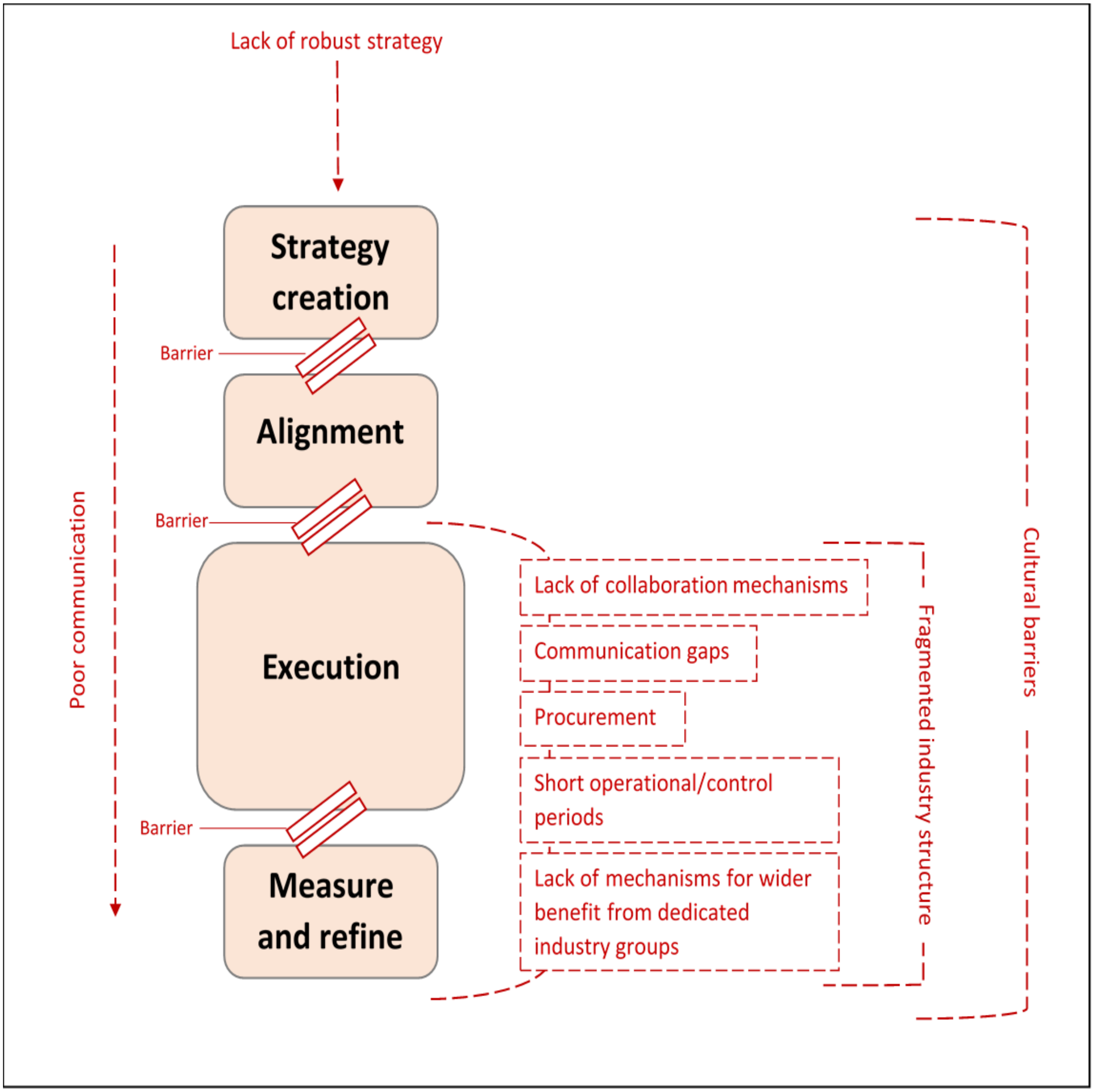


Figure 5.12 - Conceptual model of effect of process barriers on strategy

As shown in Figure 5.12, complex and inefficient process exiting in the industry effect successful implementation of strategy due to the various barriers arising from it. These include, poor communication, poor collaboration mechanisms, and complexity to procuring from new suppliers. The fragmented structure and the cultural barriers in the industry significantly contribute to the creating process barriers. The achievements of the dedicated industry groups created to address various issues that the industry faces, are also not communicated efficiently to the industry for wider benefits, which can result in work duplication.

5.3.3.7 S-RQ 10: What is the impact of strategy barriers on business within the rail sector in the UK?

The EuropeanCommission (2011) stated that the current transport system is not sustainable and continuing the business as usual will hamper the development along the same path, 40 years ahead. It recognises that the transportation faces new challenges while the old challenges remain (EuropeanCommission, 2011). It also highlights issues including, providing better services to the customers to meet their growing desire to travel, and transporting goods while preparing for resources and environmental constraints prevalent in the industry. However, the findings of this research reveal various barriers to achieving an innovative industry that meets the current and future demands. These barriers as discussed in the previous sections of this chapter effect business within the industry (c.f (De Brentani *et al.*, 2010)), which can further restrict innovation.

As discussed earlier, the fragmented structure of the industry, with its complex network of stakeholders leads to disconnect between the organisations that appear to work in silos. This leads to a poor business environment within the industry as each entity is invested in their personal interests and not driving the industry forwards as a whole. For example, C19 said: '*no one is actually invested in the rail industry apart from the ROSCO's (Rolling stock operating companies), everybody else just takes money out*'. The short operational and financial control periods also contribute to the poor business environment, as it creates short-sightedness within the industry, which lacks future planning of goals and objectives for the industry to achieve in the long term. This in return leads to lesser collaborative opportunities among the stakeholders (c.f (Filiou, 2007)) and a contractual operating environment mainly focused on delivering contracts and gaining short-term returns. Other procedural barriers to implementing strategy that result in lack of collaborations is the absence of mechanisms and frameworks for industry stakeholders to come together.

The strategy barriers also impact the market conditions within the industry. The findings of this research revealed that the industry is affected by wrong perceptive of competition. Some of the interviewees described it as basic differentiators and varied key selling points, while others regard the outside industry competition, such as automotive industry, as real competition. Another perspective captured in the findings is that the stakeholders operate in different markets with different customers and in true essence are not in real competition with each other. And as such, the industry fails to recognise what aspects are better off collaborating and what aspects of the innovation process can be competitive. Based on this perception of false competition, there is a lot of secrecy observed around innovations with reluctance to collaborate. This in hand with the diverse business interests of the many stakeholders results in a business environment based on usage and implementation, rather than investment and development.

In addition, because of the strategy barriers discussed in the earlier subsections of this chapter, the business environment within the industry lacks a market which has the various driving elements of innovation, such as demand, risk versus rewards, incentives, profitable returns within considerable timescales and the ability to attract investors. The market has been described as a: TOC30: '*a captive market or when you are in a market with very little number of suppliers it stifles innovation*', which creates monopoly and eliminates competition. This results in lesser incentives to innovate due to the lack of risk of losing business to competitors. As such the industry was found to rely on limited solutions offered that stifle innovation. The following statement made by TOC27, reflects the above mentioned view as: '*which means we are perhaps not as faced with the same competitive pressures or market requirements to innovate*'.

Lastly, the poor management of innovation risks further disincentivises the stakeholders to innovate. The profit margins within the industry were found to be very low which leaves little to no room to fail. Contractual barriers such as penalties for not meeting the contracts further discourages innovation. As discussed earlier, disconnect between industry and universities also affects business as it can aid Research and Development. The business is also found to suffer due to its leadership, as the industry is predominantly led by engineers. It was recorded that the interviewee felt that a business perspective was highly required in the leadership tier of the industry in addition to the existing technical expertise, TOC23: '*I think it's about industry deciding […] not to be led by the engineering*'.

Conclusion

In the literature Gill (2002) argues that while change must be well managed, it requires effective leadership for its successful introduction and sustainability. However, the rail industry is found to lack business perspective in its leadership as it is mostly led by engineers, which hampers effective change. The strategy barriers impact business as it leads to poor markets that stifle innovation. Limited competition, lack of collaboration, and unnecessary secrecy further stifle innovation. The poor market conditions also make path for monopoly situations which discourages potential innovators and investors, and makes breaking into the industry difficult. Due to the short operational and financial control periods, the stakeholders are mostly keen on short-term returns for their business. The industry structure as such does not support long-term strategy and planning. The poor innovation risks management and low profit margins in the industry leaves little to no room to fail which also curbs innovation. Lastly, the industry fails to exploit the potential of universities to aid R&D, however, efforts are being made in the recent times to overcome this barrier. A conceptual model, developed to present the impact of strategy barriers on business in the UK rail industry, is presented below in Figure 5.13:

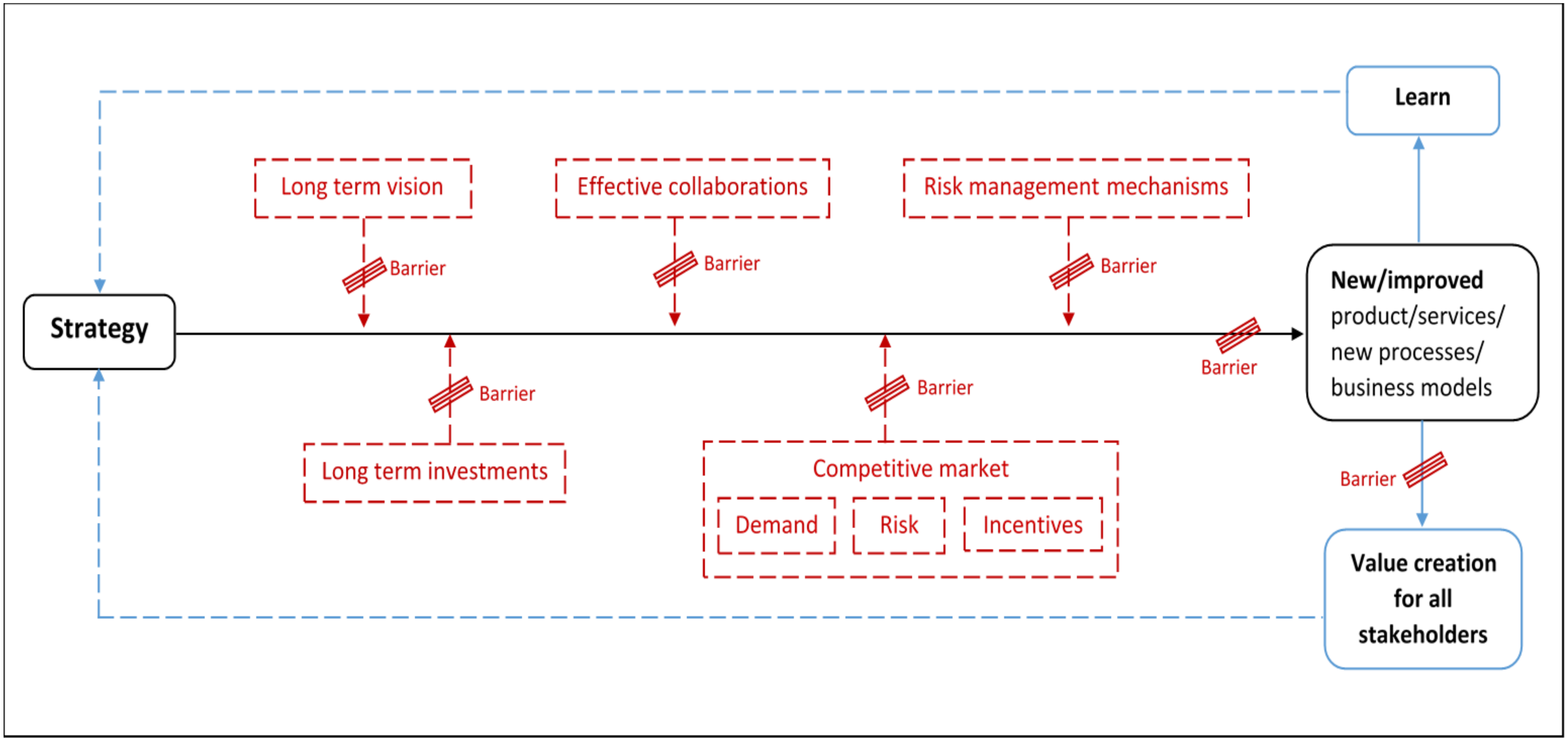


Figure 5.13 - Conceptual model of impact of strategy barriers on business

As shown in Figure 5.13, strategy barriers result in poor markets for innovation, increased risks, poor collaboration and poor value creation for stakeholders. It also hampers development of a long term vision, and long term investments. Addressing the barriers can enable improved speed of innovation, as Kessler and Chakrabarti (1996) in their research on innovation speed, state the identified barriers of this sub-section, that is, clarity of goals, support for projects, sourcing, and organisational capability factors, as enablers of increasing speed of innovation (Kessler & Chakrabarti, 1996).

5.3.3.8 Overview of the third research question RQ 3

The above discussion in section 5.3.3 discusses the strategic barriers that hamper innovation and its impact on business. These key outcomes of the discussion can be summarised as: the lack of a robust strategy was found to result in poor solutions and understanding of the issues in hand. Without an effective strategy, the innovation resources were found to be poor management and most of the industry was identified to work on short-term business cases. Further barriers were identified to arise from the regulations and specifications within the industry, and due to poor communication amongst the various industry elements. In addition, barriers arising due to the fragmented structure of the industry and how they complicate the procedures creating further barriers, were discussed. Finally, the impact of these strategic barriers is discussed, as it creates poor markets for innovation, limits competition, and does not support collaboration. The industry structure was found to not support long-term strategy and planning.

5.4. Conclusion

In this extensive chapter, the literature reviewed in Chapter Two, and the results of the data analysis presented in Findings Chapter four, were combined to present the discussion. The chapter was structured into three subsections. First, a research overview was provided, depicting the main conceptual models developed in the thesis, drawn from the reviewed literature and research findings. Subsequently, the three research questions and their respective sub-research questions were discussed. Finally, a framework and a model for innovation in rail has been developed, linking the theory and current innovation landscape of UK rail industry, and is presented below in Figure 5.14 and Figure 5.15 respectively.

Figure 5.14 presents a framework for improving innovation delivery in the UK rail industry and subsequently transform the competitive position of the industry. The different colours represent the various themes and various boxes within each colour represent the key elements of a theme. The theme on the left presents the overarching elements that influence the entire industry. the three middle themes represent the core resources and capabilities of the industry, and the right presents the outcomes of successful interactions of the other themes. This figure describes the key enablers of innovation that influence the overall innovation development and the driving elements of innovation development that enable successful innovation by means of value creation. According to this framework, the main enablers of innovation in the UK rail industry are the government, strategy and funding. With the involvement of the government, a clear direction for the industry, and the fuel for creation and improvement, barriers to innovation can be addressed for creating value for all stakeholders and gaining sustainable competitive advantage. The framework provides an effective road map approach to innovation, which involves stakeholder involvement and management, innovation risk management, and refinement of the process mechanisms involved. It creates a better focus on innovation efforts by creating market awareness to produce effective and customer centric solutions. In addition, other supporting elements of flexible and fit for purpose standards and regulations, effective testing and trialling, and enhanced communication between the systems, drive innovation to address market challenges and create competitive advantage. It identifies a flexible and collaborative culture for innovation development that exploits, strengthens, and replenishes the core innovation capabilities of the industry. A key outcome of the framework is the effective measurement of innovation outcomes that enables the identification of the industry's innovation gap. These when continuously fed back into the system can help close industry's innovation gaps resulting in value creating for stakeholders and development of sustainable competitive advantage.

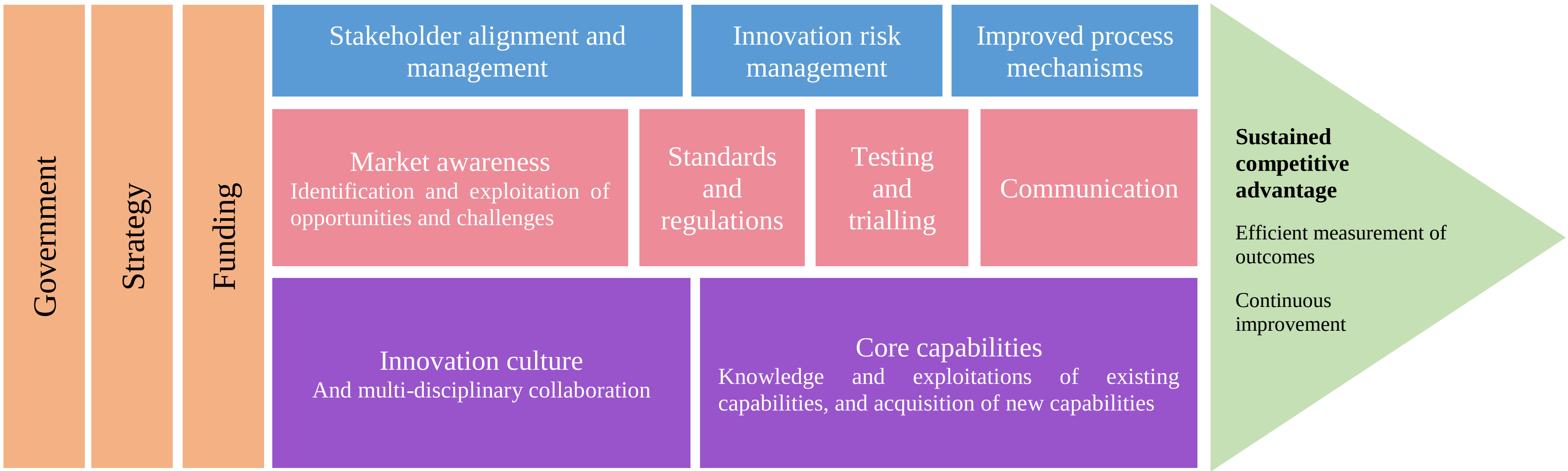


Figure 5.14 - Innovation in Rail Framework

As is evident from Figure 5.14, the framework present the innovation formula for UK rail industry. From the discussions generated to answer the research question, and in light of the detailed findings presented in Chapter four of this thesis, it was found that:

$$\mathbf{G \rightarrow F},$$

That is, F is influenced by the characteristic of G; where F is funding and G is government

Similarly, $\mathbf{S \rightarrow F}$

That is, F is influenced by the characteristic of S; where F is funding and S is strategy

Therefore, $\mathbf{GS \rightarrow F}$

Hence, it can be concluded that to bring about change the following are necessary:

$$\mathbf{GS \rightarrow F + (StM \times SIM \times C) = CA + VC_{St}}$$

Where;

- StM is stakeholder management,
- SIM is strategic innovation management,
- C is culture
- CA is competitive advantage
- VC_{St} is value creation for all stakeholders

In addition, in light of the theories underpinning this research, Leadership (L) enables to bring about successful change within organisations. As such it can be concluded:

$$\mathbf{L \rightarrow [}\mathrm{GS}\mathbf{ \rightarrow F + (StM \times SIM \times C)] = CA + VC_{St}}$$

Having developed the innovation framework in Figure 5.14, an innovation model was developed to visually present the current situation of the innovation in the UK rail as opposed to the ideal situation and the measures than can be taken in between, to achieve that. These have been presented below in Figure 5.15:

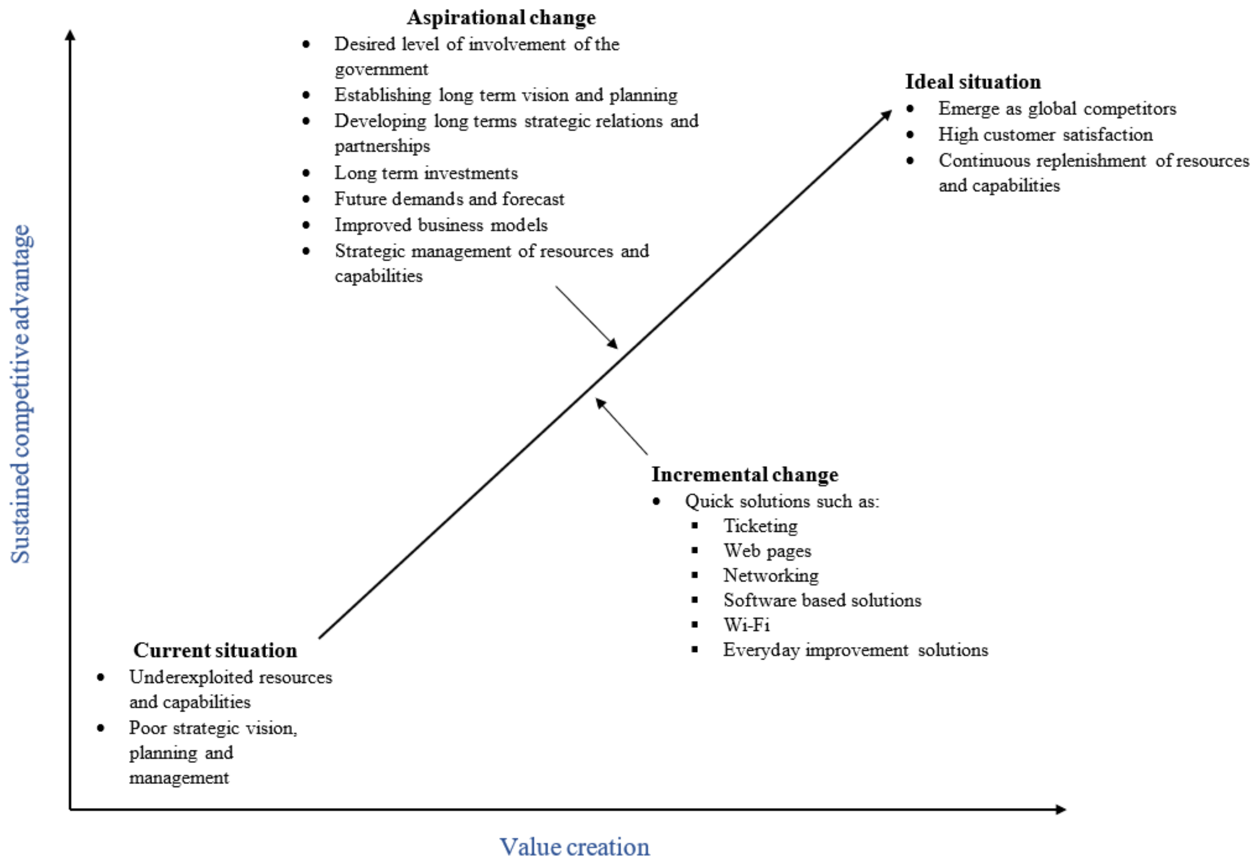


Figure 5.15 - Innovation Model

Figure 5.15 presents a matrix for creating value and developing sustainable competitive advantage via innovation in rail. As is evident, across the matrix lies the current innovation scenario in the UK rail industry and on the opposite high end lies the ideal situation. In order to achieve the ideal situation, incremental and aspirational changes may be deployed to address both short-term and long-term strategic visions of the industry. Continuous incremental value can be generated via changes that are comparatively easy to develop and implement, while laying down the ground works for aspirational changes, which are long-term and comparatively challenging in nature. Incremental changes while generating value cannot be the means for long-term developments alone in absence of a long-term vision and investments to forecast and sustain future demands. However, when supported by the aspirational changes, both together can enable the UK rail industry to achieve the envisioned ideal innovation scenario.

In conclusion, this chapter has made all necessary links to answer the research questions and produce output in the form of an innovation framework and formula, which bridges the theory and practice, of an otherwise neglected area of research. The final contributions will be detailed in the next and final chapter of this research – Conclusions, along with limitations of this research and recommendations related to possible future research.

6. Conclusion

6.1. Introduction

The final chapter of this thesis, draws together the conclusions of this research to summarise and present the innovation landscape of the UK rail industry in terms of the identified barriers to innovation. Particular attention is given to the Innovation Framework and Innovation Model developed in the previous chapter, and will be briefly discussed and presented. This chapter will also provide an overview of the research objectives, how they were approached and the resultant findings, by briefly reviewing the main three research questions of this research. The chapter will then draw upon the main contributions of this research and discuss its limitation. Recommendations for future research are also presented. The chapter ends in a reflective note to capture the overall research journey of the researcher.

6.2. Review of the original research aims and objectives

The uniqueness of this research is that it presents an unbiased evidence based account of a nascent research area, that is, the innovation landscape in the UK rail industry. The research explores the complex inter connections and links between the diverse stakeholders involved in the innovation process. As detailed in the reviewed literature in chapter two, innovation faces a number of barriers in transportation, such as barriers to developing and implementing an innovation strategy (Dodgson *et al.*, 2015), government policies (Ross *et al.*, 2012), management deficiencies (Nooteboom, 1994; Zolnik & Sutter, 2010), resistance to change (Orcutt & AlKadri, 2009b), and costs (Ross *et al.*, 2012). At the same time, there has been an increase in the need for innovation due to the demand for sophisticated services, globalisation that has increased competition, and deregulation that increases the pressure to innovate (Busse & Wallenburg, 2011). In addition, the future scarcity of oil resources and the rapid climate change, demands more energy efficient and cleaner transportation systems (EuropeanCommission, 2011). Therefore, the research aim of this thesis was:

Through engagement of both primary and secondary stakeholders, to identify current barriers to innovation in UK rail sector.

In order to achieve the research aim, a mixed method approach was adopted, which employed both qualitative and quantitative methods of data collection and analysis. As detailed in Chapter Three – Methodology, a pragmatic paradigm was adopted and the research was conducted in two phases. In the first phase, employment of an exploratory sequential phase led to the collection of rich qualitative data, by interviewing 49 industry professionals, which when analysed through thematic analysis informed the design and development of the survey questionnaire for the second phase of the research. Phase two utilised a convergent parallel design, to collect and analyse quantitative data, collected via 57 survey responses; in parallel to collection and analysis of qualitative secondary data (industry reports).

The two-phased research design, backed up by the rich literature review, enabled the research to meet its aim by satisfying the research objectives, which were:

I. To develop a critical review of the extant relevant literature on strategy, innovation and innovation in transportation.

II. To breakdown and simplify the complex industry structure and identify the key stakeholders involved in the innovation process.

III. To identify the barriers to innovation in the UK rail sector.

IV. To compare the identified barriers to the perceived barriers established by the industry.

V. To develop an innovation framework and model to support innovation in the UK rail sector.

The critical review of the rich literature enabled the researcher to obtain an in-depth understanding of the innovation practises in transportation and the experienced barriers to innovation. It provided the theoretical justifications to the research questions and identified the gaps in knowledge specific to the UK rail sector. The identification of the stakeholders led to the understanding of the relations and links between them which aided the researcher in navigating through the complex industry structure to collect rich qualitative and quantitative data. Analysis and synthesis of the collected data on one hand, identified the barriers to innovation in the UK rail sector; and on the other hand, the comparison of the identified barriers to the perceived barriers by the industry, identified by secondary data analysis, brought to light the gaps in industry knowledge and opportunities for improvements. Finally, the comprehensive data collection and analysis contributed to the development of innovation framework and model to enable industry to accelerate innovation via stakeholder engagement, and to create value and sustain competitive advantage in present and in future respectively.

6.3. Overview of the research findings

This section consists of the overview of the research observations in terms of the three main research questions of this research. The overview of the three main research questions will enable the summarisation and conclusion of the findings and discussions of this thesis.

6.3.1 RQ 1: How do the enveloping external factors of funding and, government and media, impact innovation in the UK rail industry?

The qualitative data analysis, complemented by the quantitative data analysis, revealed that there are three main external factors that impact innovation in the UK rail sector; these are: funding, government, and media. The findings record a lack of interest and engagement from the government, which results in the lack of direction for the whole industry. In view of the complex fragmented structure of the industry, with a number of various different reporting bodies, aligning of strategies becomes challenging. As such, the role of government was found to negatively impact innovation as the lack of vision/direction from the government results in the lack of implementation of a robust industry strategy. These complex networks were also found to impact on funding as along with the lack of structure, vision and direction, bureaucracy was reported to prevail in the industry and political priorities were found to influence investments.

The findings record an overall lack of funding in the industry and also found it to be lower when compared to funding in rail in other countries. As stated by Archibugi *et al.* (2013)the lack of funding can limit the level of innovation of a firm, and the same creates issues in the UK rail sector especially in higher Technology Readiness Levels (TRL), which are associated with high costs as innovation activities in many cases requires a prior investment in highly sophisticated technical equipment which raises the possibility of producing unique, diverse and high quality products, which results in an increased value for the firm (Kostopoulos *et al.*, 2002). Similarly higher TRLs in UK rail sector; which are associated with testing and trialling in the concerned environment, in order to gain compliance as per industry standards, and manufacturing and commercialisation, with continuous monitoring whilst in market to establish continuous safety and compliance; particularly suffer due to the lack of funding because of the associated high costs. These high costs particularly limit the innovation activities of SMEs that have been identified in the literature as resources deficient organisations (Ross *et al.*, 2012) (Madrid-Guijarro *et al.*, 2009). In addition, the SMEs were found to be incapable of generating optimum results due to the lack of skill and knowledge, to produce successful funding applications, especially when in competition with bigger and/or established firms. Another aspect of funding that fails to support innovation, is the funding mechanisms. The funding mechanisms were reported to be tedious and time consuming. This further increases the risks associated with innovation due to the time and costs associated with slow processes. The funding timing was also found to hinder collaborations as the different stakeholders were found to be in control of varied amounts of funding at different times. Lastly, funding was found to fail support innovation due to its poor management. As discussed in the extant literature review, RBV strongly emphasis that a firm's resources when worked upon using firm's capabilities, have the ability to transform into competitive advantage for the firm. However, the leadership was revealed to miss opportunities or fail to exploit the available funding for optimum results (Bakar & Ahmad, 2010). In addition, funding fails to produce tangible results due to the emphasis on the short-term returns owing to the short funding cycles and lack of overall funding, resulting in poor business cases. In conclusion, funding was found to impact innovation due to being poorly specified in the overall strategy by the government, due to its poor strategic management as a key resource, and due to the poor capabilities of the industry for its successful exploitation and replenishment to support innovation.

The third external element found to impact innovation is the media, which was recorded to mostly negatively promote innovation in the UK rail sector. The negative publicity of the failures of the past has created nervousness among the management, thus, discouraging them to think outside the box and to take risks. In view of the reviewed literature that recognises the importance of marketing skills for the implementation and exploitation of innovation (Hultink *et al.*, 2000; Kostopoulos *et al.*, 2002), there is an urgent need to highlight the UK railway industry's success stories in order to attract potential innovators and investors.

6.3.2 RQ 2: What elements inhibit the UK rail industry from transforming into an innovative industry?

The rich body of literature reviewed for this research suggests that for a firm to gain competitive advantage, the organisational purpose must reflect within its employees (Apsalone, 2017), there must be a creative and flexible environment that encourages new ideas and new ways of achieving goals, and provide the flexibility for experimentation and for adapting to the external and internal changes (Kendra & Wachtendorf, 2003), and a must have a continuous feedback loop of learning (Tyas Indah Twi *et al.*, 2018). These are reflected in the culture of an organisation, which in the case of UK rail sector as revealed by the findings, inhibits the industry from transforming into an innovative industry. The industry was found to be paralysed by the practises of the past, that might not be best suited for the current times and situation. This presents a barrier to innovation as it eliminates the probability of entertaining new ideas, taking risks to develop it, and accepting that failures are a part of the innovation process. The industry culture is popularly defined as conservative, risk averse, and safety critical. These attributes contribute to the low appetite for risk in the industry, poor strategic management of innovation, lack of freedom of action, and the overzealous attitude towards safety. The cultural barriers were recorded to hamper innovation, as it creates reluctance to accepting innovation from other environments and countries, and limits the perception of the benefits of innovation. The literature emphasises the positive role of culture in implementing change (Dougherty, 1992) (Al-Ali *et al.*, 2017). But the findings of this research conclude that the safety critical culture is so deeply engraved in UK rail industry that it has become an automatic reaction to innovation proposals, without fully considering the benefit of innovation. The nervousness created by the media, as concluded in the previous sub-section, pushes the directors to decide to the very granular levels of the decision making chain, thus, limiting the freedom of creativity and flexibility to the staff which inhibits the development of an overall organisational culture of innovation. Such an attitude, limits an organisation to fully exploit its employees as a valuable resource to a firm for gaining sustained competitive advantage.

6.3.3 RQ 3: What are the strategic barriers to innovation in the UK rail industry and how do they impact business?

The data analysis of the research revealed that the main barriers to innovation in the UK rail industry stem from the lack of vision and strategy within the industry. The claim is justified by the reviewed literature, where Sull *et al.* (2018)argue that in the current dynamic markets, ongoing success typically requires innovation and change, and among other authors, Cooper and Edgett (2009); Dodgson *et al.* (2015); Kim *et al.* (2015)advocate the need for strategic management and an innovation strategy, where the lack of it in a dynamic market, hampers innovation, as the industry fail to identify, exploit and replenish its strategic resources. As such this research established that improvements in performance depend widely on innovation, and an effective innovation requires a strategic approach.

The **lack of strategy**, as recorded in the findings of this research, leads to a poor understanding of the challenges and opportunities the industry faces, and can lead to delivery of poor solutions. In the absence of a long term direction, the rail industry operates on short-term returns and has developed a reactive nature to problem solving. The lack of strategy fails to join the industry via effective communication. The lack of collaborations and disconnect from the customers were recorded as the main issues arising from poor communication. This disconnect from the customer jeopardises gaining competitive advantage, as argued by Verbeke and Tung (2013), offering innovative solutions to customer problems, a firm earns their loyalty, purchase intent, positive attitude and minimised scepticism regarding the quality and ethical issues related to the product/service. The poor understanding and communication risks in the wrong interpretation of innovation or defining innovation in one single form. The findings reveal that innovation is mostly interpreted as technical and radical. This stands in contrast to the OECD (2018) definition that states that the innovation process involves both the product innovation and process innovation. Wagner (2008) further argues that organisations need to be aware of both of these innovations and invest in different innovation activities simultaneously, in order to improve the current services and reduce the costs of delivering these services. As such, strategy impacts a wider range of factors leading up to innovation, which have been summarised as follows:

In view of a poor vision and direction of future, the **processes and procedures** were also recorded to be significantly influenced by the success gained pre-privatisation which influences the overall innovative mind-set of the work force in the industry. Other contributing factors, as summarised in the previous sub-section, including a risk-averse culture, lack of support from government, and continuous scrutiny by the media, pushes the industry to adhere to the strict standards of the past, with very little flexibility for change. In addition, the findings revealed that the processes and procedures are opaque in nature and particularly create barriers to entry for potential innovators and for SMEs due to the costs and time associated in passing through them. In light of the lack of standardisation of processes and standards, recorded in the findings, the complex network of a large number of stakeholders involved in the innovation process further complicates the process.

Another key stage of innovation, that experiences barriers, as identified by the findings of this research, is the **testing and trialling stages** of innovation. The poor strategy fails to put in place the testing and trailing resources and capabilities and effectively communicate it to the innovation society of the industry. As such the barriers to testing and trialling innovation in the UK rail sector begin with poor information of the testing facilities in terms of the tests, equipment they offer and their availability. In addition, the findings reveal that the testing facilities are not sufficient in meeting the testing demands of the industry and a significant percentage of the analysed data, recommended the need for a centralised testing facility and/or a realistic test lab that can enable innovators to test and plan ahead for the future. Other barriers recorded were related to the costs of testing and trialling and gaining access to live rail for trialling. The tests results from other environments were also found to not be readily accepted by the industry, neither were the results from simulations and virtual testing which argued by Tahera *et al.* (2012) at higher TRLs can aid high fidelity testing and save time and costs, by making the physical testing more focused as the boundaries are set by virtual testing. The costs related to testing and trialling were also popularly regarded as prohibitive especially for SMEs.

The mixed methods data analysis further revealed barriers to innovation due to the **poor communication** within the UK rail industry. Communication has been stated as one of the key enablers of successful change by the American Management Association survey (Gill, 2002). As mentioned above, on one hand, the poor communication with end user can result in the development and delivery of poor solutions, and on the other hand it inhibits the needs of the industry being conveyed to potential innovators and investors. A similar disconnect within the stakeholders hampers the development of long terms relationships to be established so as to be more strategic and open to bringing about change in the long term future. Other communication related barriers revealed were the lack of information and data on product performance. This includes performance data of already existing systems and components, which the new technology is trying to interact with. Collecting such background information before testing and trialling can add significant costs and time to the innovation process, especially of the SMEs. The poor communication can also lead to work duplication as the findings of this research suggest that the work done by various organisational groups is not well and widely communicated across the industry. The poor communication was lastly, found to create barriers to entry as finding the right contacts within the industry was widely stated as challenging.

Further, to the barriers arising from the lack of a robust strategy, the findings also revealed the barriers to the formulation and implementation of the strategy in the UK rail industry. The main barriers identified is the complex, haphazard, fragmented **structure of the industry**. As identified in literature, Karabag and Berggren (2014)argues that the structure of the industry plays a vital role as it impacts a firm's profit margins and productivity significantly. The UK rail industry comprises of a large number of stakeholders with an unclear hierarchical structure. This results in ambiguity as to who is the leader or the driving force that has the vision to drive the industry forward towards being an innovative industry. The stakeholders operating within the industry have varied operational time cycles and interests. It creates barriers to long-term strategy formulation as owing to the other factors, such as franchising periods and control periods; the stakeholders prioritise making temporary profits for themselves in the given set periods as long term investments make for poor business cases. This has led to the stakeholders not being used to engaging as an industry and working in silos, thus, as mentioned in the previous sub-sections, creating cultural barriers. The long chain of stakeholders' makes implementation of strategy challenging. A number of stakeholders may be in control of the various aspects of innovation, and as such, it adds time and costs to project in order to align their interests and strategies. With a lack of future vision and disconnect between the stakeholders, this haphazard structure makes it difficult to streamline innovation processes. It also raises barriers to entry for small companies, as finding the right contacts can be challenging.

The complex structure in turn creates **procedural barriers** to innovation. Because of the factors discussed previously, complex network of stakeholders and poor communication, the existing procedures were found to slow down the innovation process. The UK rail industry is found to have a contractual/project based operating nature which make it challenging to innovate as failures and delays add costs to the project. The complex fragmented structure gives rise to large number of contractual interfaces which causes delays. In addition the hectic procurement procedures hamper procurement rom new suppliers.

As a result of the above concluded strategy barriers, the **business** within the rail sector was recorded to suffer in various ways. The strategy barriers impact business as it leads to poor markets that stifle innovation. Limited competition, lack of collaboration, and unnecessary secrecy further stifle innovation. The poor market conditions also make path for monopoly situations which discourages potential innovators and investors, and makes breaking into the industry difficult. The leadership in the industry also falls short of managing successful change mainly because it lacks a business perspective. As the findings revealed the industry was found to be mainly led by engineers. Further, due to the short operational and financial control periods, the stakeholders are mostly keen on short-term returns for their business. The industry structure as such does not support long-term strategy and planning. The poor innovation risks management and low profit margins in the industry leaves little to no room to fail which also curbs innovation. Overall the industry fails to attract potential innovators and investors because of being perceived as low returns and high risk industry.

The findings of this research supported the development of an Innovation Framework and Innovation Model, which have been concluded in the following sub-section:

6.4. *The specific valuable outputs of the research*

The exploratory mixed-methods research, has led to the generation of an Innovation Framework and Innovation Model, which are the final conceptual outcomes of this research that present the recommendations of this research and link them with the research's contribution to knowledge.

6.4.1 Innovation framework

Based on the findings of this research and supported by the rich literature, the framework provides UK rail industry specific, effective road map approach to innovation. It combines the strengths of the main enablers of innovation, and provides a road map for successful integration and exploitation of the key elements of innovation, such that the barriers to innovation can be addressed, and value created for all stakeholders while gaining sustainable competitive advantage. As presented in Figure 6.1 below, the three main enablers of innovation are the government, strategy and funding. These three elements when acting in unison can act as an umbrella for developing and implementing innovations within the industry. With the involvement of the government, a clear direction for the industry can be established, which when powered by the fuel for creation and improvement, that is funding, can help establish long-term vision and a robust strategy supporting innovation. With the main enablers in harmony, the stakeholders can be effectively aligned and managed, innovation risks can be better managed, and process mechanisms can be further improved and successfully implemented. As depicted in the Innovation Framework, such measures can then create a better focus on innovation efforts by creating market awareness to produce effective and customer centric solutions. These when supported the elements of flexible and fit for purpose standards and regulations, effective testing and trialling, and enhanced communication between the systems, can drive innovation to address market challenges and create competitive advantage. Further, in order to maximise the innovation potential of the industry, the framework includes flexible and collaborative culture for innovation development that exploits, strengthens, and replenishes the core innovation capabilities of the industry. A key outcome of the framework is the effective measurement of innovation outcomes that enables the identification of the industry’s innovation gap. These when continuously fed back into the system can help close the UK rail industry’s innovation gaps resulting in value creating for stakeholders and development of sustainable competitive advantage.

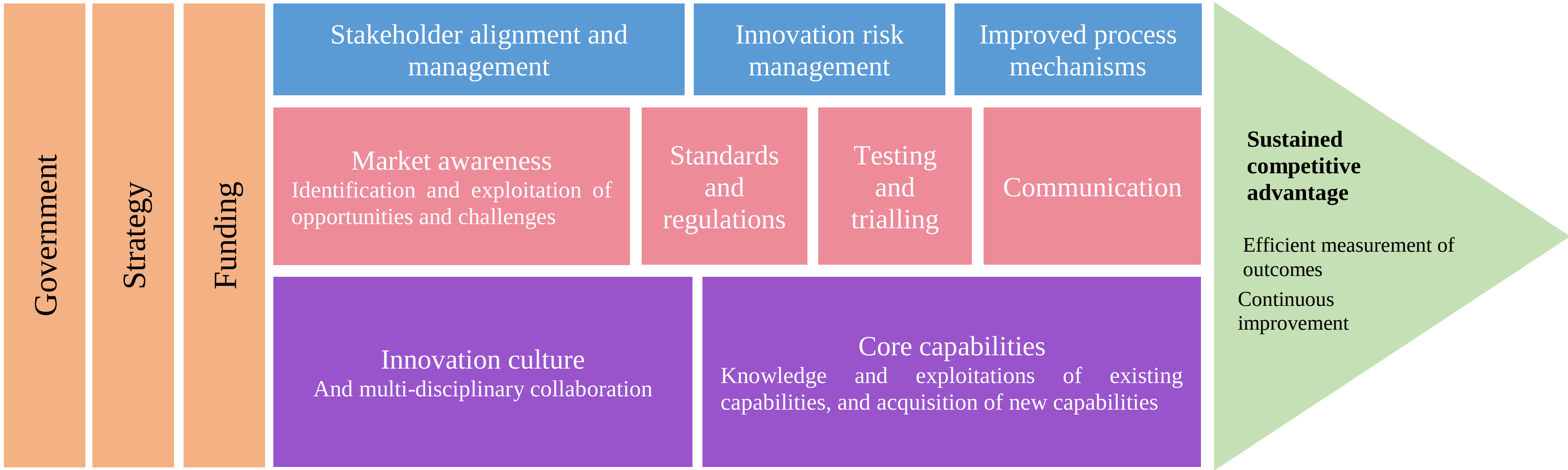


Figure 6.1 - Innovation framework for UK rail industry

6.4.2 *Innovation model*

Based on the findings of this research and supported by the rich literature, the developed innovation model presents a visual presentation of the current innovation scenario in the UK rail industry, along with the measures than can be taken to achieve the desired ideal situation. The Innovation Model is presented below:

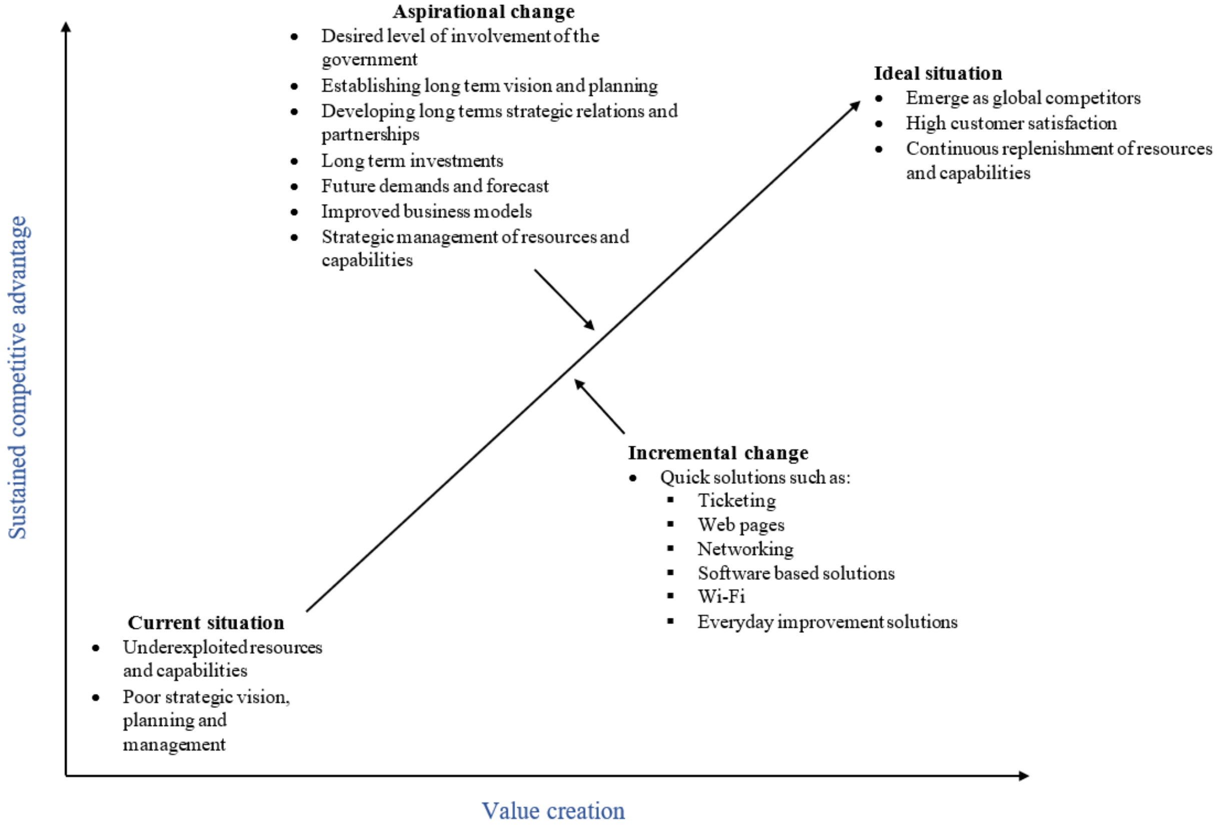


Figure 6.2 - Innovation model for the UK rail industry

As evident from Figure 6.2 the current innovation scenario lies on the lower opposite end of the ideal innovation scenario in the industry. However, the Innovation Model provides means of creating value and establishing sustained competitive advantage in order to achieve the desired ideal innovation scenario. The model suggest that while incremental changes should be continuously employed to address the everyday challenges, foundations of a long-term development must also be laid down simultaneously. It provides the means to strike a balance between meeting both the current and future innovation demands of the industry. Incremental changes while generating value cannot be the means for long-term developments alone in absence of a long-term vision and investments, to forecast and sustain future demands.

However, when supported by the aspirational changes, both together can enable the UK rail industry to achieve the envisioned ideal innovation scenario.

6.5. Contribution of this research

This section will highlight the main contributions of this research to existing knowledge, enabling the justification of the Doctorate level of this thesis. This section aims at communicating the distinctive value of this research, best claimed under the incremental category of contributions (Nicholson *et al.*, 2018).

Incremental contributions are based on the traditional gap spotting approach to reviewing literature (Alvesson & Sandberg, 2011) (Hällgren, 2012) (Nicholson *et al.*, 2018). Within this broad strategy of gap spotting, Sandberg and Alvesson (2011), proposed two main sub-categories of confusion spotting and neglect spotting. Confusion spotting involves rationalising previously published results, where the previous themes have failed to reach an agreement (Nicholson *et al.*, 2018); and neglect spotting involves focusing on neglected or under-researcher areas, in terms of theories, constructs or methodologies, and if there is lack of empirical research (Nicholson *et al.*, 2018). This research makes an incremental contribution under neglect spotting, which is pitched and measured against existing knowledge, while its value and importance shows progress over what is currently known (Nicholson *et al.*, 2018). Incremental contribution has received concern by Alvesson and Sandberg (2011) over being only mildly critical. However, Nicholson *et al.* (2018) reviewed 538 papers in three leading industrial marketing journals and found incremental contributions to be the most dominant strategy, with more scholars identifying areas of neglect than confusion. The study confirmed the dominance of incremental strategies both when combined with other strategies or as a free-standing strategy (Nicholson *et al.*, 2018). Further the contributions of this research are justified as the semantics of the contribution are in agreement with the semantics of neglect spotting as identified by Nicholson *et al.* (2018). These have been referred to Nicholson *et al.* (2018)appropriately in the following sections.

6.5.1 Contribution to knowledge

As such, this research contributes to the existing knowledge, by providing an unbiased evidence based, empirical account of relatively unexplored (Nicholson *et al.*, 2018) area of innovations within the UK rail sector. This research fills the gaps in literature on the nascent subject of barriers to innovation within the UK rail industry. The research expands the previously conducted researches such as the work of Dodgson *et al.* (2015) specific to strategy in Crossrail, to encompass the overall innovation scenario in the UK rail sector. As stated this research provides an unbiased evidence based results where there is a shortage of research (Nicholson *et al.*, 2018), as most of the work related to innovation in the UK rail industry, exists to inform as published by the industry with an agenda. However, this research utilised the existing industry work to identify the gaps in knowledge of the industry on the complex phenomenon of innovation.

In addition, this research explores the multiple stakeholders active within the industry, the area of research that has received relatively less attention (Nicholson *et al.*, 2018), to identify the barriers to innovation from secondary and primary stakeholder perspectives. This forms a valuable contribution as owing to the complex fragmented structure of the UK rail industry, this research successfully provides a cross industry perspective of the barriers to innovation which has been little understood (Nicholson *et al.*, 2018) up to now.

This research finally attempt to address the critical issue of academics and practitioners related to overcoming barriers to innovation in the UK rail sector, this was achieved by analysing rich sources of qualitative and quantitative data, in order to develop an Innovation Framework for UK rail industry (as discussed in section 6.4 subsection 6.4.1). Pitched and measured against the existing knowledge (Nicholson *et al.*, 2018), the Innovation Framework as presented in Figure 6.1, combines the strengths of the main enablers of innovation, and provides a road map for successful integration and exploitation of the key elements of innovation, such that the barriers to innovation can be addressed, and value created for all stakeholders while gaining sustainable competitive advantage. The framework can enable the UK rail industry to transform into a world class industry by promoting team-work environment, enhancing operational efficiency, developing processes for continuous improvements and ultimately gaining an advantage over their competitors (Bamford *et al.*, 2015).

6.5.2 Contributions to practice

This research, as discussed in section 6.4 provides two valuable outputs for practice. These are an Innovation Framework as presented in Figure 6.1 and an Innovation Model presented in Figure 6.2. The Innovation Framework provides an effective roadmap to navigate the complex innovation landscape in the UK rail industry. It identifies the key elements of the innovation process and combines their strengths to successfully integrate and exploit the innovation potential of the UK rail industry. The framework even though has its foundations in the theoretical evidence, when combined with the valuable findings of this research, it expands it to practice in the UK rail industry. The framework simplifies the complex industry structure, by putting together the pieces of the puzzle that create barriers to innovation in an effective way so as to harvest their strengths and bring to light their valuable inter links and relations. The framework ultimately enables the industry to build upon its resources and capabilities to create value for stakeholders, which when effectively fed back into the system, can enable replenishment of these resources and capabilities creating competitive advantage.

In addition, the Innovation Model provides the practitioners the means of achieving the ideal innovative state desired by the industry. It positions the current innovation situation in the UK rail industry in terms of the value and competitive advantage it creates, in contrast to the desired ideal situation. It further provides short and long-term means for the industry to transform from the current situation to a world class innovative industry. The model highlights the relation between long and short-term goals and importance of simultaneously addressing both. It gives examples of continuous incremental changes that can be made to continuously create value, while identifying the key areas for long-term goals in order to start creating sustainable competitive advantage. As depicted by the Innovation Model, when the two areas identified are addressed simultaneously, they can have the potential to transform the industry to a global competitor while satisfying and creating value for all its stakeholders.

6.6. Recommendations of this research

Having reviewed the relevant literature and discussed the rich findings of this research, this thesis makes recommendations to overcome the barriers to innovation in the UK rail industry. The thesis recommends focusing on three main areas which are strategy, stakeholder integration and management, and feedback loops of value creation to continuously feed back into the system. As discussed in chapter five discussions, majority of the barriers arise from the lack of a strategy. As such the thesis stresses on the strategic management of innovation, stakeholders and processes involved in innovation. Having a clear direction can enable effective integration of the identified key elements of innovation, as prescribed by the Innovation Framework. Successful integration of primary and secondary stakeholders whilst improving communication, can enable the successful exploitation of the industry resources and capabilities in order to create value for all stakeholders. With a continuous feedback loop, these resources and capabilities can be continuously replenished, and develop learnings, to ultimately gain sustained competitive advantage. The Innovation Framework, can therefore, provide guidelines for integrating the key elements that face barriers to innovation, while highlighting their inter-links and relationships for optimum benefit. The second recommendation of the thesis, is to integrate short and long-term goals for continuous development. The Innovation Model can guide this simultaneous action, while benefiting from the strategic management informed by the Innovation Framework. As a result, the barriers emerging from the lack of strategic intent and management, segregated stakeholders, and absence of continuous learning, identified in chapter four findings, can be successfully addressed. These developments can then also be supported by barrier specific measures under a common strategic element.

Expanding on the barrier specific measures, this research strongly recommends a stronger leadership within the industry to enable change and transformation. Started from the top, more effective involvement from the government can create a long term vision and set a direction for the industry. This can aid agility and rapid adoption of innovation, by setting realistic expectations and mitigating innovation risks through better funding models that values collaboration and further supports R&D. With a long term strategy in place, corresponding communication strategies can be developed involving cross industry interactions and cross fertilisation with other industries, for adoption of innovation and sharing of best practises. An effective communication strategy can also aid employee integration and better coordination nationally by aligning goals and widely communicating the valuable work of the industry groups such as RDG, TLG and RSG. Such industry bodies consists of industry experts and effective communication can increase the involvement of the wider industry to create effective solutions. Effective communication can further bridge the gap in knowledge, allow effective exchange of data and information, and create long term relations and partnerships among the industry stakeholders. Under a strong leadership, the business strategies can be effectively implemented, and a culture for innovation can be developed. By being less prescribed and engaging the middle management and frontline staff, the leadership can promote innovative thinking as a part of daily routine, and promote freedom and authority to innovate addressing the ‘what is there for me’ attitude identified in the findings of this thesis. A culture that supports innovative thinking can attract better talent and make the industry attractive to the new generations and manage skills shortage which is expected to cost £316m per year by 2024 if not intervened by the industry (DfT & BEIS, 2018). This can in turn aid knowledge capture and transfer so as to not lose the expertise within the industry, which can reduce costs to business base by £60m and to the government by £67m (DfT & BEIS, 2018). Having the above enablers in place can support the creation of appropriate incentives for all stakeholders to be untie under one overarching strategy.

Having the above enablers in place, can effectively support the industry to evolve into a customer focused industry and meet its 2050 targets as stated in (DfT & BEIS, 2018). Developing customer specific solutions, making intelligent use of funding, and clearly identify competitive areas and opportunities for collaboration can support the industry to intensify its R&D and innovation as it aims to reach 2.4% of GDP investment in R&D by 2027 (DfT & BEIS, 2018) in order to support innovation. The support to innovation as stated in (DfT & BEIS, 2018) includes £40m through Innovate UK for rail innovation competitions targeted at UK based suppliers and UK based SMEs under a three year programme (DfT & BEIS, 2018), £35m targeted at digital innovations (DfT & BEIS, 2018), £92m secured by UKRRIN (partnership between rail supply industry and eight universities) to establish UK as world class centre of rail excellence (DfT & BEIS, 2018), and £245m to Network Rail for RD&I of rail infrastructure over CP6 – 2019-2024 (DfT & BEIS, 2018). Building on the findings, contributions and recommendations of this research, it can support the UK rail industry to transform into an innovative industry; as stated by (DfT & BEIS, 2018) by means of £450m allocated for developing digital signalling technology to increase reliability (DfT & BEIS, 2018) and £84m to develop the corresponding range of trains with in cabin digital signalling equipment, aiming to transform the whole rail system by 2025 (DfT & BEIS, 2018). The emphasis on collaboration laid down in the recommendations of this research can support the industry to create best value for the overall £53bn planned to be spent between 2019-2024 (DfT & BEIS, 2018).

6.7. Limitations of this research

Whilst the research has produced successful tangible outcomes, the research has a few limitations. One of the main challenges that the researcher faced was accessing the required data. Considering the complex and fragmented structure of the UK rail industry, the researcher faced barriers in gaining access to this closed domain. Despite conducting a stakeholder analysis, not all the stakeholders could be involved in the research, due to their large number and limitations of access. As mentioned in chapter three methodology, the researcher gained access to participants through networking at industry events and snowball sampling technique. As such, the sample population was limited to the stakeholders attending such events and the recommendations being made by the participants. Furthermore, reluctance was witnessed amongst the approached potential sample population, where only one third of the invitations sent were accepted. As such, the final sample population was small in size compared to other studies reflecting views of the general population. The researcher faced further challenges in collecting quantitative data, which also received a low response. As such the researcher acknowledges that some of the quantitative research findings might not be generalisable or transferrable on their own. However, due to the systematic nature of the work, when in complementary position to the in depth qualitative data, as justified by the literature, the findings can provide accurate indications of the phenomenon under study.

The current research even though employs mixed methods approach, the current results might be considered as being mainly qualitative. As mentioned earlier, the initial aim of the research was to equally utilise qualitative and quantitative data analysis to answer the research questions, the quantitative sample size was relatively small to support a robust analysis on its own. A larger quantitative sample could have strengthened the findings of this research. In addition, due to the limited access to the sample population, the sample criteria in terms of specific experience of working with innovation could not be strictly exercised, even though the quantitative data sample recorded a range between 1 – 47 years of experience within the UK rail industry. From the qualitative findings it could be deduced that not all the participants were experienced enough on comment on all identified aspects of innovation. However, the rich data gathered from qualitative analysis which comprised of all levels of management who had the overall and intermediate view of the business, and engineers who worked at the grassroots levels of innovation, an in-depth knowledge was gained into the innovation scenario within the UK rail industry.

Finally, the last limitation comes from the qualitative data collection and analysis. As most of the views captured were personal to the interviewee based on their experiences, there was a risk of biased data manipulation. Similarly, there was risk of the researchers personal views developed along the process to manifest in the data analysis stages. However, the researcher managed the two forms of bias, by linking the small set of collected data which was mainly dominated by personal specific experiences and ideologies, especially witnessed among the innovators, and middle management to those of the directors and senior management who had an overall view of the business. This provided a more rational analysis, and also gave indications of the nature of culture prevailing within the industry. For managing the risks personal bias of the researcher in interpreting the data, each interview of transcribed and direct quotes from interviewees were used to support the research findings. At the same time the researcher recognises that different patterns of data could have emerged from the collected data which can serve as inspiration for future research.

6.8. Recommendations for future research

The aim of this research was to investigate the barriers to innovation in the UK rail industry. Despite the contributions made by the current study, this is an area which has just began to be researched. As such this study opens avenues for further research on innovation phenomenon in the UK rail industry. As mentioned in chapter one – introduction, the initial scope of the research shifted from concentrating on only the testing and trialling stage of innovation to the overall innovation phenomenon in the UK rail industry. Owing to the lack of previous research in the field, studying only a single piece of the puzzle would not have produced valuable outcomes. Now, with this research completed, it lays down the foundations of carrying out further research in this particular field.

The main recommendation for future research would be to individually study the various key elements identified in this research in order to understand the localised deeper roots of the issues that create barriers to innovation. This can include further research into the strategy within the industry, the funding scenario, operations of the Train Operating Companies and their contributions to innovation, culture within the industry and further research into various other industry stakeholders to tie in their contributions to innovations in the UK rail industry. This may include expanding on the study of Dodgson *et al.* (2015) on strategy within the Cross Rail project, to the entire industry. On the funding side future research may involve investigating effective funding models that address challenges arising from the fragmented structure of the industry. in consideration to the £40m investment made to engage SMEs, future studies may involve investigating models to embrace and exploit the potential of start-ups and SMEs and to study the outputs of the made investments. In addition, a key area for future research can be the investigation of various measures taken recently by the industry such as making innovation a key element in the franchising contracts and the setup of The Strategic Vision Industry Rail Board, a joint government and rail industry board to oversight the implementation of the Sector Deal 2018, in order to measure its effectiveness on the innovation capabilities of the industry.

Further to this, a scope for future research is identified by the fact that this research is mainly qualitative in nature. Therefore a more quantitative strategy is a possible evolution of this study. This can be employed to study and evaluate the measures taken by the industry to address the issue at hand, and feedback the learning for further improvements. As such, being the first of its kind, this research answers the questions related to what are the barriers to innovations and is limited by the scope of the research to explore fully the deep rooted causes of these barriers, which have been addressed to some extent within this research. Therefore the future recommendations of this research would be to study the why's of this research in more depth. In addition, the innovation landscape within the UK rail industry can be studied region wise to compare and contrast the outcomes, and learnings that can be shared to benefit the wider industry.

6.9. Reflective commentary

The development of the current thesis, allowed the researcher to establish expertise in the field of innovations specifically within the UK rail industry. This was achieved by combining the researcher's interest in operations management, picked up from a previous industry placement, strategy, innovations and the UK rail sector. The synthesis of the core bodies of literature of strategy, innovation and transportation, in order to identify the gaps in knowledge was a relatively challenging process. But, it enabled the researcher to develop relevant conceptual models to address the gaps and to build substantial amount of theoretical knowledge. The research topic also enabled the researcher to expand the engineering knowledge gained form previous university courses and work placements, to business management, especially academic knowledge to derive better results and profits from engineering processes. This was also one of the reasons for the researcher's interest in this particular research.

Subsequently, the selection of appropriate research approaches provided the researcher with an opportunity to explore and learn about research philosophies, the various paradigms and the diverse techniques and tools that can be utilised for gaining optimum results. Through the extensive and challenging, yet crucial exercise of collecting and analysing data, the researcher gained the practical knowledge for the development of this thesis.

The particular focus of this research on innovation, and its combination of business and engineering aspects of the UK rail industry, has inspired the researcher to investigate further the business aspects of exploiting engineering/technical resources of an organisation to support the overall business. It has also inspired the researcher to further explore the topic of innovations, in particular in the UK rail sector, in order to transform an organisation/industry into a word class competitor. Therefore, the contributions of this research to knowledge can strength the research of innovation within the UK rail sector. Finally, the knowledge and experiences gained from this research lay down strong foundations for the researcher to build a career in innovation management, specifically within the UK rail industry.

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Appendices

6.10. *Appendix 1*

Initial questionnaire focused on testing and trialling (for example: Innovator):

- Introduce myself and the aims of the project, and how the interview will help me. Thank them for taking the time out for this interview.

- Mention that the details of the interviewees will be anonymous and if required, findings of the research will be shared with them.

1. Describe your work and your position in your firm.

2. What is innovation to you?

3. Can you describe the innovation process please?

4. At what stage of the innovation process are you?

5. What do you think about the acceptance process in the UK rail industry? How much knowledge do you have of the acceptance process? How do you plan to find out the required information? Do you know who to contact in the industry?

6. Are you familiar with the requirements you need to meet in order to gain compliance? Such as the standards. If yes, how did you find it out? If no, how will you be gaining this information?

7. How do you plan to test your innovation in the UK? Do you know which testing facilities meet your requirements? And what about gaining access to the live railway for trialling?

8. How do you feel about the costs associated with testing and trialling?

9. Are there any tests that you have done in an external environment? Are they acceptable in the UK?

10. Are you aware of the funding options that are available? What are your thoughts about the funding process? Are you receiving any kind of funding?

11. What are the other barriers you face while testing, that we may have not been identified in the above discussion?

12. Are there any suggestion that you have to make the testing and trialling in UK simpler and efficient?

6.11. Appendix 2

Semi-structured interview focused on the overall barriers to innovation (for example: Manufacturer):

- Thank you for taking the time for this interview.
- All the details of the interviewees will be anonymous and confidential. I will share the findings of the collated research with you via tailored reports.

1. Describe your work and your position in your firm.

2. What is innovation to you?

3. As an organisation how are you promoting and supporting innovation in the UK rail industry? (Policies, funding etc.)

4. In your opinion what are the barriers to commercializing innovation in the UK rail industry? (E.g. strategy, policies, IP issues, costs, funding etc.)

5. How does the industry structure/business environment effect innovation?

6. How can these barriers be removed in the UK rail industry? (New processes and procedures)

7. Any suggestions and contacts you can share please?

6.12. Appendix 3

Semi-structured interview focused on the overall barriers to innovation (for example: Train Operating Company):

- Thank you for taking the time out for this interview.

- All the details of the interviewees will be anonymous and if required, I am happy to share the findings of the research.

1. Describe your work and your position in your firm.

2. What is innovation to you?

3. As an organisation how are you promoting and supporting innovation in the UK rail industry?

4. Can you describe your acceptance and testing process please?

5. Where do you think are the barrier in your internal testing process/acceptance process, or where do you think is the scope for improvement in order to accelerate development time scales and reduce business case risks? (E.g. lack of commitment, communication and feedback, long development timescales, access to live rail, test repetition)

6. How does industry structure/business environment affect innovation? Are the short franchising periods a barrier to invest and gain profitability from an innovation?

7. In your opinion what are the barriers to commercialising innovation in the UK rail industry, especially in the testing and trialling process? (E.g. costs, access to test facilities, interpretation of standards, IP issues, working with the industry, acceptance process etc.)

8. How can these barriers be removed in the UK rail industry? (New processes and procedures)

9. Any suggestions and contacts that you can share please?

6.13. Appendix 4

Survey instrument:

Introduction

I would like to invite you to take part in the study on barriers to innovation in the UK rail industry. Your response will contribute to a PhD project aimed at identifying and overcoming the barriers to innovation in the UK rail industry.

Purpose of the survey: is to collect information about the barriers to innovation in the UK rail industry.

The British railway transport sector is supporting continuous development and improvement of rail technology to satisfy its growing demand. Innovations have been identified as a key enabler of a beneficial and prosperous rail industry (TSLG, 2012). Innovations are essential in railways in order to satisfy the interests of its customers, both passengers and freight and to make railways financially and environmental y viable in the longer run. As such, this study aims at providing an insight into the barriers to innovation in the UK rail industry and finding possible suggestions on how they can be overcome.

Time: The survey is divided into 5 sections and takes 10-15 minutes of your time. Please answer all the questions (unless stated otherwise) in order to get a complete picture of the innovation landscape and for suitable comparison to be made between respondents.

Privacy: your details and responses will be kept anonymous and strictly confidential.

End results: I am happy to share the end results of my research with you. Please contact me at: zibrj.ahmad2@hud.ac.uk

If you would like any further information or details about the study, please email me at: zibrij.ahmad2@hud.ac.uk

Thank you for taking the time to share your knowledge and experiences with me. I look forward to receiving your responses.

Reference: TSLG. (2012). THE RAIL TECHNICAL STRATEGY 2012. London.

Innovation

The following questions are related to the need of innovation, the types of innovation and strategic approach to innovation in the UK rail industry.

1. What type of innovations take place in the UK rail industry and to what extent?

Please don't select more than 1 answer(s) per row.

	Never	Seldom	Sometimes	Often	Almost always
Radical (breakthrough)	☐	☐	☐	☐	☐
Incremental	☐	☐	☐	☐	☐
Transformational (disruptive)	☐	☐	☐	☐	☐
Business model	☐	☐	☐	☐	☐
Adoptive innovation (from other industries)	☐	☐	☐	☐	☐

2. What type of innovations does the UK rail industry need and to what extent in order to transform into an innovative industry?

Please don't select more than 1 answer(s) per row.

	Never	Seldom	Sometimes	Often	Almost always
Radical (breakthrough)	☐	☐	☐	☐	☐
Incremental	☐	☐	☐	☐	☐
Transformational (disruptive)	☐	☐	☐	☐	☐
Business model	☐	☐	☐	☐	☐
Adoptive innovation (from other industries)	☐	☐	☐	☐	☐

3. To what extent are the following factors responsible for your decision to innovate?

Please don't select more than 1 answer(s) per row.

	Not important	Somewhat important	Neutral	Important	Very Important
To gain competitive edge	☐	☐	☐	☐	☐
Need for better services and value to the customer	☐	☐	☐	☐	☐
Address the growing demand for increased capacity	☐	☐	☐	☐	☐
Due to the contractual requirements and pressure	☐	☐	☐	☐	☐

4. Is there a robust (effective, strong) strategy in place to bring about innovation?

☐	Yes
☐	No (please see the below question a)

4.a. If no, to what extent does it lack the following?

Please don't select more than 1 answer(s) per row.

Please select at least 4 answer(s).

	Strongly disagree	Disagree	Not sure	Agree	Strongly Agree
Strategic vision	☐	☐	☐	☐	☐
Strategic plan execution and evaluation	☐	☐	☐	☐	☐
Culture	☐	☐	☐	☐	☐
Clearly quantified goals and their impact on future performance	☐	☐	☐	☐	☐

Funding

The following questions are related to types of funding and funding mechanisms for innovation.

5. Does your organization have a well-defined innovation budget?

☐	Yes, internal funding
☐	Yes, external funding (please see below question part a)
☐	Yes, internal and external (please see below question part a)
☐	There is lack of budget (please see below question part b)

5.a. If you have used external funding sources, how will you describe the process?

Please don't select more than 1 answer(s) per row.

Please select at least 4 answer(s).

	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
Straightforward	☐	☐	☐	☐	☐
Cumbersome	☐	☐	☐	☐	☐
Time consuming	☐	☐	☐	☐	☐
Expensive	☐	☐	☐	☐	☐

5.b. To what extent are the following factors responsible for the lack of budget?

Please don't select more than 1 answer(s) per row.

	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
Lack of information on external sources	☐	☐	☐	☐	☐
Lack of expertise for the funding applications	☐	☐	☐	☐	☐
Cumbersome funding mechanisms	☐	☐	☐	☐	☐

Others, please specify:

Innovation process

The following questions are related to organizational and leaderships approach to innovation.

6. To what extent do the following characterize the innovation process?

Please don't select more than 1 answer(s) per row.

	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
Innovation process is strongly linked to the organization’s strategy	☐	☐	☐	☐	☐
Effective processes are in place to manage innovation risks	☐	☐	☐	☐	☐
Lack of resources	☐	☐	☐	☐	☐
Lack of expertise/team	☐	☐	☐	☐	☐

Others, please specify:

7. To what extent do the following characterize the innovation culture?

Please don't select more than 1 answer(s) per row.

	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
Senior management encourage innovation by demonstration (that is, "it's ok to fail")	☐	☐	☐	☐	☐
Innovation projects are handled by a cross functional team	☐	☐	☐	☐	☐
Innovation forms an integral part of the day to day jobs of the people	☐	☐	☐	☐	☐
Innovation is well supported by the rail industry	☐	☐	☐	☐	☐

Testing and trialling

The following questions are related to testing and trialling facilities and procedures.

8. How would you describe the testing & trialling process in the UK rail industry?

Please don't select more than 1 answer(s) per row.

	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
Insufficient testing facilities	☐	☐	☐	☐	☐
Lack of information on testing facilities (availability and facilities provided)	☐	☐	☐	☐	☐
Expensive	☐	☐	☐	☐	☐
Trialling process is fluid and flexible	☐	☐	☐	☐	☐
Trialling process is complex	☐	☐	☐	☐	☐
Time consuming	☐	☐	☐	☐	☐
Restrictive standards	☐	☐	☐	☐	☐

Industry structure

The following questions are related to the impact of industry structure on innovation and procurement.

9. Does the current franchising structure encourage innovation?

☐	Yes
☐	No (please see the below question a)

9.a. To what extent do the following hamper innovation?

Please don't select more than 1 answer(s) per row.

	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
Short franchising periods	☐	☐	☐	☐	☐
Lack of resources	☐	☐	☐	☐	☐
Biding mechanisms	☐	☐	☐	☐	☐
Lack of competition	☐	☐	☐	☐	☐

Others, please specify:

10. Is the fragmented industry structure a barrier to innovation?

☐	Yes (please see the below question a)
☐	No

10.a. To what extent are the following the bi product of industry fragmentation?

Please don't select more than 1 answer(s) per row.

	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
Lack of collaboration	☐	☐	☐	☐	☐
Conflict of interests	☐	☐	☐	☐	☐
Complicated structure to navigate through	☐	☐	☐	☐	☐
Difficult to break into the industry	☐	☐	☐	☐	☐

Others, please specify:

11. To what extent do the following characterize the procurement in the industry?

Please don't select more than 1 answer(s) per row.

	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
Buyer dominance	☐	☐	☐	☐	☐
Disconnect amongst supply chain	☐	☐	☐	☐	☐
Difficult for new SMEs to break into the industry	☐	☐	☐	☐	☐
Poor visibility of demand and opportunities	☐	☐	☐	☐	☐

Others, please specify:

Summary

12. In your opinion what are the key areas to be addressed to improve innovation?

Please don't select more than 1 answer(s) per row.

	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
Strategy (technical& business	☐	☐	☐	☐	☐
Leadership	☐	☐	☐	☐	☐
Fragmentation of the industry – work in silos	☐	☐	☐	☐	☐
Better processes and procedures (please mention the areas that require development)	☐	☐	☐	☐	☐

12.a. Processes & procedural areas and others please specify

13. In your opinion what are the key measures to be taken to accelerate innovation?

Personal details

And final y, please answer the following questions about yourself. This will help to understand the innovation landscape better. As stated earlier, the responses of the survey are anonymous and confidential.

14. Please specify the name of your organization and your position in the firm

15. Please specify the number of years you have been working for in the rail industry

16. Please specify your age

☐	25 - 35
☐	35 - 45
☐	45 - 55
☐	55 and above

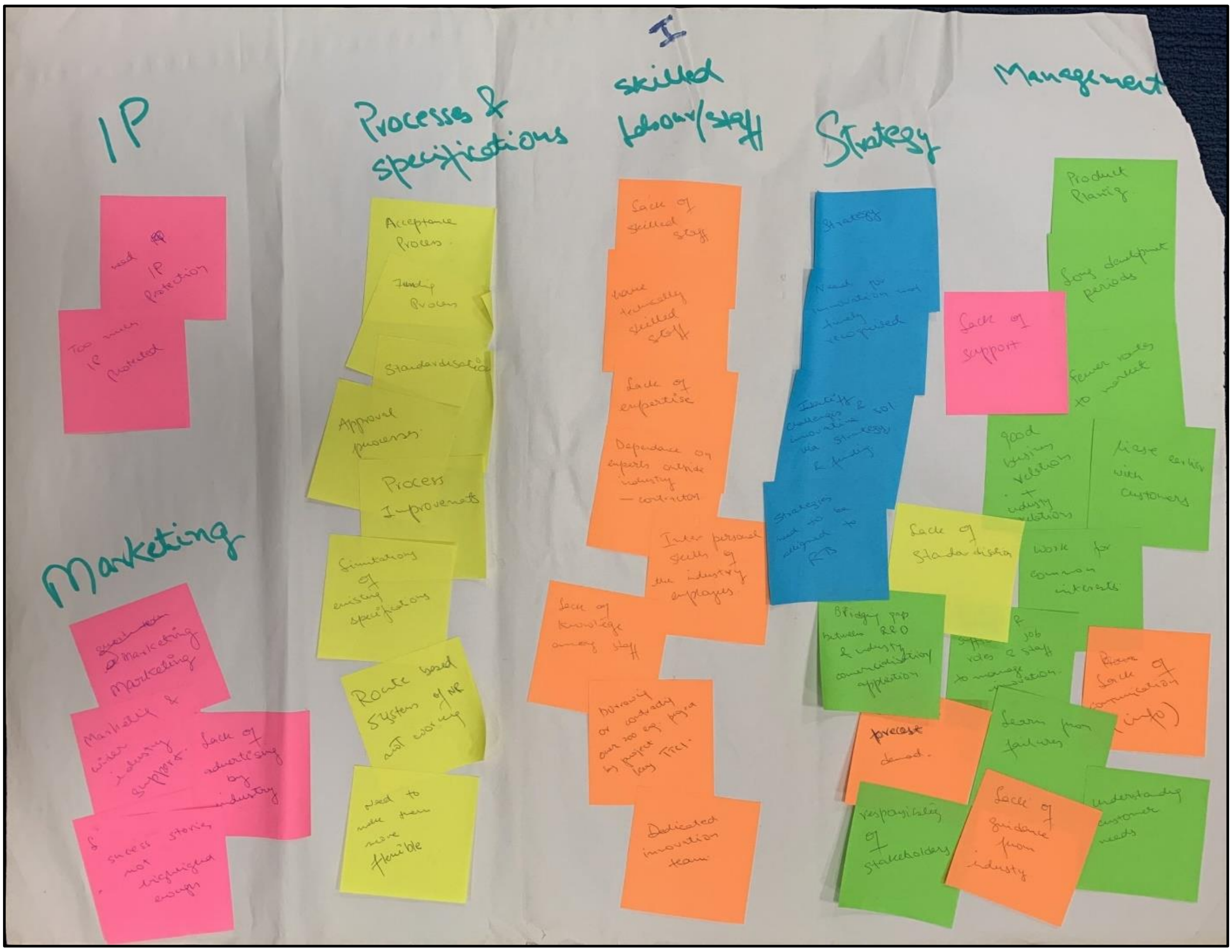
End

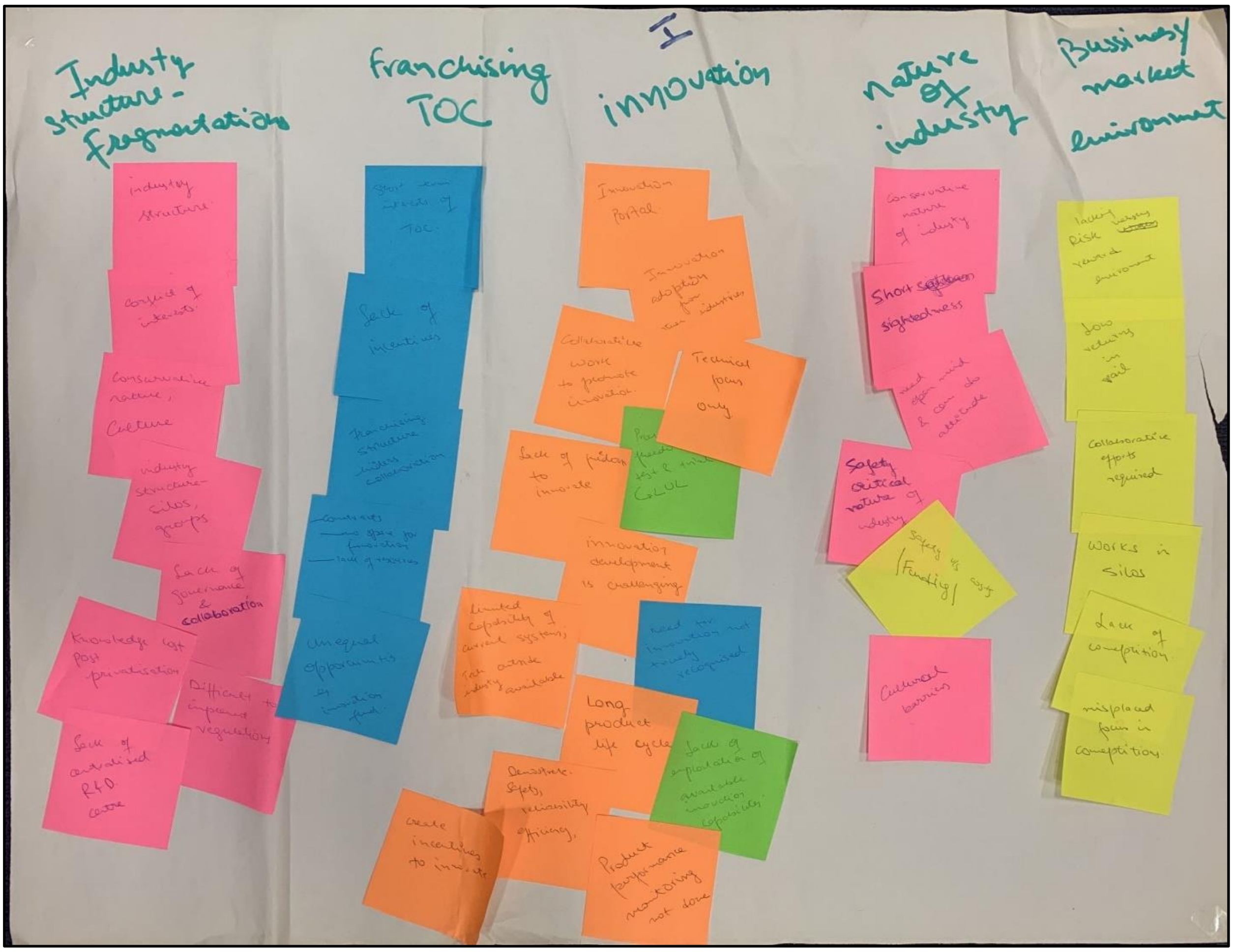
Thank you for completing the survey.

If you are interested in the results please contact me at: zibrij.ahmad2@hud.ac.uk

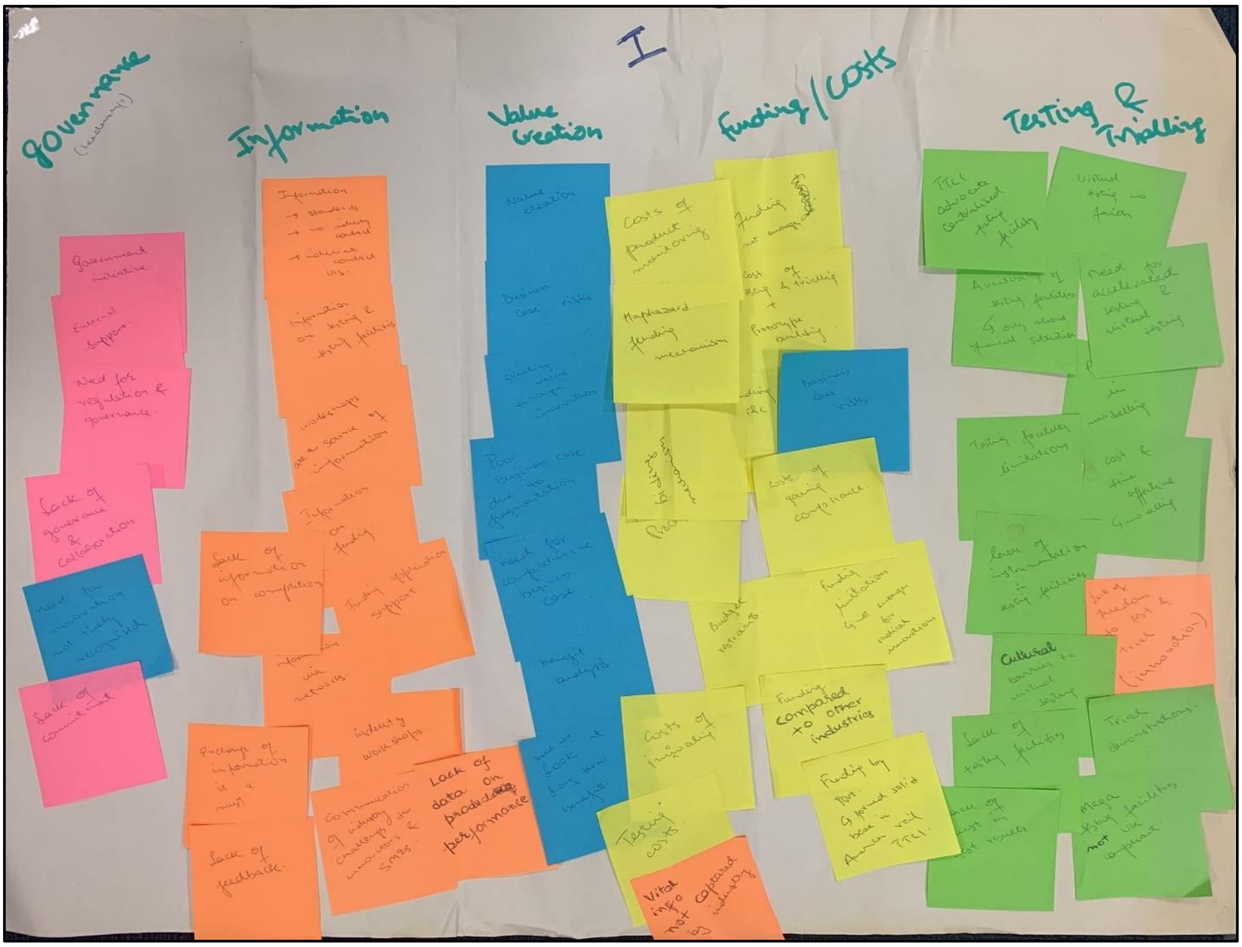
6.14. Appendix 5

Thematic analysis Group I





Industry structure - Fragmentation
Franchising TOC
I
innovation
nature of industry
Bussiness market environment
industry structure
conflict of interests
Conservative nature, Culture
industry structure - silos, groups
Lack of governance & collaboration
Knowledge lost post privatisation
Difficult to implement regulations
Lack of centralised R&D centre
Lack of incentives
Franchising structure hinders collaboration
Unequal opportunities in innovation fund
Innovation portal
Innovation adoption for industries
Collaborative work to promote innovation.
Technical focus only
Lack of freedom to innovate
innovation development is challenging
Limited capability of current systems;
Need for innovation not truely recognised
Long product life cycle
Lack of exploitation of available innovation capabilities
Create incentives to innovate
Product performance monitoring not done
Conservative nature of industry
Short sightedness
need open mind & can do attitude
Safety critical nature of industry
Safety vs cost
(Funding)
Cultural barriers
Risk reward environment
Collaborative efforts required
Works in silos
Lack of competition
misplaced focus in competition


I
Governance (leadership)
Information
Value Creation
Funding/Costs
Testing & Trialling
Government initiative
External support
Need for regulation & governance
Lack of governance & collaboration
Lack of commitment
Lack of information on compliance
Lack of feedback
Lack of data on production performance
Costs of product monitoring
Haphazard funding mechanism
Costs of going compliance
Funding compared to other industries
Testing costs
Vital info not captured by industry
Cultural barriers to virtual testing
Need for accelerated testing & virtual testing
Trial demonstrations

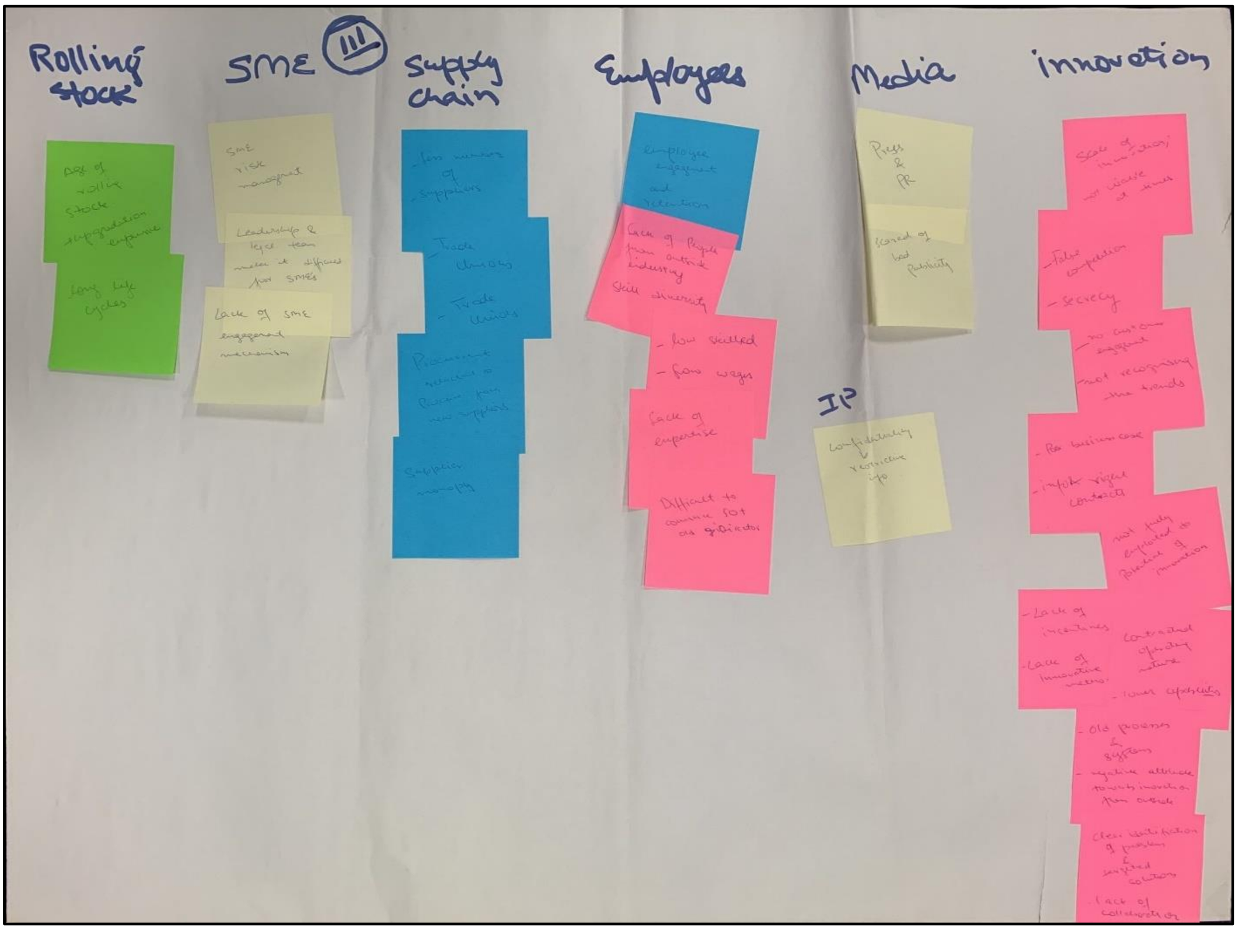
Thematic analysis Group II

Testing & Trialling
Nature of industry
Industry Structure/fragmentation
Franchising - TOC
Governance
Lack of testing facilities
Low returns
Cultural barriers
Cultural arrogance
Risk averse industry
Safety critical nature
Complicated network of stakeholders
Many stakeholders involved
Lack of communication
Lack of collaboration
Complex structure
Need for centre of excellence
Understanding the needs of industry
Short franchising periods
Lack of resources
Limitations of TOC, resources & time
Franchising contracts


II
Information
Skilled staff/ labour
Strategy
Process & requirements
Knowledge sharing to be encouraged
Poor knowledge capture
not easy to capture knowledge
Lack of communication
expert / skill replenishment
Lack of resources
Older work force
Skill replenishment
Skill & expertise transfer
Trade union
Required Dedicated to innovation
Lack of strategic planning
Lack of wider strategy
Strategy for innovation
Developing innovation culture
Evaluating strategy
Lack of strategy
need for strong strategy
Slow process bureaucracy
funding applications
Process mechanisms
series of approvals & demos
opaque
Leadership
Leadership
need to strong leadership
Funding
funding application
Lack of funds
Lack of funding
Resourcing
funding

Thematic analysis Group III


Strategy
Nature/
Culture
Market
Innovation
industry
Structure
Communication
Vision
Highly regulated
Monopoly
Work in silos
Poor info
Lack of competition
Slow to change
Risk averse



Rolling stock
SME
Supply chain
Employees
Media
innovation
IP
Age of rolling stock
long life cycles
SME risk management
Leadership & legal team
Lack of SME engagement mechanism
few number of suppliers
Trade unions
Supplier monopoly
Employee engagement and retention
Lack of People from outside industry
Skill diversity
- low skilled
- low wages
Lack of expertise
Difficult to convince
Press & PR
Scared of bad publicity
Confidentiality & restrictive info
- False competition
- secrecy
- not recognising the trends
- No business case
not fully exploited to potential of innovation
- Lack of incentives
- Lack of innovative metrics
Contractual operating nature
- Old processes & systems
- negative attitude towards innovation from outside
lack of collaboration