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TECHNOLOGY ACCEPTANCE, ENABLING ADOPTION IN THE
PUBLIC SECTOR - A PRACTITIONER'S PERSPECTIVE

Thesis

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LIST OF ABBREVIATIONS

Abbreviation	Description
SLR	Systematic Literature Review
TAM	Technology Acceptance Model
DOI	Diffusion of Innovation
IS	Information Systems (Success model)
TPB	Theory of Planned Behavior
TRA	Theory of Reasoned Action
TOE	Technology, Organization and Environment
UTAUT	Unified Theory of Acceptance and Use of Technology

LIST OF KEY DEFINITIONS

Acceptance	The likelihood of the individual to accept and then use the technology	(Davis, 1985) (Tehseen, 2015, p.3)
Adoption	A term that refers to the acceptance, integration, and use of new technology at society level	(Tehseen, 2015, p.3)
Determinant	a precursor factor that affects the outcome of a model or framework.	(Ajzen and Fishbein, 1975; Rogers, 2003; Venkatesh, 2008)
Diffusion	The process for which new technology innovations spread are adopted within a social system	(Goldsmith, R. E, Foxall, 2003, p.321)
Innovation	An activity which is novel and capable of opening opportunities to improve service quality and efficiency without raising budget.	(Kusumasari et al., 2019, p.433)
Snowballing	Ad-hoc addition of articles based on their association with others either by reference or citation.	NA
Technology	Assembles and deploys specialized individuals and heterogeneous assets that are intricately related to advances in scientific and technological knowledge for the purpose of creating and capturing value for a firm. Often introduced as part of an innovative activity. This may be beyond typical technologies such as IT and Computing and could be machinery, automation or enabling solutions.	(Bailetti, 2012, p.8)
Success	Adoption or acceptance of technology that delivers value.	(Szajna, 1996a; Tucker et al., 2020)

1 Chapter 1: Introduction

1.1 Research Context

The UK rail sector announced its biggest reformation in the last 25 years in 2020. A main principle of reformation is to improve technology acceptance, to drive industry efficiency. A white paper which has been produced which describes the industry as ‘fragmented and overly complex’ and “in need of change for the user, operator and passenger” (Shapps and Williams, 2021, p.11). The changes required not only affect the users and operators, also the government in their ability to determine appropriate policies to enable and encourage technology acceptance (Shapps and Williams, 2021, p.5).

This research has been undertaken the same time the transformation is happening within the UK Railway. The changes which are proposed by the government in the UK will change the societal view of the railway, the organisations involved and end user’s perspective on technology as the UK commences its industry wide change to reform the railway. As the industry goes through the biggest reformation in 25 years and modernised, one of the fundamental outcomes is to be more accepting of technology (Shapps and Williams, 2021). Technology will have more focus and so understanding ‘what are the determinants of technology’ and ‘how is success measured’ will help to enable a successful transition. The Williams-Shapps Plan for Rail was a turning point for the rail industry, specifically identifying technology acceptance from innovation as one of the pillars of change and a pivotal point which will drive regulation and policy shaping the railway industry and is the initiator of the study.

There is a considerable amount of research literature which relates to technology acceptance as found in the systematic review in Chapter 2. This thesis presents a number of determinants in section 2.4 which affect technology acceptance at both an individual (Kim, 2016) and organisational level (Lacey et al., 2019). Yet, even with this available knowledge, technology is still often not accepted in practise, either partly or to the fullest extent as seen from the information presented in Chapter 4 as noted by an NR executive director;

“those that fail, you fail as quickly as you can to minimise the costs.”

R11

This phenomenon is not unique to the UK Rail Sector (Pannell and Zilberman, 2020; Tang et al., 2014) but does not appear to have been explored extensively regarding this

context. It is this UK Rail Sector context which will be investigated, and this will entail using learning from other industries, contexts and cases because by understanding the determinants there might be greater chance of predicting success and realising the corporate strategy. Not accepting technology in a timely way can be very time consuming and costly and can diminish moral in the organisation (Mundra and Lawlor, 2018) ultimately holding back the organisation by reducing market share or diminishing the potential financial and productivity returns. This is important for the UK Rail Sector as referenced earlier, technology acceptance is an area which requires improvement (Shapps and Williams, 2021).

Understanding Technology Acceptance is of critical importance to Network Rail to maximise the benefits as well as to reduce the time and cost of potential failure (Venkatesh et al., 2003). Within Network Rail, a public organisation which invests public money, there is a necessity to maximise the opportunity each investment can make for the public purse and technology acceptance will play a key part. This is the reason why the organisation is funding this research as it will play a direct part in understanding how to maximise the effect of every pound spent on technology within the sector(Regulator, 2023).

The research phenomenon is to understand why technology acceptance does or does not succeed in the UK Rail Sector, and the outcome of the study is to understand why this is the case and how to improve the chances. What are the determinants which influence the success of technology acceptance. The reason for the importance behind the phenomenon relates to political and public reputational pressures as well as the impact on resource planning and financial availability for the industry. The research is authored from the perspective of a practitioner, although care has been taken to reduce and eliminate bias, the application of the research within the Public Sector, Rail industry in the UK is the novel element of knowledge creation.

There is a considerable amount of research available from the field of social sciences in relation to technology acceptance. Diffusion of an idea was first documented as a phenomenon in 1943 (Ryan, 1943). The context of the acceptance was hybrid corn seed developments at a farm level within Iowa. This research took the perspective of a geographical spread of a new way of working to improve agricultural yield. Later in 1962, Rogers built on this work and published an early book which presented four main elements which influence the spread of an idea, the innovation, the communication channels, time and a social system being in place (Rogers, 1962). In total Rogers has

published 5 editions of the Diffusion of Innovation up to 2003. Edition 3 is primarily used as the starting point for this research as this edition introduces a critical approach and specific contexts to the diffusion of innovation but more importantly, the potential of non-linear communication of ideas which has an impact within a social setting (Rogers, 1983). The later editions focus on new techniques to share information such as the internet and the impact this has on diffusion across a population, no longer bound by geography and so less limited to a specific industry context in isolation. The latter additions focus further on specific contexts of using technologies such as the internet, the core requirements from Edition 3 remain unchanged and hence this is the version which has been used within the thesis as the inclusions in edition 4 and 5 would support future research opportunities.

Around a similar time to the publication of Edition 3 in the mid 1980s, further research looking at an individual's willingness to change was being published. (Ajzen and Fishbein, 1975). This work and its association with individual change was picked up and built upon by Davis who (1985) presented a framework which aimed to improve the understanding of technology acceptance in the context of Information Technology, therefore aiming to increase the chance of successful acceptance. When Davis (1989) formulated the Technology Acceptance Model, the benefit of introducing and accepting technology was aligned to affecting a single business requirement such as the implementation of a computer assisted graphic software (Davis, 1985, p.37). Through development and refinement of the model over time, it has been applied more broadly to drive whole organisational value in cases. Practitioners now have both the Technology Acceptance Model (the factors which affect an individual's decisions to accept technology), and the Diffusion of Innovations (the proliferation of technology across a given group of individuals) to apply in any context they required and so from this point in the mid 1980s research developed and expanded considerably.

The available research on the topic presents a number of models or frameworks with associated determinants that have been used for a considerable period of time to help industry accept technology. Many of these models such as TAM have been tried and tested since inception and developed further to inform more recent models such as TOE (Baker, 2018). Latterly research has also considered the quantum of measurement as not only the individual, but also the collective acceptance which leads to organisational adoption. Both terms are included within the definitions and for purposes of this research, individuals will be asked for their perspectives, but wholly anticipated that with

personal perspectives, both individual and organisation level considerations may be voiced and so frameworks considering adoption of technology will be included as will technology acceptance.

Technology acceptance models have more latterly been used as concepts to understand how to support those who influence the acceptance process. 'Management innovation' is now regarded as an important area for technology acceptance to succeed due to the influence it poses (Moussa, McMurray and Muenjohn, 2018; Zidonis and Nazyrov, 2020). Technology acceptance enables innovation to be successful (Kusumasari et al., 2019), and lead to an improvement either for the individual consumer, company or government (Read et al., 2016b).

The Author of the research is an employee of Network Rail who has sponsored the research and therefore is intrinsically linked with the success of the study and its ability to be disseminated back into the business. Having worked in the business for 15 years including holding a number of senior executive level roles, through witnessing major projects fail in their ability to return a direct benefit. Where technology has been implemented but has failed to achieve the level of benefit it set out to deliver, there is an opportunity to learn and develop understanding of technology acceptance within the business which became the reason to undertake this research study. The research is written from the perspective of a practitioner employed within the organisation studied, although care has been taken to reduce or eliminate bias by focussing on teams not with in the researchers span of control. The application of the research within the Public Sector, Rail industry in the UK is the novel element of knowledge creation so comparing against existing works is not possible.

Network Rail who is the funder of this study, sits as an arm's length public body overseen by the Department for Transport who regulate the industry via the Office of the Road and Rail Regulator. Undertaking its role as the infrastructure manager, as a single organisation it receives the majority of the funding raised through ticket revenues followed by 'track access charges' and finally a governmental grant (Network Rail, 2024). Network Rail not only maintains the national infrastructure it also creates and maintains the national train timetable, the backbone of access for trains to operate and therefore can often be seen in the national media when performance, safety or the spending of public finances is bought into question. The following figure (1) simplifies the UK rail sector structure showing Network Rails position as central to the industry.

Network Rail has been openly criticised in the national media and exhaustively challenged by governmental bodies as to whether it is seeing value from investing in technological change. The challenge is often this is not due to the technology and benefits it is likely to bring but the way in which it is accepted which should always try to maximise the benefit of implementing such technology. Due to Network Rail's funding position, it is the taxpayer who is the ultimate investor and stakeholder, spending money investing via the Department for Transport, a government department. When government finances are tight, and 2% of all trips in the UK utilise the railway (Transport, 2024), the reputational impact of projects which fail to see their proposed benefit is damaging for both the organisation and the government. Although the benefits enabled by the Rail Sector in the UK touch every household, prioritisation of future investment must be determined based on evidence of successful outcomes.

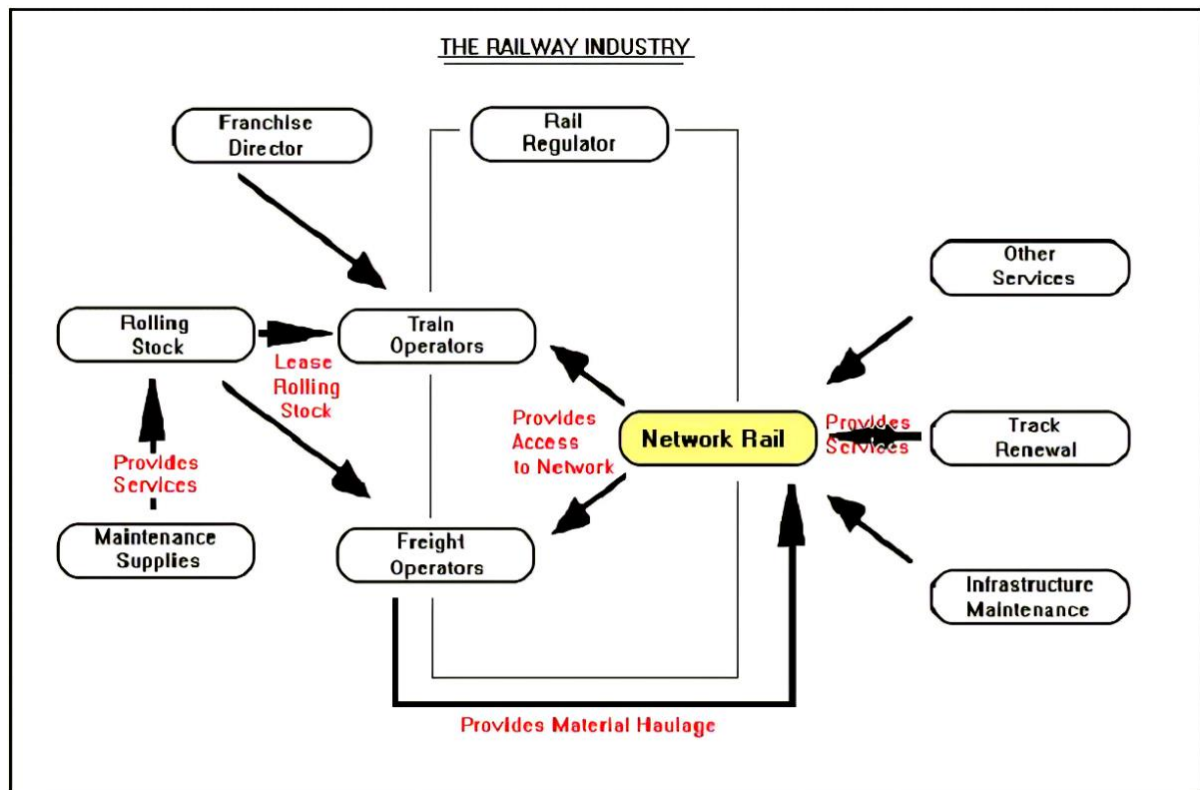


Figure 1 - Simplified view of the UK Rail Industry Structure. Source; (TrainWeb, 2024)

1.2 Research Aims and Objectives

Within the UK Public Sector, the railway is a publicly owned asset whose operating of trains is contracted through to different organisations. Network Rail features as the

infrastructure owner and charges out access to the train operators. In doing so it overhauls the timetable, infrastructure assets and the majority of technology introduction due to the investment in renewals and enhancement programmes. Widely publicised in 2021, the need for industry reform to better support passengers and freight was articulated in the paper presented by Shapps and Williams (2021) including the need to improve the acceptance of technology. Responding to this need, the aims of the research are as follows;

To offer credible and usable information and guidance which can be applied to policy and practise that will enable Network Rail to be successful in technology acceptance. Influencing company policy and real-world practises relating to technology acceptance will increase the chance of successful technology acceptance meaning improved efficiency as well as further cost avoidance. Making sure that changes in the way the business works effect both its leadership and those who inform positive outcomes at a project level will enable the business to redefine how it engages with the technology acceptance process to maximise efficiency.

An aim of the research is to also look at the practical value of the available frameworks and models which are available and how they can be applied in practise for both technology acceptance and success. When considering the model and frameworks, some may not be applicable within the railway environment. This could be due to numerous reasons such as they were developed specifically for mining which is not an activity or environment undertaken by the railway, however determinants within the model or framework may still be applicable. The availability of technology could be a determinant related to mining which also relates to the railway even if the overarching framework does not offer synergies. This is why both the determinants, and the model or framework are important when considering the application. Therefore, recommendations of the research will consider the suitability of the models identified. The research objectives which follow inspire the research questions which guide the whole thesis and study.

Research Objective 1: To understand the frameworks and therefore the determinants of technology acceptance within the UK Public Rail Sector, informing policy and practise and allowing the organisation to improve in its approach.

Which leads to the question –

Research Question 1: What are the frameworks/theories and determinants of technology acceptance applicable to the UK Public Sector Rail Industry?

Research Objective 2: When understanding what the frameworks and associated determinants of technology acceptance are, it is important to understand what success means because this should inform what needs the priority of focus to drive positive impact as an outcome of the study.

Which leads to the question -

Research Question 2: What are the factors of successful technology acceptance within the UK Public Sector Rail Industry, including the applicable theories?

1.3 Thesis Structure

This thesis is presented in a structure which is suitable for the social sciences field of study as part of a Doctorate in Business Administration. The Thesis covers sections which deliver a structured approach to development of the business phenomenon into several research outcomes, understanding what research exists and using this to structure a set of questions which can be put to the business to extract novel information. Once the information is gathered it can be compared back to the research literature to understand if there is knowledge which can be created, refuted or further developed. The conclusion of the thesis covers the impact of the research relating to the knowledge generated as well as the benefit to policy and practise within the sponsor organisation. The following is the structure of the thesis;

- *Chapter 1 – Introduction*
 - *The introduction presents the phenomenon which is to be investigated by the research which is the research context and also the aims and objectives.*
- *Chapter 2 – Literature review, including the data process of seminal articles*
 - *A documented process for the extraction of data from the social sciences databases, organisation, and presentation with the presentation of models and frameworks which were used to structure the empirical study data collection.*
- *Chapter 3 – Methodology*

- *The confirmation of the study epistemology and ontology as well as the documented process for data collection. This chapter also presents how the data will be coded and interpreted.*
- *Chapter 4 – Thematic Findings*
 - *Chapter 4 breaks down each research objective and outlines the information presented from themes identified through the data collection and coding process. This chapter portrays to the reader the areas which will lead to the building and developing of knowledge and key outcomes which will be presented back to the business to aid the development of policy and practical applications.*
- *Chapter 5 – Discussion*
 - *The discussion builds on the thematic findings by comparing them to the information from the systematic literature review. This chapter begins to develop the findings which will be turned in to recommendations in the next chapter.*
- *Chapter 6 – Impact Analysis and Recommendations*
 - *Focussing on the building of knowledge, the impact on policy and practise if the recommendations are applied and outlining key milestones which should be engaged with to maximise the opportunity of learning from the study. The penultimate chapter articles what needs to be done to make sure the rigour of the study can be used to benefit both academic learning and also the sponsoring organisation.*
- *Chapter 7 – Conclusions*
 - *The final chapter of the study concludes the work undertaken over 4.5 years. Offering closing information and summarising the outcomes of the work. The final chapter concludes the golden thread and sets out the potential for further work and study to build on the knowledge created.*
- *References*
- *Appendices*

To create knowledge which will build on the existing available research regarding Technology Acceptance within the public sector. The thesis includes a systematic literature review which has understood what material exists and has used this to structure an empirical study to collate data surrounding the phenomenon from the industry. The gathered information from both the systematic literature review and the empirical study

was critically reviewed and compared to enable the presentation of a summarised version of the models and frameworks relating to technology acceptance and how they are applied in industry. As information pertaining to the railway industry as a context is new to the literature, new data was used to build a case that knowledge can be shared from other industry applications but also that within the railway the data recovered was used to create new knowledge. As the thesis will be a peer reviewed academic study, using data from both research and the business this has satisfied the credibility of the information due to the reliability and robustness of the data sources.

2 Chapter 2: Literature Review

2.1 Literature Review

A systematic literature review (“SLR”) is a methodologically robust approach to searching, screening and reporting existing research material on a particular topic. The SLR aims to critically evaluate the information which importantly can be repeated to demonstrate a robust process. An SLR is appropriate method for this study because it provides a comprehensive understanding of the existing research across social sciences and due to the structured process of interpreting data is useful at identifying gaps in the existing research (Lame, 2019).

To undertake a SLR, it is first important to understand the process which is undertaken to extract a suitable data set. A common method to plan and undertake a systematic review of the literature has been completed (Denyer and Tranfield, 2009; Tranfield, Denyer and Smart, 2003). This same structured methodology extracted academic literature which was determined as high quality to be screened then reviewed to identify descriptive and thematic findings. The SLR methodology was used in the context of this study due to the common approach with many of the academic literature that was reviewed for the positioning study. The methodology of a systemic literature review provides a “reliable knowledge stock and enhanced practice by developing context-sensitive research” within the field of management (Tranfield, Denyer and Smart, 2003, p.207).

Once the articles are extracted, the descriptive and thematic findings will be explored. The method used, is one which is found in the seminal articles by Tranfield (2003) and Denyer (2009). This has been itself cited 249 times and lays out a clear and structured method to ask the research question of the data. It provides a method which is tried and tested that is similar to methods such as PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Moher et al., 2009). These seminal articles outline 5 core elements to complete a Systematic Literature as seen below;

- *Planning;*
- *Searching*
- *Screening;*
- *Extraction and synthesis (data extractions)*
- *Reporting (findings)*

The research questions from Section 1.5 inspired the development of a set of keywords which then were formed in to search strings using Boolean coding which is understood by the research databases, the coding can be found in Appendix A. The search terms from appendix A have been turned in to the search strings which can be seen below.

(Determinant OR Driver* OR Barrier* OR Challeng*) AND (Technolog* OR Innovati* OR Asset) N/3 (Within 3 words of) (acceptanc* OR adoption* OR Implement*) NOT (Medic* OR Biolog* OR Biometric* OR Nurs* OR School OR Educat* OR Health OR Telemedi* OR Cloud*)*

And

(Determinant OR Driver* OR Barrier* OR Challeng*) AND (Technolog* OR Innovati* OR Asset) N3 (acceptanc* OR adoption* OR Implement*) AND (Success* OR benefit OR improve* OR achieve* OR measure*) NOT (Medic* OR Biolog* OR Biometric* OR Nurs* OR School OR Educat* OR Health OR Telemedi* OR Cloud*)*

The search strings can be applied to the databases typically used for social science studies to enable a robust and repeated method of data extraction. The strings were searched on the same day in each of the databases firstly to understand which database was the most suitable for data extraction.

The search strings seen in appendix A were considered for the SLR across 4 databases. These are known as Scopus, EBSCO, Web of Science and ABI. These databases are commonly used within the field of Social Science and therefore contain academic information related to the area of knowledge.

Scopus and Web of Science contain academic data which is more discipline based whereas ABI and EBSCO contain information associated with the business and management discipline. This means that there was a high risk of duplication across the databases and very likely that there will be more research articles in the business management databases due to context of technology acceptance being considered a business phenomenon.

When initially testing the databases, EBSCO and ABI returned the high proliferation of articles with Scopus and Web of Science offering duplicated entries. It was decided to focus on the academic literature being presented by EBSCO and ABI in relation to the review questions as summarised in Table 1.

	Advantages	Limitations	Include
ABI/ Inform	Worldwide focussed on industry sectors including manufacturing and technology. Includes business trends, economic changes and also media articles where positive news often published in the industry trade press	Data accessibility and ongoing use can be challenging. Can be difficult to identify those articles which can be used as peer reviewed versus those which are opinion or paid for articles.	Yes
Scopus	Specifically includes technology, medicine and social sciences.	Articles relating to medicine, chemistry and health related technology which is aimed more at Doctor Patient applications	No
EBSCO	As well as technology also includes environmental, management and engineering which is the broadest range of all of the databases reviewed and when testing the searches came back with the most results.	A lot of results in this field are generated from this database with many referencing the topic rather than being directly adding to the literature in the required context.	Yes
Web of science	Focussing predominantly on arts and humanity including pure science areas within social sciences.	Life sciences prevalence means less likely to focus on technology acceptance resulting in a low number of articles.	No

Table 1 - Database Advantages and Disadvantages of use

In searching EBSCO and ABI, initially a return of 33,126 articles were found. This was an open timescale with any information possible to be included. By restricting the timescale, from the inception of the Technology Acceptance Model by Davis (1985) to November 2023, only choosing articles written in the English Language and restricting to published documents this was reduced. There were two reasons for this, the span of choices for some of the terms was too wide, and returning articles which were not aligned to technology, but used the term within the abstract. Acceptance and its synonyms have been chosen to be within 3 words of technology and its synonyms because within 4 returned over 10000 articles and within 2 returned less than 1000, restricting this has helped to address the breadth of the information to focus in on the articles produced by the review question, this is a pragmatic approach meaning that the digestion of information would be manageable within the time permitted. Further refinement of the

search strings and criteria were undertaken to make sure that peer reviewed articles are those which are used to produce credible data which has been tested by the academic community. The volume of data is a suitable number to review in line with the method outlined by Denyer (2009), Tranfield (2009) and Moher (2003).

Inclusion criteria	
Language	English only
Date	1 st April 1983 to 1 st January 2024
Scrutiny	Scholarly reviewed articles only
Availability	Full document can be found, in its entirety.
Journal	Any journal will be considered, quality will be determined by the ability of the article to address the research question.
Associations	Acceptance must be within 3 words of Technology or their synonyms

Table 2 - Inclusion Criteria

Exclusion criteria	
Language	Non-English Language
Date	Prior to 1 st April 1983
Scrutiny	Marketing and communications documents, articles which have not been peer reviewed.
Structure	Structure is not of a style which considered the background research, methodology, findings and conclusion.

Table 3 - Exclusion Criteria

The inclusion and exclusion criteria was used to develop the search protocols which can be seen in table 2 and 3.

The final search strings used across the two databases are seen in appendix A.

This final search strings returned;

- *RQ1-- 6503 articles and once duplicates were removed a healthy number of 6214 (5006 EBSCO, 1208 ABI) articles are returned for further review.*
- *RQ2-- 3312 articles and once duplicates were removed a healthy number of 2626 (1008 EBSCO, 1538 ABI) articles are returned for further review.*

- *As ProQuest returned less than 500 articles for each search with the majority duplicates of ABI, this database is no longer being included within the search.*

Each of the articles were reviewed for its own quality and eligibility through an assessment process. The quality criteria can be seen below in Table 4 and was applied to each article to determine it followed a robust process which could be relied upon for robust data. what kind of purposes were considered relevant in the order for the paper to be included based on its background?

Quality criteria	
Background/Rationale	Is the purpose of the article presented aligned to the acceptance or adoption of technology within or on behalf of an organisation. An organisation maybe a commercial entity, or public company department as an entity.
Sampling Strategy	Has the study sample been selected in a purposeful way shaped by theory, for example a qualitative study with a small number of respondents due to the readiness of availability of respondents rather than a correlation of data may not be suitable
Paper Contents	Abstract, Literature review, Methodology, Findings, Conclusion
Interest	Related to the search criteria specifically, technology acceptance, adoption, or diffusion as per the included definitions and consideration for frameworks, models or determinants
Context	The application, adoption or diffusion of technology must be within industry and requiring individuals to be involved in the process to enable success. For example, replacing automation without changing the Human Machine Interface would not be included as this is likely to be a decision based purely on financial expenditure and return.
Data Quality	Data is produced from robust and reliable sources such as existing organisations or directly from individuals.

Table 4 - Quality criteria

The method of development of the quality criteria was produced following research undertaken by Tranfield Denyer and Smart (2003). Each document was screened by its title and abstract firstly in line with the quality criteria in table 4 which reduced the number of articles considerably. After this, the full document was screened in line with table 4 to make sure that the relevant areas were included to enable a full and detailed review as part of the literature review.

The initial restriction of the search strings relating to the time frame, being published in English language and peer reviewed reduces the initial search volume to 1048 articles. Removal of any duplicate articles further reduced the number of articles however the main reduction was when considering the title and abstract. The title sift was immediately undertaken with the abstract to confirm if the title was reflective of the article before keeping within the study, and also applying the existing inclusion criteria. This activity identified 177 articles which were taken through to the quality review and the criteria for exclusion was applied taking the total to 71. Within some of the papers reviewed, secondary papers were cited which offered useful perspectives in relation to the research questions, these papers were also added into the index by a process known commonly as "Snow balling". These additional papers took the final count of articles included for consideration to 81. All articles extracted have been catalogued to enable review and assessment. A summary of the process can be found in Figure 2.

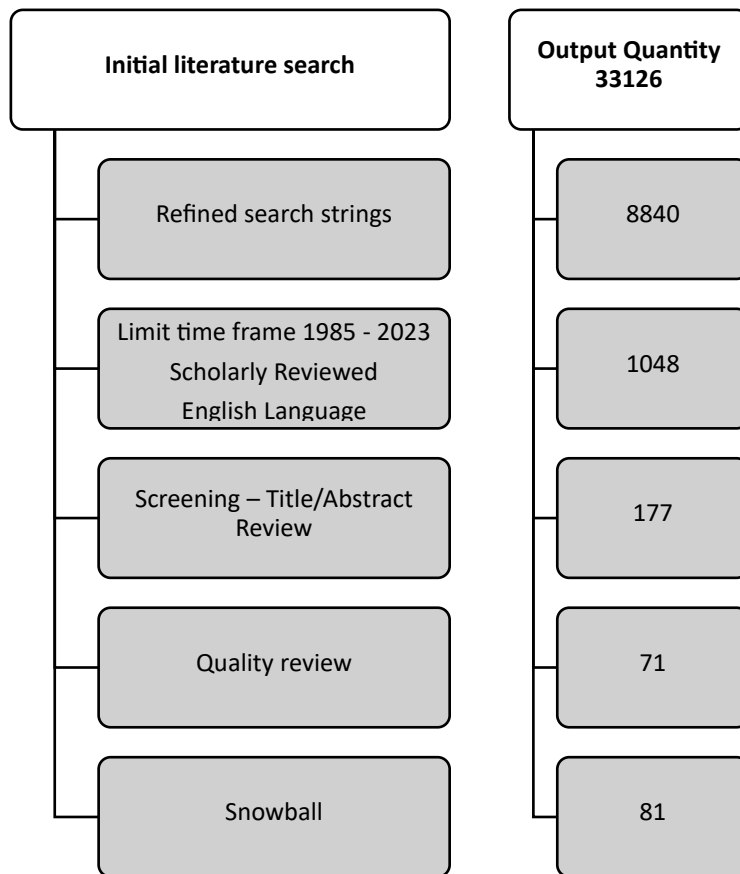


Figure 2 - Screening results of SLR data extraction results

2.2 Reporting

The example data extraction form seen in Appendix B was repeated for each research paper identified. This created a table which would allow the referenced papers to be reviewed for themes and outcomes. The reporting of descriptive and thematic findings are presented in this section of the study and focuses on both mechanistic outcomes as well as specific considerations for each of the research questions.

2.2.1 Article Chronology

Figure 3 shows the number of articles which have been returned from the two databases that have met the inclusion criteria from the search. It shows an increase in the number of articles since Davis (1985). This shows that this field of technology adoption is being more researched. A considerable number of early articles are testing (Parente and Prescott, 1994), and building on TAM (Attewell, 1992) rather than developing new or changing methods.

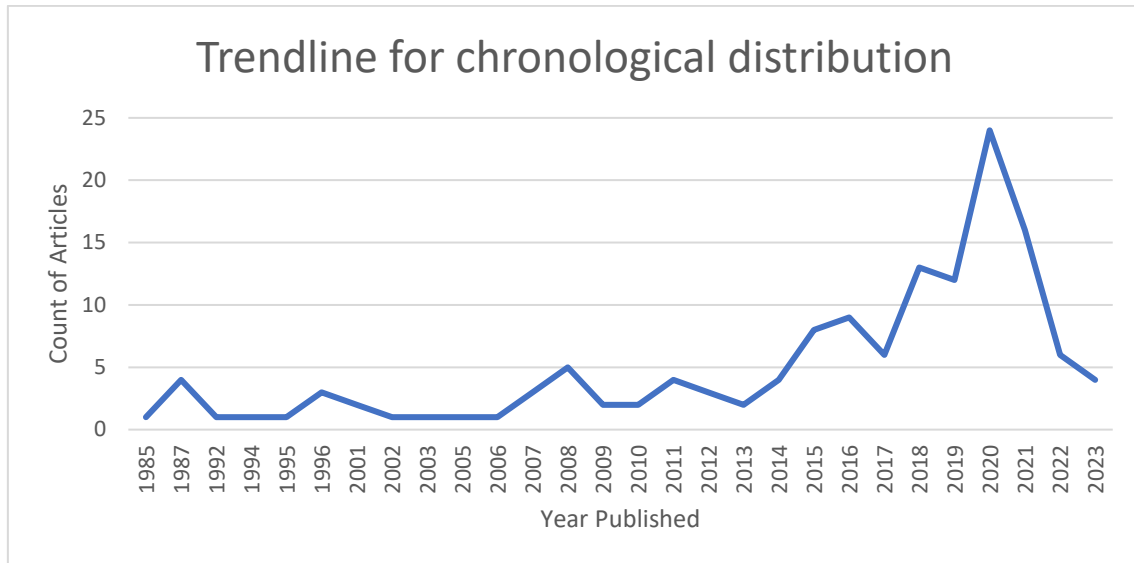


Figure 3 - Trendline of chronological distribution for articles which meet the inclusion criteria

What is noticeable from the literature, there appears to a repeated cycle where over a 5-year period either a further development of TAM or a new framework building on the previous learning is published. This cycle presents how knowledge in this field is being established, developed, and then applied before it is refined and diversified. This has been previously partly been identified by other authors (Lai, 2017; Lee, Kozar and Larsen, 2003; Parente and Prescott, 1994) but not fully described. The following chronology are proposed from the articles identified;

Establishment— 1985 to 1996 establishing the theory and frameworks (Conrad and Duchatelet, 1987; Davis, 1985; Norton, J. Bass, 1987; Parente, S. L. Prescott, 1994)

Extension and Development— 1996 to 2005 developing the existing and new spin frameworks for alternative perspectives (Lai, 2017; Lee, Kriscenski and Lim, 2019; Szajna, 1996b) as well as seeing new industrial applications (Bartoloni and Baussola, 2001)

Application— Articles between 2005 and 2010 many focus on the individual uptake and growth, this community based (Luken and Van Rompaey, 2008; Luque-Martínez et al., 2007; Wiegman, Hekkert and Langstraat, 2007) or individualistic approach to technology acceptance (Bruner and Kumar, 2005; El-Gayar and Moran, 2006) follows on from TRA but for example in just 2009 there are over 25 of the 81 articles in the search alone relating to individual adoption.

Diversification— 2010 to 2015 offers examples of a specific adoption of a product or activity. This is where there is research which can be used to outline the anticipated determinants with the research either supporting or refuting the prevalence. (Devi et al., 2013; Isa, 2014; Jennings, Arlikatti and Andrew, 2015; Salimon, Yusoff and Mohd Mokhtar, 2016; Tang et al., 2014). This also now focusses heavily on “individual choice” as a key driving factor and the impact this has on the larger technology adoption within an organisation or communities. (Ehrenhard, Kijl and Nieuwenhuis, 2014; Kim, Shin and Park, 2015)

Expansion— 2015 to present day appears to focus on technology application (i.e. applying known technology in new fields such as nano tech (Chang et al., 2017), geographic perspectives (Richey and Davis-Sramek, 2021; Rudnick et al., 2019) and establishment and growth of enabling technologies (Bonnin Roca and O’Sullivan, 2020; Dehghani, 2018).

2.2.2 Journal Publications

Within the articles which have been identified as part of the systematic literature review, the Journal of Cleaner production is the most prolific for publishing documents relating to technology acceptance. Figure 3 outlines the journals which published the extracted research articles included within the SLR.

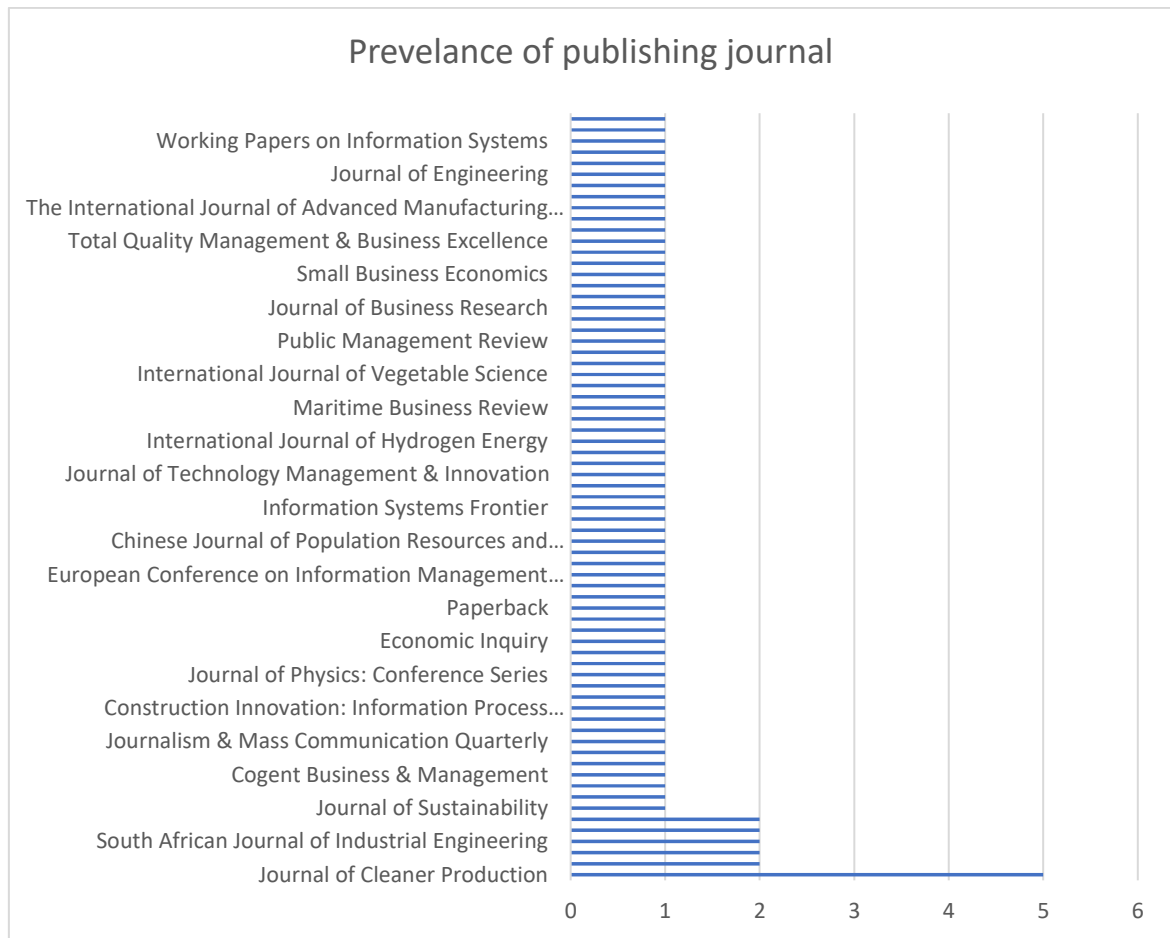


Figure 4 - Most recent prevalent publications

The Journals vary in rating and impact and those found include both high and low rated journals, coupled with a consistent overall increase year on year. There is an increasing number of authors publishing findings relating to technology acceptance, and therefore are interested in the phenomenon. Table 5 shows for the specific subset included within the SLR the Impact and Ranking of the Journal.

	Publications	Impact Score	ABS Ranking
Journal of Cleaner Production	6	7.246	2
Management Science	3	3.935	4*
Construction Innovation	2	2.67	NA
Journal of Hospitality Marketing and Management	2	6.97	1

Problems and Perspectives in Management	2	1.27	1
Resources Policy	2	5.44	1
Social Responsibility Journal	2	2.21	1
Technology in Society	2	4.75	NA
Technovation	2	6.66	3

Table 5 - Most common publications, impact and rating (CABs, 2023)

2.2.3 Published authors

Although there are 81 core articles in the review, the following authors in table 6 feature in more than 1 article. It is worth noting, there are not many for each common author which may suggest that the field of research has a broad level of interest.

Author	Qty	Refences
Bossle	3	(Bossle et al., 2020a, 2016, 2020b)
Darko	3	(Chan et al., 2017; Darko et al., 2018; Darko and Chan, 2017)
Groher	2	(Groher et al., 2020; Groher, Heitkämper and Umstätter, 2020)
Narkhede	2	(Narkhede et al., 2020a; Raut et al., 2019)
Szajna	2	(Szajna, 1996b, 1996a)

Table 6 - Common authors from extracted literature

36% of the SLR extracted literature refer back to Davis (1985) and Rogers (1983) suggesting that the seminal works still are robust in their application as can be seen in Figure 5. More latterly, TOE and UTAUT and to a lesser extent Iacovou et al (1995) model have also been referenced.

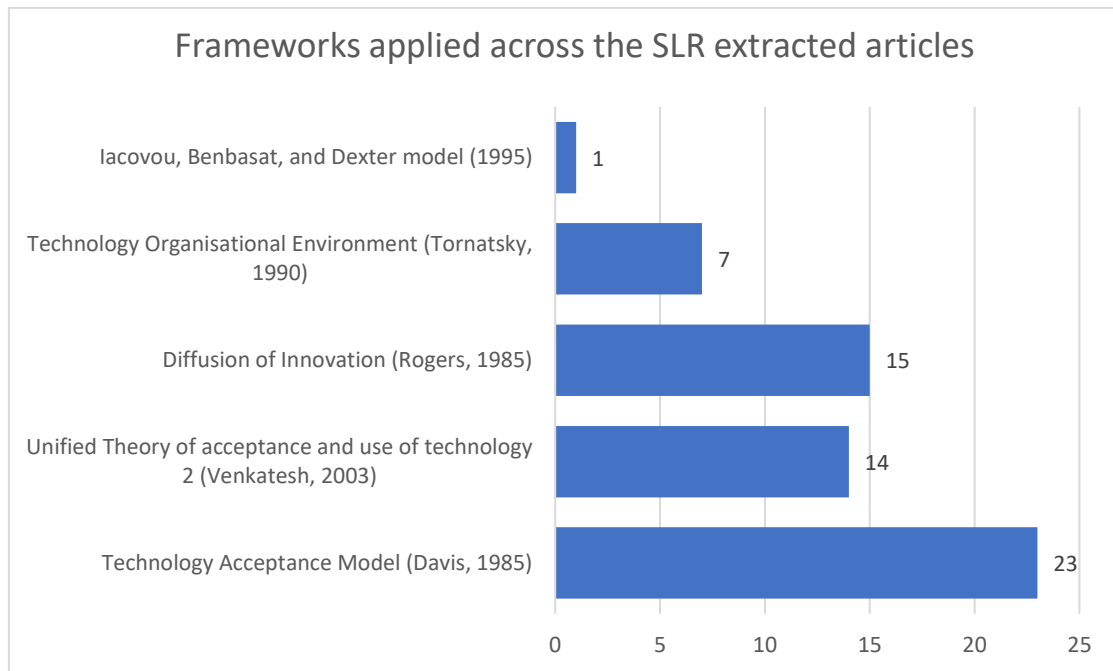


Figure 5 - Number of citations across the data extraction for the use of models

For some of the literature presented in the SLR, the seminal papers are not referenced, in these examples new ideas are being presented mainly due to a new type of technology or industry context (Greenland et al., 2019; Nasirov and Agostini, 2018) that are going back to first principles. These cases suggest that technology acceptance is an area of development, and this field is changing, and the seminal theories are still being tested. As new technologies are invented, within new contexts, knowledge and understanding will continue to evolve and remain fresh (Kusumasari et al., 2019; Moussa, McMurray and Muenjohn, 2018). That being suggested, the additional understanding of technology acceptance within the rail sector would be a welcome addition to the research already available in this area.

2.2.4 Geographical Context

The inclusion criteria which was applied when extracting articles as part of the literature review ensured that the authors used English. With the span and use of the railway particularly across the globe the geography could be internationally. The majority of the articles, 54, presented the territory. This can be seen below in the following table and figure;

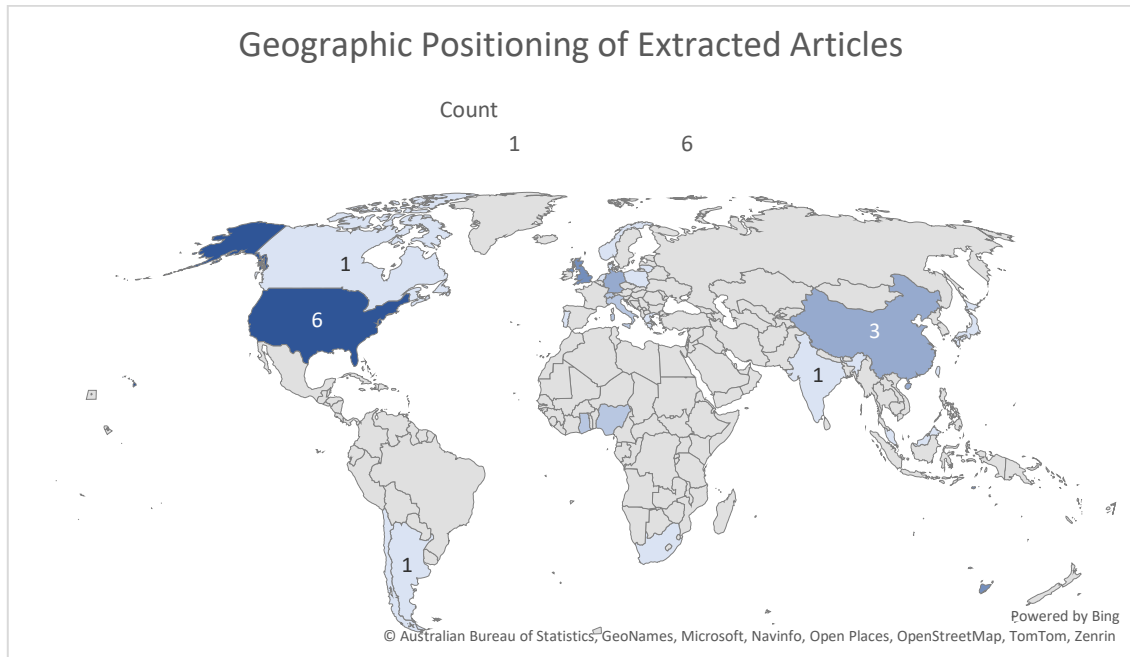


Figure 6 - Geographical distribution of extracted literature

Table 7 shows the predominant country for published articles is the USA. There is a higher prevalence of research available from areas which are more developed.

Country	Count	Territory	Count
Argentina	1	Europe	20
Australia	4	Asia	11
Canada	1	North America	7
Chile	1	Africa	5
China	3	Australia	4
Croatia	0	International	4
Denmark	1	South America	2
Europe	2	Middle East	1
Germany	3		
Ghana	2		
Greece	1		
India	1		
Indonesia	1		
International	4		
Italy	2		
Japan	1		
Korea	3		
Lithuania	1		
Malaysia	1		
Netherlands	1		
Nigeria	2		
Norway	1		
Poland	1		
Portugal	1		

Saudi Arabi	1
South Africa	1
Switzerland	2
Taiwan	1
UK	4
USA	6

Table 7 - Extracted literature - Geographical Locations

When the data is broken down which industries are common across the geographic location which can be seen in Table 8 it shows that there is a proliferation as part of the data set relating to worldwide construction, energy, IT and then public sector activities, agriculture and manufacturing. As IT is what technology acceptance is based on this is not surprising but also probably less surprising is that construction and energy which feature on all continents are a focus, especially with many multinational agencies working across territory. Public transport does not feature as a common industry but public sector is featured offering some alignment and consistency relating to the phenomenon. This supports the view that technology acceptance in the rail sector is novel in its approach.

Construction	Energy	IT	Public Sector	Agriculture	Manufacturing
Australia	Denmark	Italy	<i>Germany</i>	Argentina	Germany
Europe	Greece	Poland	<i>Indonesia</i>	Ghana	India
Ghana	Malaysia	Taiwan	<i>Lithuania</i>	Switzerland	USA
Netherlands	Nigeria	UK	<i>UK</i>	Worldwide	
Saudi Arabi	USA	USA			
USA					
Worldwide					

Table 8 - Common Industries present by literature by geographic region

2.2.5 Theoretical perspectives

Across the extracted literature, the frameworks and models are the theoretical foundation of the literature however in a small number of cases, organisational theories are also applied. The perspectives drawn from applying institutional theory are the most prevalent (Betts, Super and North, 2018; Stanger et al., 2013), however this is not consistent and stakeholder, legitimacy and organisational theory are also considered but to a lesser extent.

- *Legitimacy theory (Ozdora-Aksak and Atakan-Duman, 2016)*
- *Stakeholder theory (Mascarenhas, Nunes and Ramos, 2015)*
- *Institution theory (Stanger et al., 2013)*

- *Organisational theory (Rasmussen and Hall, 2016)*

It could be the case that a theoretical perspective is less influential on outcome of the research because frameworks and models have been developed without a perspective in mind or that each framework has evolved from a named theory to become a standalone concept. For the purposes of the empirical study, the focus will be on the determinants as per the research question rather than any theoretical position. The articles which do apply well developed theoretical perspectives, are not using it to determine process but more establishing the scene and definitions which can then be used to confirm research outcomes. (Bello et al., 2018; Hsu et al., 2019; Rose, Manley and Widen, 2019).

The focus for all the articles reviewed is the “model(s)” which are being applied to the technology acceptance process are more important as a consideration than the theoretical lens it was viewed through. As the study being undertaken for Network Rail is focussing on the phenomenon which will see the relevant models and frameworks being applied, the theoretical lens is of a lesser importance because the theoretical lens and model are already linked respectively. Therefore, a specific lens is not being applied to the research rather than the focus of the study being in regard to the models, determinants and successful outcomes.

There is an emerging theoretical perspective coming from the articles post 2018 focussing on management innovation, in particular the effect of leadership on technology acceptance (Hickman and Akdere, 2018; Oorschot, Halman and Hofman, 2020). For the examples presented from the literature in this sample, the articles relate to the public sector and considered with an institutional theory lens (Narkhede et al., 2020b), the articles propose the structure and openness of the organisation has an effect on its ability to accept technology.

2.3 Thematic Analysis

As the descriptive findings have been presented, the thematic findings will delve much deeper in to each of the frameworks, models and then in to the specific determinants from the literature pool. Considerations when looking at the determinants such as the industrial context where they are applied will also be reported on in this section as that will help to understand the suitability of the application within the UK Rail Sector.

2.4 Research Objective 1 – Determinants

From the literature pool, 3 theories and 4 frameworks have been identified from across 81 articles which passed the quality assessment and met the inclusive criteria. These have been widely used in the research since their inception which are detailed below.

Those articles which have been used in this literature review mainly follow one of two methodologies.

- *Qualitative research only (68%) which is based on a literature review to develop theory which is then applied to a set of person-to-person interviews is by far the largest proportion at over two thirds of the papers presented with very similar paper structures. This method questions between 10 and 40 agents as to what the determinants of technology adoption are. These agents represent many industries and geographies. This suggests that for this context this method is the most well-known within this literature area.*

Examples; (Bossle et al., 2020a; Naber et al., 2017; Okundaye, Fan and Dwyer, 2019).

- *Quantitative research which makes up 30% of the articles identified generally applies the same method of a literature review then using a questionnaire sent to a large sample set to gain individual responses. Respondents are often in the 1000s to create large data sets*

Examples; (Arens, Worrell and Eichhammer, 2017; Chung, 2021; Hubert et al., 2018) (1708, 7231 and 6160 Individual respondents respectively)

When it comes to the extracted data, models, frameworks, and determinants were identified throughout the 81 articles. What follows is description of the models, frameworks and then determinants identified as part of achieving research question 1.

“What are the determinants of technology acceptance within the UK Public Sector Rail Industry?”

The models and frameworks identified are organised in chronological order. In some cases, the framework leads on to the next, for example TRA to TAM which is discussed in 2.4.4 but others are standalone models positioned in time;

- *Theory of Reasoned Action (Ajzen and Fishbein, 1975)*
- *Diffusion of Innovation (Rogers, 1983)*
- *Theory of Planned Behaviour*
- *Technology Acceptance Model (Davis, 1985)*

- *Technology Organisation and Environment Framework* (Tornatzky, Fleischer and Chakrabarti, 1990)
- *Lean Management* (Voss, 1992)
- *Iacovou Model* (Iacovou, C. L., Benbasat, I., & Dexter, 1995)
- *Organisation Adoption* (Galuvan, 2001)
- *Unified Theory of Acceptance and Use of Technology* (Venkatesh, 2008)
- *Social Cognitive Theory* (Wood and Bandura, 2014)

The section will now go on to discuss each framework in turn as well as its applicability to the study. The section will also look at the application from the literature pool for each of the frameworks to understand the suitability and alignment to the context of the study.

2.4.1 Theory of reasoned action (“TRA”)

The Theory of Reasoned Action suggests that a person's behaviour is determined by their intention to perform the behaviour and that this intention is, in turn, a function of their attitude toward the behaviour and subjective norms (Ajzen and Fishbein, 1975). The fact that an individual can act within their own volition, of their own will and do this when they deem suitable is fundamentally what this theory considers. The theory provides a method which can help to predict and understand cognitive psychological determinants and is based around the individual and the behaviours which they demonstrate that exist to support the behavioural change. The theory builds on the earlier works around the theory of propositional control based within the field of psychology and continues to be developed. Vallerand (1992) applied the theory to moral behaviours with an intent to show the theory supports this physiological behaviour prediction and Figure 7 offers the layout of the framework.

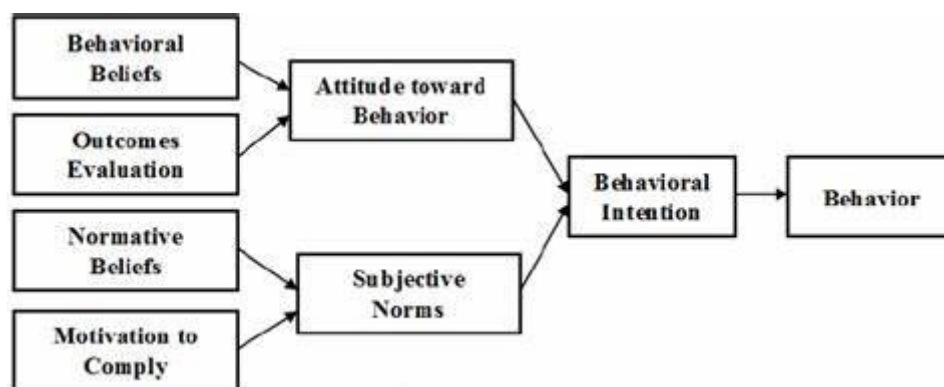


Figure 7 - Theory of Reasoned Action (Ajzen, 1975)

Determinants of TRA extracted from Figure 7 are:

- *Behavioural Beliefs*

- *Outcome Evaluations*
- *Attitude toward behaviour*
- *Normative Beliefs*
- *Motivation to comply*
- *Subjective Norms*

This theory also has its challenges and has been deemed as falsification due to its potential to create and offer risk decisions (Trafimow, 2009).

2.4.2 Diffusion of Innovation (“DOI”)

Diffusion of innovation theory was developed by Everett Rogers and explains how new technologies can be accepted and spread through groups and organisations (1983). The theory presents a methodology that organisations will follow when deciding whether to accept technologies individually or in the workplace. Rogers (1983) presents the idea of innovators, early adopters, majority and laggards depending on the time and individual effort required to accept the change which technology will bring. Figure 8 shows the model including its determinants.

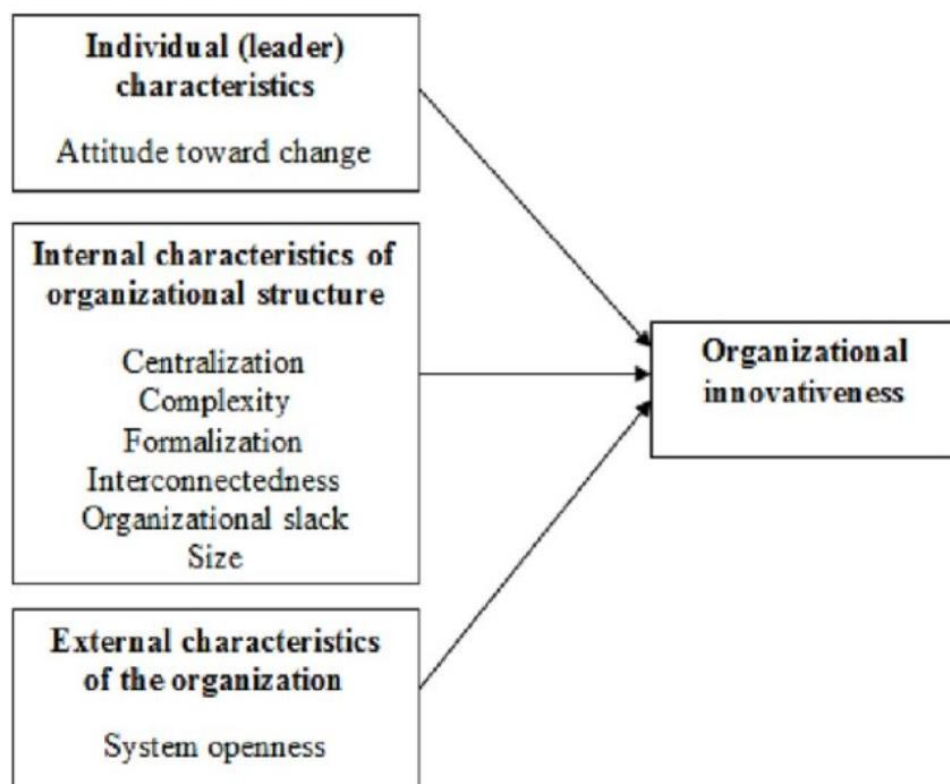


Figure 8 - Diffusion of innovation by Rogers (1995)

Determinants from DOI framework shown in Figure 8 are as follows:

- *Attitudes towards technology*
- *Centralisation*
- *Complexity*
- *Formalization*
- *Interconnectedness*
- *Size & Slack (Capacity)*
- *System openness*

DOI is still relevant and will have use in terms of this study (Baker, 2018; Halaweh, 2019; Nagel and Schumann, 2020). The theory has also been added to beyond its original intent, Rose (2019) added a further determinant due to the influence it carried;

- *Procurement Systems— Added to DOI (Rose, T. 2019)*

2.4.3 Theory of planned behaviour (“TPB”)

TPB is a model which was constructed by developing the Theory of Reasoned Action from the perspective of influences which are beyond the individual's control, such as the availability of resources or personal opportunities (Ajzen, 1985). The theory considers a goal driven intent by an individual who is planning to achieve an outcome. The diagrammatic view of TPB is shown in Figure 9.

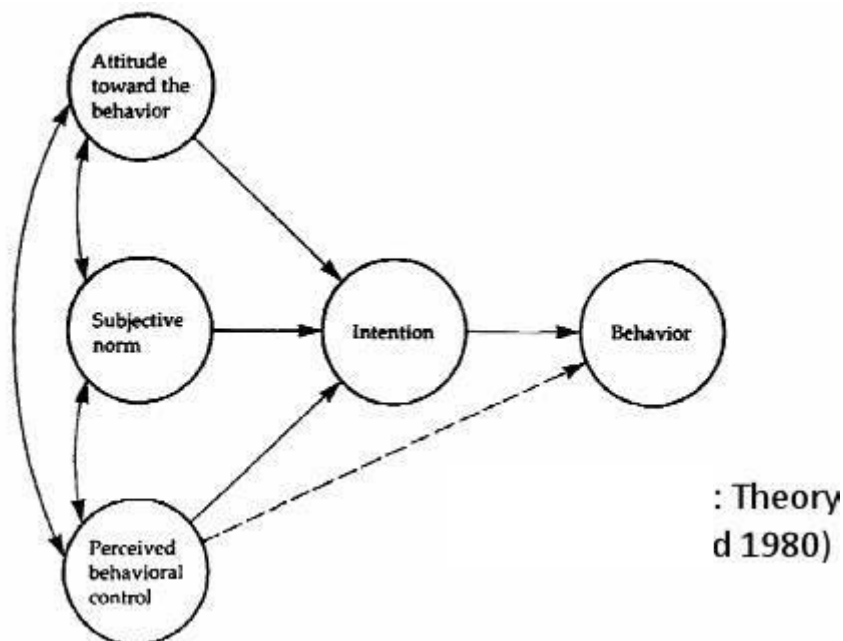


Figure 9 - Theory of Planned Behaviour (Ajzen & Fishbein, 1985)

Determinants of TPB extracted from Figure 9 are:

- *Attitude toward the behaviour*
- *Subjective norms*
- *Perceived behavioural controls*
- *Intention*
- *Behaviour*

2.4.4 Technology Acceptance Model (“TAM”)

The theory of reasoned action “**TRA**” (Vallerand et al., 1992) and the theory of planned behaviour “**TPB**” (Ajzen and Fishbein, 1975) were combined in the development of the technology acceptance model by Davis (1985). TPB and TAM are referred to as being directly comparable in their application when looking at technology acceptance (Leng et al., 2020; Ndubisi, 2006). As TRA and TPB are the foundations in the development of TAM, the technology acceptance model applies both sets of determinants in the technological acceptance context, therefore in this study, only TAM will be referenced to reduce duplication. Therefore, neither TRA or TPB will be considered further in the study due to the potential to duplicate determinants. TAM is widely known in research and was created to look at how Information Technology systems would be accepted in to use (Davis, 1985; Lai, 2017). This includes both hardware and software which requires an individual to accept the technology for it to work.

Lai outlines for us the chronology of technology acceptance model as a linear timeline up to 2003 (2003, p.755) showing the development and challenge to the framework. Although the determinants of TAM are fundamentally unchanged, the context it is being applied in is changing - changing technology, and changing attitudes of the business (Bogea and Zamith Brito, 2018) and needs of the consumer (Panagiotopoulos and Dimitrakopoulos, 2018) are requiring different determinants to that of TAM alone. What is common and has been demonstrated by other authors, is that the prevalence of the determinants changes (Venkatesh, 2008) based on the context, and even in some cases new determinants such as the demographics of those using the technology (Roberts et al., 2021). The additional determinants do not change the fundamental principles of the original theory, but it is not also clear how they feature in the model either.

Although the model is widely referenced through research, it has its own challenges in its application where it is warned that TAM can have perverse success outcomes because of the following;.

1. *Poor data and or responses.*
2. *The nature of the system.*
3. *Not enough voluntary use of the system.*
4. *A field versus laboratory setting.*
5. *A poor or incomplete model.*

(Barnard, 1996; Lucas and Spitler, 1999)

Understanding how TAM should be applied in practise is therefore an important consideration if it is to be recommended for use.

TAM2 which was amended in 2008 to include individual differences, system characteristics, social influences and facilitating conditions (Lai, 2017). TAM 3 was produced as an updated version of the model which added in the idea of the individual needing an Intention to use and some varying inputs as an evolution of the original framework. This added a cultural dimension to the framework which will be added as a comparator to the other frameworks but overall the principles for comparison remain the same. (Szajna, 1996a; Venkatesh and Bala, 2008)

For purposes of the study, TAM2 will be utilised as the principles remain the same as with TAM3 and a direct link to the original TAM, the determinants can be seen in figure 10.

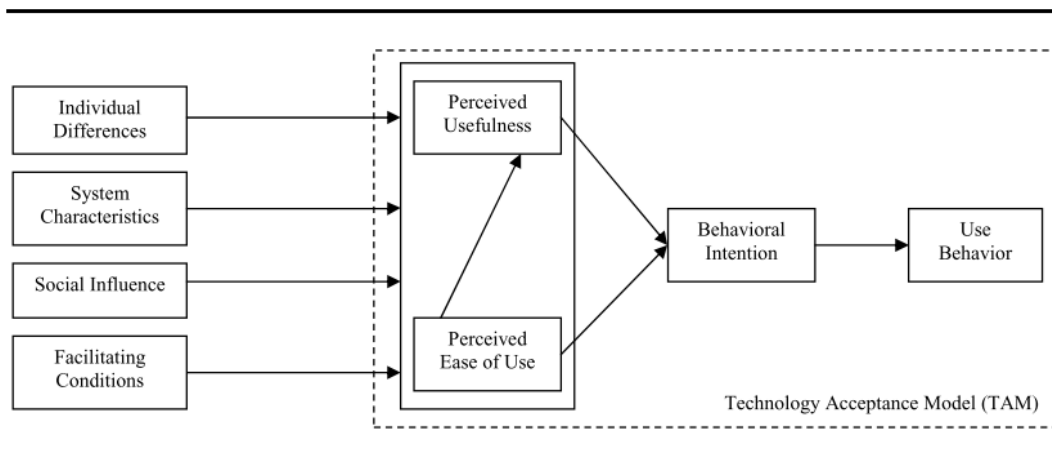


Figure 10 - TAM2 showing the most prevalent determinants (Venkatesh and Bala, 2008)

Determinants of TAM extracted from figure 10 are:

- *System Characteristics*
- *Perceived Usefulness*

- *Perceived Ease of Use*
- *Social Influences (Consumer/Peer Pressure)*
- *Facilitating conditions*
- *Individual Difference*

2.4.5 Technology Organisation and Environment (“TOE”)

TOE was introduced by Tornatzky (1990) and different to TAM and Diffusion of Innovation this framework considers how technology is accepted at an organisational level rather than for the individual. The TOE framework is based around three contexts, technology, organisation and the environment and this structure enables practitioners to analyse the multifaceted nature of technology acceptance within organisations (Tornatzky, Fleischer and Chakrabarti, 1990). There is evidence within the extracted research to show that TOE is able to be applied to technology acceptance along side the diffusion of innovation which can enable a better understanding of technology acceptance for both the organisation and the individual (Baker, 2018).

The contexts of TOE can also be considered through an institutional theory lens (Oliveira, Martins and Lisboa, 2011). In this scenario and context, institutional theory adds a new dimension where technology adoption could be required as a direct response to external pressures such as “market competition”. Olivera (2011, p.116) offers at least 3 examples where technology acceptance has been driven by external pressures on the organisation. The determinants of TOE can be seen in figure 11.

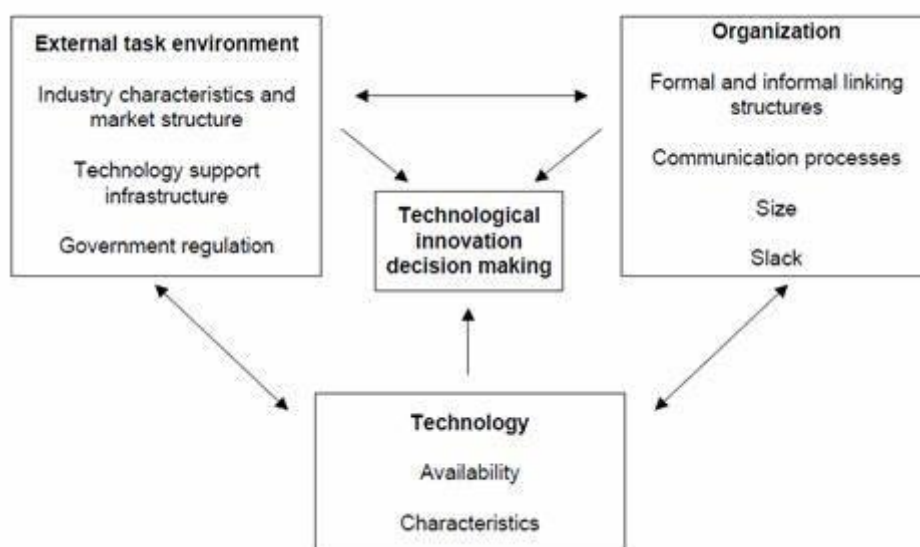


Figure 11 - TOE Framework (Tornatzky, 1990)

Determinants from TOE shown in figure 11 are as follows:

- *External task environment – Industry characteristics and market structure*
- *External task environment – Technology support infrastructure*
- *External task environment – Government regulation*
- *Organisation – Formal and informal linking structures*
- *Organisation – Communication processes*
- *Technology – Availability*
- *Technology – Characteristics*

There are common determinants between TOE and TAM, both frameworks consider success as the individuals perception of the technology being accepted, TAM considers the effect this has on the behavioural intention for the individual to use whereas TOE considers specifically the impact of their environment an organisational level (Fox, 2020).

Lin and Chang (2011) identify success as the “incremental impact of various external factors on beliefs, attitudes and intentions and challenges the position that responsibility can solely be given to the organisational level for technology acceptance to be achieved. This meaning that to be successful, the focus must be on the individuals within the organisation rather than looking at the organisation as a whole in order to create a “behavioural intention to use”(Lin and Chang, 2011, p.427). TOE specifically focusses on the group of individuals within an organisation and their direct impact on technology acceptance due to their collective experiences within the organisational environment. The suggestion is that technology acceptance can be slow, depending on the size, complexity of the team and the environment they are in (Tornatzky, Fleischer and Chakrabarti, 1990). Considering Network Rail is a team of 40,000 people, nationally in different routes, regions, and local teams this could be considered very complex.

2.4.6 Iacovou model

Only presented in 1 extracted article the prevalence of the Iacovou model in social sciences is considerably less than the other models discussed in this chapter. The model focuses on the application of e-commerce and more specifically the decisions required to be made to accept specifically e-commerce technologies (Iacovou, C. L., Benbasat, I., & Dexter, 1995). Although the model has a specific interest relating to adoption across organisations when using technology to benefit electronic commerce transactions, it presents specific determinants which are not replicated with other models presented.

The uniqueness of the antecedents which are seen below, and the fact that the model is relatively newer than its predecessors may potentially help with the identification of themes from the empirical study. Figure 12 presents determinants of the Iacovou Model.

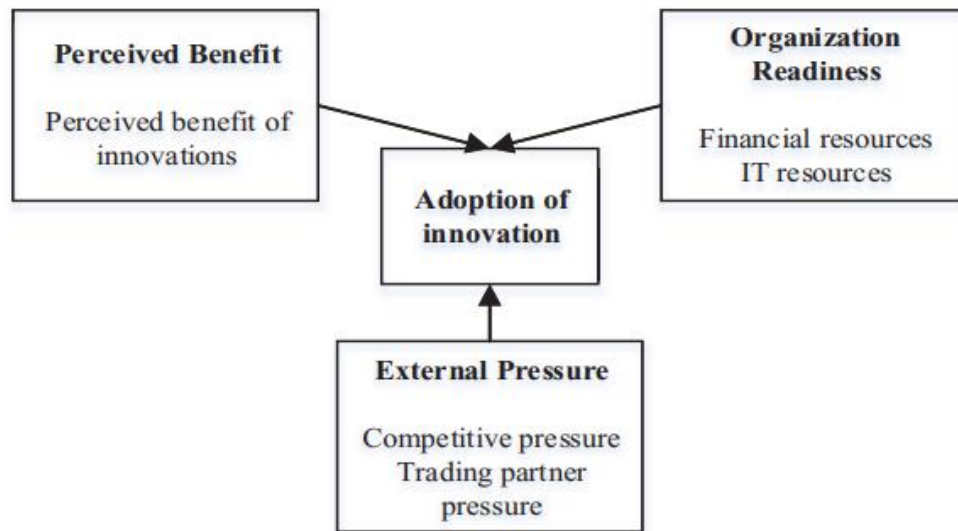


Figure 12 - Iacovou Model (Iacovou, C. L., Benbasat, I., & Dexter, 1995)

Determinants included in the Iacovou et al model from figure 12 are as follows:

- *Financial Resource*
- *IT Resources*
- *Perceived benefits of innovation*
- *Competitive Pressures*
- *Trade partner pressure*

2.4.7 Lean Management

“The Toyota Production System” (Ohno, 1988), is recognised as the beginning of Lean Manufacturing and over time has turned into Lean Management as it encompasses all areas of the manufacturing business. Lean Management is a problem-solving process aimed to improve the output efficiency of a production activity using manufacturing mechanisms by preventing failure and increasing consistency (Ohno, 1988). These mechanisms which are applied and introduced into the factory environment include hardware, software and the associated processes which are comparable to the hardware and software being applied in Technology Acceptance (Emiliani, 2006). Toyota was not the only organisation to take on this method and it was established in others due to the

core values and opportunity to reduce waste and increase productivity offering a competitive benefit.

Although the hardware and software being applied is technology and it must be accepted, Lean Management is a set of practises and techniques which are trained and then applied to allow a company to identify opportunities to improve its productiveness rather than a set of distinct and linked determinants. Due to the lack of determinants, this framework is not being included going forward as it does not align with the proposed research objectives.

2.4.8 Organisation Adoption

Organisational Adoption is based on the Diffusion of Innovation (Rogers, 1983) and Theory of Planned Behaviour (Ajzen and Fishbein, 1975). Organisation Adoption looks at how Technological Innovations are assimilated into an organisation based on earlier work included within the Diffusion of Innovation (Galuvan, 2001). Whereas the diffusion of innovation considers the individual, organisational adoption combines the individual views and articulates them as the collective attitude of the organisation. The work undertaken was intended to generate knowledge at an organisational level. Damanpour (2006) specifically describes Organisational Adoption as the process to accept new products, services, processes, policy's structures or administration systems within the organisation.

As organisational adoption is a construct of determinants presented by other models such as Diffusion of Innovation, and not specifically considered for hardware or software technology, this framework is not being used within the study.

2.4.9 Unified Theory of Acceptance and Use of Technology ("UTAUT")

UTAUT aims to explain and unify user intentions in regard to the acceptance of technology and is built from the seminal research in to the technology acceptance model (Venkatesh et al., 2003).

UTAUT bases the potential acceptance of technology for the individual on some core areas such as expectation of performance, the level of effort required, social influences and the expectation of outcome including reward all based around the individual and their influence on technology acceptance. Examples exist where this is presented as comparable to TAM and TPB and therefore is solely positioned to align to the individual

rather than the organisational level (Baker, 2018; Oliveira, Martins and Lisboa, 2011; Renaud and Biljon, 2008) but what Venkatesh (2008) shows is that the level of social influence is less than anticipated suggesting that the organisational or community level may have a limited effect in some cases. Figure 12 presents the determinants of UTAUT2.

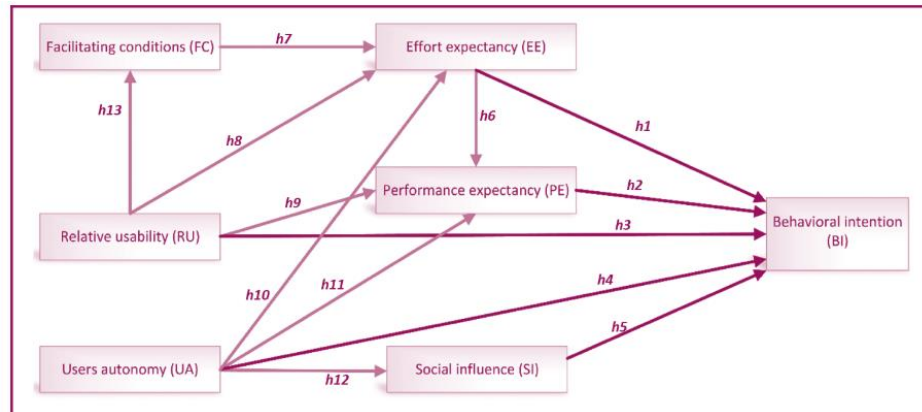


Figure 13 - UTAUT2 framework (Kuciapski, 2017)

Determinants within the UTAUT framework (Venkatesh et al., 2003);

- *Performance Expectance*
- *Effort expectancy*
- *Relatively usability*
- *User autonomy*

UTAUT and TAM2 are intrinsically linked as there are common determinants which are shared between both frameworks (Roudi et al., 2022; Venkatesh et al., 2003; Venkatesh and Bala, 2008). This is expected as both models are formed from the same seminal research (Davis, 1985) and over time have been developed (Kuciapski, 2017; Lai, 2017). The following three determinants are common between TAM2 and UTAUT.

- *Social influence*
- *Facilitating conditions*
- *Behavioural intention*

When the two models are connected and applied in the same context, the outcome is UTAUT2 (Kuciapski, 2017).

As there is replication between TAM and UTAUT, to prevent duplication the additional determinants added to UTAUT for purposes of this study will remain assigned to TAM2 as this is the more mature of the two frameworks.

2.4.10 Social Cognitive Theory (“SCT”)

Social Cognitive Theory has been referenced in literature as a link towards understanding the need to accept change as it is a framework for understanding and predicting human behaviours. Wood and Bandura (2014) produced research presenting application frameworks which look at observing and accepting change. As the framework is used to support further understanding of attitudes and behaviours, these determinants are already referenced in TAM and therefore the focus will be on TAM determinants rather than SCT as a framework. Therefore, this method will not be considered further.

2.4.11 Common determinants within the SLR

Figure 14 shows all determinants across the extracted data by the percentage of articles they feature in and some which don't feature widely such as cognitive factors (Roberts et al., 2021), experimentation (Mergel, 2018) and accessibility (Haneem, Kama and Bakar, 2019).

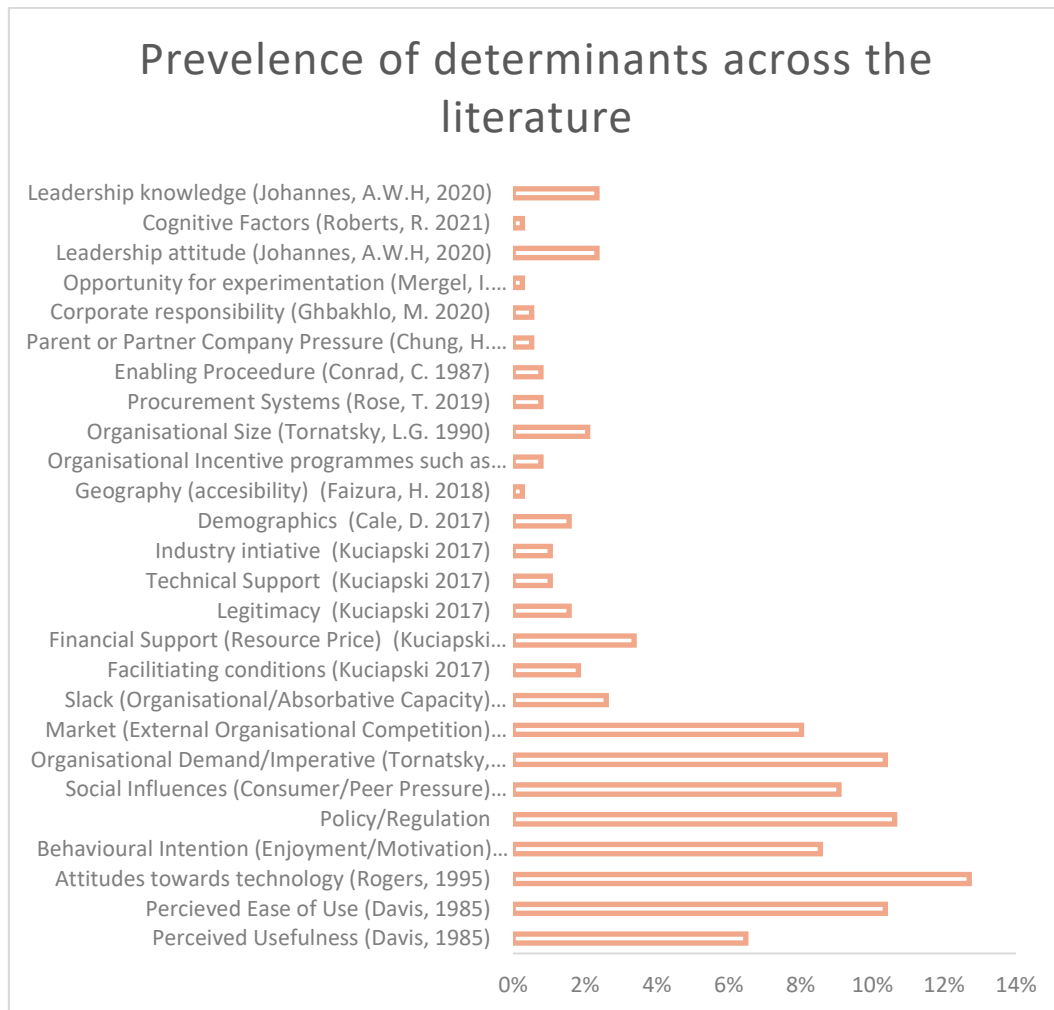


Figure 14 - Prevalence of determinants from the SLR

As has been discussed there are common frameworks throughout the literature, this also means that there are common determinants which can be seen. Figure 15 shows the percentage of articles out of the 81 total which include the most common determinants, these are a subset of Figure 14 to focus in on those which are the most prevalent.

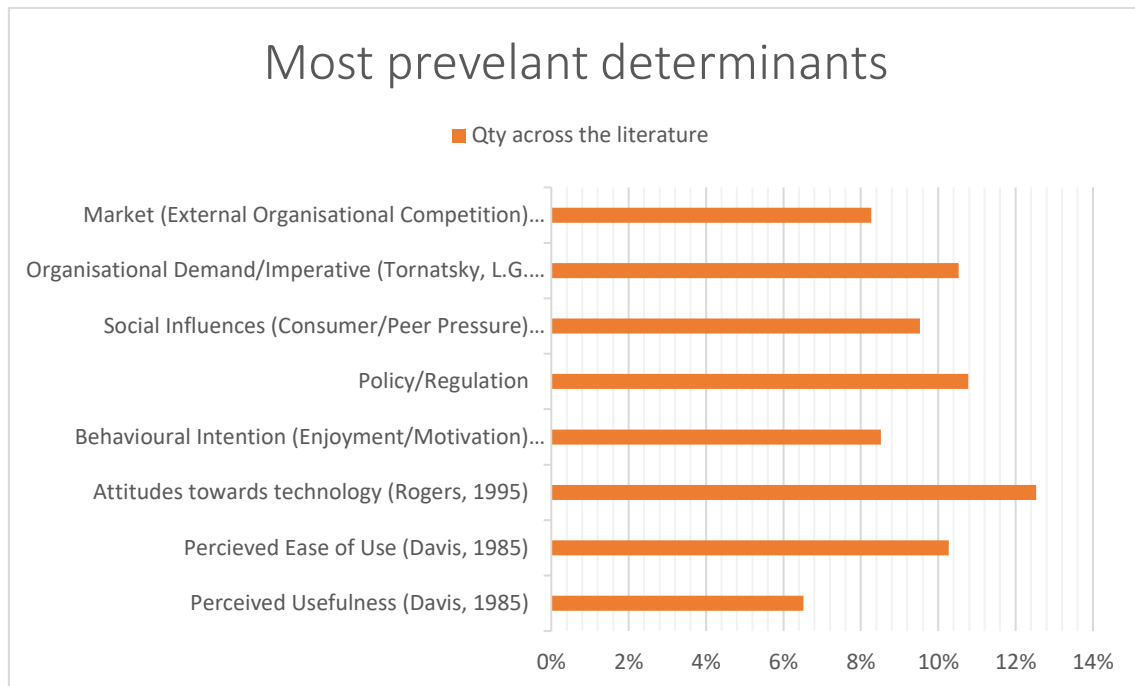


Figure 15 - Key determinants from the SLR

Some authors challenge the use of common established determinants by suggesting that without other forces such as, market forces (Corrocher and Fontana, 2021), increased consumer demand (Anugwom, Anugwom and Eya, 2020) and peer pressure (Wang et al., 2020b)) there would not be a driver to accept any adoption, in essence creating an imperative to change. It is this imperative which forces an increased level of adoption by directly affecting other elements such as attitudes, or perceived usefulness (Goodarzi, Aflaki and Masini, 2019; Nicoletti, von Rueden and Andrews, 2020). This creates a circular reliance which does not feature in any of the models which are presented however there are examples where importance or superiority of determinant is considered, almost rendering determinants null in the context being applied. This doesn't mean they don't any longer exist, just that in the specific context, their level of influence is minimal (Venkatesh, 2008).

2.4.12 Determinants which are separate to an established model

Technology acceptance has been investigated for over 40 years (1985) even longer if you consider the diffusion of innovation was first developed in the 60s (Rogers, 1983). There have been many spin offs in research which provided support (Jouda, 2020), additions (Jun, Park and Cho, 2019) and also refuted (Brown, Venkatesh and Hoehle, 2015) the research over time which means there are developments in theories and

frameworks. As well as the development of existing theories, there are many considerations which have been reported to be important, but not part of one of the developed theories themselves. For this research, these have been termed as independent determinants.

In reviewing the extracted data, there are a number of determinants which do not align to the extant frameworks. These often come from testing or applying the frameworks to new contexts or industries and a specific determinant from that contextual area (Kim and Chung, 2018; Oorschot, Halman and Hofman, 2020). Another approach to new individual determinants can be evidence with recent literature that appears to be moving away from the typical application of a technology based framework by applying frameworks such as TAM and moving to organisational models and context specific requirements by undertaking local empirical studies (Gruenhagen and Parker, 2020; Mamer and McCardle, 1987; Zidonis and Nazzyrov, 2020). The intention of investigating the determinants of technology acceptance in this manner aims to develop new considerations which are context and application specific. As a different approach to simply applying and testing an existing model, it is being undertaken in industries where firm foundations have been established on existing technology acceptance models.

Determinants which are not associated to existing models are listed as follows;

- *Geography (Haneem, Kama and Bakar, 2019)*
- *Governance initiatives - Enabling (Read et al., 2016a)*
- *Organisational Incentive programmes such as Lean Management (Rose, Manley and Widen, 2019)*
- *Organisational Demand/ Imperative (Adner, 2002)*
- *Corporate responsibility (Lee et al., 2015)*
- *Opportunity for experimentation (Mergel, 2018)*
- *Leadership Legitimacy (Damanpour and Schneider, 2006)*
- *Leadership attitude and leadership knowledge (Oorschot, Halman and Hofman, 2020)*
- *Demographics (Cale, Rai and Margolis, 2017)*

2.4.13 Summary of determinant themes

For technology to be successful, the original methods proposed by Davis (1985) and Rogers (1983) need to be expanded to include other factors such as social influences

and facilitating conditions (Venkatesh and Bala, 2008). This has given rise to variations of the original models such as TAM2 (Davis, 1989) and TAM3 (Venkatesh, 2008) but also different perspectives on the problem including TOE (Baker, 2018) and UTAUT (Venkatesh et al., 2003) and the Iacovou model (Oliveira, Martins and Lisboa, 2011). The analysis of the literature has enabled the focus on 5 distinct models which could be applied to help to understand technology acceptance within the UK Railway are detailed below:

- *Diffusion of Innovation (Rogers, 1983)*
- *Technology Acceptance Model (Davis, 1985)*
- *Technology, Organisation and Environment (Tornatzky, Fleischer and Chakrabarti, 1990)*
- *Iacovou model (Iacovou, C. L., Benbasat, I., & Dexter, 1995)*
- *Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003)*

From these 5 models, there are in total 34 different determinants of technology acceptance. The extracted research data also showed little research based within the UK Railway context, industries presented where numerous, agriculture (Rodgers, Morgan and Harri, 2017) to online banking (Alalwan et al., 2015). As national media in the UK and political outlets were advertising the challenges to adopt technology within the UK's rail industry it may be the case that research now follows this trigger (Shapps and Williams, 2021).

The following table (16) presents determinants identified from each model or framework. It is intended to show which frameworks could offer support to technology adoption at the organisational and strategic level to improve the chances of success. These areas will be taken forward into the empirical review.

TAM	DOI	UTAUT	TOE	Iacovou Model
System Characteristics	Attitudes towards technology	Performance Expectance	Environment – Industry characteristics and market structure	Financial Resource
Perceived Usefulness	Centralisation	Effort expectancy	Environment – Technology support infrastructure	IT Resources

Perceived Ease of Use	Complexity	Relatively usability	Environment – Government regulation	Perceived benefits of innovation
Social Influences (Consumer/Peer Pressure)	Formalization	User autonomy	Organisation – Formal and informal linking structures	Competitive Pressures
Facilitating conditions	Interconnectedness	Social influence	Organisation – Communication processes	Trade partner pressure
Individual Difference	Size & Slack (Capacity)	Facilitating conditions	Technology – Availability	
Behavioural Intention	System openness	Behavioural intention	Technology – Characteristics	
Use Behaviour				

Figure 16 - Determinants identified from the common frameworks

- *Dark Grey = Models and frameworks which focus on the individual and individual influence*
- *Green = Models and frameworks which focus on the organisation and the organisational requirement to accept technology.*

The table shows that there are several themes which are consistent across the models and frameworks. One of the reasons for this is that many of the theories presented have been developed considering the Theory of Planned Behaviour and so it is not surprising that there are similarities which can be seen below;

- *Yellow – Individual attitudes*
- *Red – The organisational conditions which support technology acceptance*
- *Blue – The individual perceived attitudes towards use*
- *White – distinct to the model/framework*

The white elements are determinants which have been added by applying the frameworks in different contexts. The prevalence of those determinants which have not been colour coded are a result of the specific context of the application of technology. So when technology is applied in the rail industry in the UK, these may or may not be as prevalent. This potential outcome will be explored in the empirical section of this thesis.

2.4.14 Combining frameworks

The vast and broad array of potential determinants, inevitably leads to some attempting to consolidate these into a single framework (Sepasgozar and Davis, 2018). Leonard, De Kock and Bam (2019) present a model by combining together the varying determinants into a structural cube model which groups determinants into categories. This cube requires all the determinants to be positively impacted to be successful. This paper does not attempt to align with previous frameworks such as TAM and explains that successful acceptance is difficult to predict due to the number of variables. There are two main issues with this model as referenced by the author themselves, the fact that the model needs all inputs to be positive to enable the outcome to be achieved, but we know that the determinants often do not enable a positive outcome as they are down to an individual's perspective and so variable (Davis, 1985). The second issue is with the number of variables, because of the number of discrete inputs the level of data is difficult to obtain and process but almost a given that one data stream will not enable a positive outcome making it unlikely to be the case that an outcome can be achieved (Leonard, De Kock and Bam, 2019).

A further 18 other articles use at least 2 models or frameworks to increase the opportunity to accept (Daradkeh, 2019; Haneem, Kama and Bakar, 2019; Valacich, Wang and Jessup, 2018). In these cases, the technology application is software, this is well understood and have been explored through research as we have seen in particular with TAM so there is evidence to build from but this isn't as clear in differing contexts in particular the type of industry where there are different external factors (Kuciapski, 2017), therefore it cannot be assumed that matching two models will benefit the rail sector,. Others simply acknowledge that external factors have an effect (Lee, Kozar and Larsen, 2003, p.758) but this is not quantified as the presence of external factors does not largely affect the dependents, again this is context specific. The examples given show that there is differing thoughts on the combination of models and the benefit of doing this, it should not be assumed that more is better when it comes to determinants.

Even if the models and frameworks cannot be combined and applied, there is evidence to suggest suggests that for some applications the determinants can be grouped together from the different frameworks such as TOE and UTAUT (Baishya and Samalia, 2020; Baker, 2018) due to the commonality in the technology, environment and approach.

There are unique ideas also presented such as the proposal that the risk of 'industrial relationships' can create a barrier or enabler (Rose, Manley and Widen, 2019, p.216) this is only considered in one of the extracted papers but is pertinent when considering the public sector and the impact this could have. If teams need to work together to achieve the outcome, but one team is averse to change, the chance of introduction will always be met with a barrier, which makes sense, and a barrier for management innovation (Hsu et al., 2019), Relationships are therefore important, at an individual level as we have evidence that peer pressure has an effect on the ability to enable technology acceptance (Davis, 1985) but also at a team and functional level the misalignment of outcomes and therefore success has the opportunity to stifle progress. Relationships have shown to play a key part in technology acceptance and this is likely to be a feature of the empirical study.

Similarly to TAM, the Unified Theory of the Acceptance of Technology (Venkatesh et al., 2003), Technology Organisation and Environment (Tornatzky, Fleischer and Chakrabarti, 1990) and Diffusion of Innovations (Rogers, 1983) are well established in literature and are used to determine the potential level of acceptance of technology but using different variables. Whereas TAM is structured around the intention and attitude toward use, TOE, UTAUT and DOI focus on other determinants in order to achieve acceptance such as social influences and technological support to determine the level of acceptance (Oppl and Stary, 2020). One could argue these are determinants relating to TAM but on a more granular level – a fundamental of TAM is the attitude to use, TOE suggests that there needs to be the right environment to enable use and the right environment will have a direct relationship to the attitude of the individual to use (Puklavec, Oliveira and Popovič, 2018). There is likely to be a reason why TAM hasn't been associated with other frameworks directly through interdependencies, and that maybe due to the context variations but also it could be down to the difficulty in establishing determinants which can be directly associated considering the perspectives already discussed specific to the context and environment. What is key, is that to some extent, all of the frameworks have some element of individual choice which reverts back to the Theory of Planned Behaviour, and the fundamental basis for Technology Acceptance. Each framework has added its own contextual specific perspective on what is the same fundamental challenge, getting individuals to do something different. Achievement of individual change is also a common feature with the Success Model (DeLone and McLean, 2003), suggesting that what ever the determinant, from a research perspective, individual choice drives both the acceptance of technology and the level of success.

Using a specific method to accept technology is a choice of the organisation, and although the determinants chosen will range based on the method applied, all of the methods fundamentally start with the same theory behind TAM, the theory of reasoned action when considering the individual behavioural intention to use and attitude towards use (Lai, 2017; Vallerand et al., 1992). As TPB and TRA are both common behind all of the theories and frameworks but in particular TAM, this model would be offer a suitable first attempt to understand if technology is likely to succeed (Lee, Kozar and Larsen, 2003).

The main differences suggested by the literature between the established TAM derived models is the suitability and context in which they are applied. As an example of this Tornatsky (1990) considers technology acceptance from the organisational context and Venkatesh (2003) provides a framework which crosses over between TAM, UTAUT and TOE for the organisational context which can be seen below in Figure 17 many determinants are exclusive in their impact, some are inclusive. From literature, IT acceptance tends to utilise the TAM framework (Elmorshidy et al., 2015; Mittal et al., 2020), whilst public sector and large corporate organisations would look towards TOE or UTAUT (Ladasi et al., 2019; Puklavek, Oliveira and Popovič, 2018). This is not always the case and frameworks are used without discretion which is not appropriate as the contextual basis as to which they apply differs, for example TAM is based on the individual yet the decisions around public sector implementation is based on organisation level requirements suggesting a model which favours corporate factors. What Figure 17 also suggests is that if you want to consider technology acceptance from an individual perspective, you are more likely to determine success by applying the TAM model, whereas at the organisation level, TOE and this does come across in the literature based on the fundamental constructs of each model but recognising the different perspectives on the individual may have an important effect for example the employees intention to use will be effected by the conditions they are placed in, the two perspectives cannot be considered in isolation even if both models cannot be applied. More recent articles use two or more frameworks to determine acceptance to improve the chances of success, as this enables a better consideration for the context as to which the technology is being accepted (Ammar, Ahmed and McMillan, 2016; Lorente-Martínez, Navío-Marco and Rodrigo-Moya, 2020). Throughout the literature study, there has not been evidence to suggest that the outcome of combining does improve the outcome consistently, this may

be worthy of further exploration but what is consistent is that in a new context, any framework even if solely must be tested first for appropriateness (Lai, 2017).

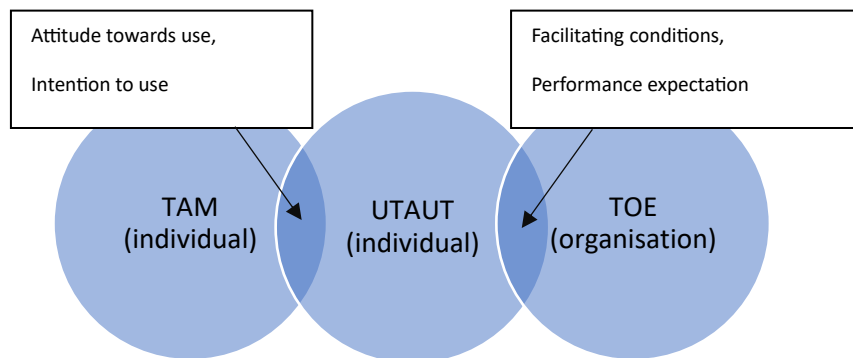


Figure 17 - Venn diagram showing the cross overs between TAM, UTAUT and TOE frameworks

Specifically looking at alignment of determinants with frameworks and not the whole of the framework, examples exist where the lacovou model and TOE are linked together to enable a more likely, successful outcome (Chatain and Plaksenkova, 2019; Hsu, Chen and Chen, 2020; Lin et al., 2020). . Other examples exist where lacovou model and DOI have been applied in the same process to achieve a successful outcome regarding technology acceptance (Wang and Yu, 2015; Zhang and Zhu, 2020). This combination of lacovou and DOI is aimed to give a better chance of success in specific and common contexts. This would suggest that not having many reported similarities with lacovou model is not a detriment if other theories can offer support and understanding when applied to the same technological adoption activities. It is worth noting however, the papers which show the combined opportunity of the frameworks (Wang and Yu, 2015; Zhang and Zhu, 2020) do not then go on to understand if there would be the same likelihood of success by using one framework, neither is it offered if the extra time and effort achieves a magnitude or an incremental benefit which could be an expensive activity..

Whatever the driver behind the search for the determinants, the list is extensive and has the potential to affect technology adoption. it is important to understand whether affecting all the determinants is worthy of effort, or for some context, are there primary and leading determinants which positively affect the rest. The empirical study will attempt to identify a set of factors, in the context of the rail industry which will be the most relevant that can be considered in line with the research question.

2.4.15 Industrial context and applications

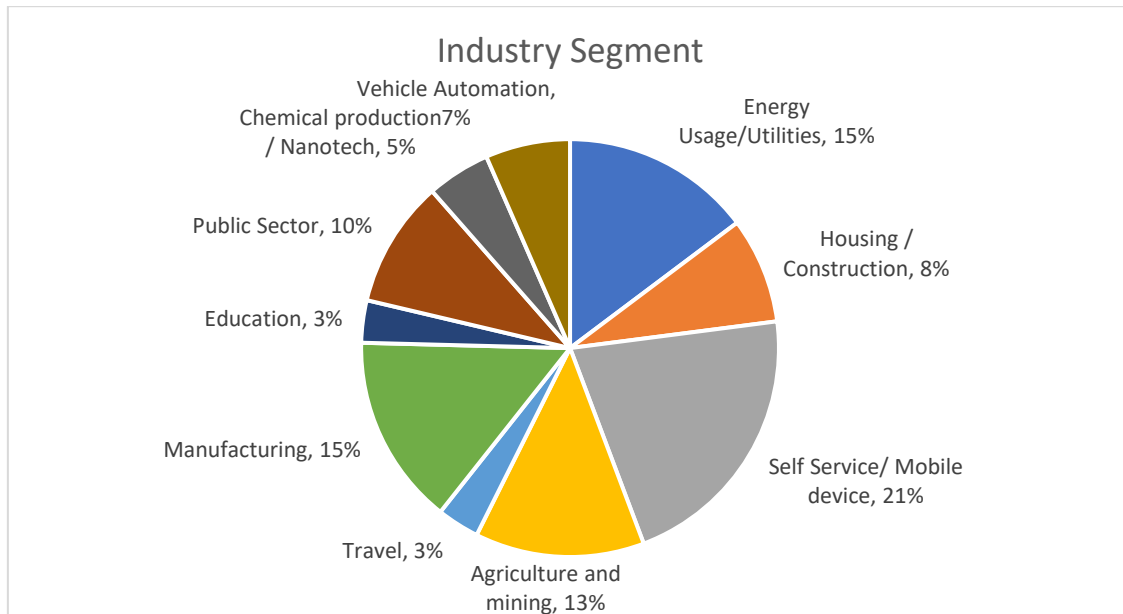


Figure 18 - Industry Segmentation

The specific sector in question is the rail industry within the UK Public Sector. Considering the industry applications as shown in Figure 18, vehicle automation (Madigan et al., 2017; Molnar et al., 2018; Rahman et al., 2017), and self-service (Gill and Shaghaghi, 2020; Salehi-Esfahani et al., 2017) are becoming more and more prevalent due to the establishment of commonly used devices such as phones and tablets requiring even more key enabling technologies to be developed (Rymarczyk, 2020; Sjödin et al., 2018). This consumer fuelling of the 4th Industrial Revolution (Barata, Rupino Cunha and Coyle, 2020; Chung, 2021) may be resulting in a heightened interest in this technological field and hence the increase in published articles within this field of technology adoption. However, the rail sector does not feature, the only two references made to railways feature below for context and did not progress through the quality assessment;

- (Nordhoff, Van Arem and Happee, 2016) – *Autonomous driver like pod vehicles and their reference to driverless trains*
- (Ferdous et al., 2015) – *Application of a composite sleeper and its use.*

There are references to social mobility enabled by public sector decision making which it could be considered that the railway sector is part of (Kurniawan, Ong and Cheah, 2018). There are two potential outcomes to the lack of research within the railway sector,

there is little interest in technology acceptance within the Rail Sector, or that the context of technology acceptance within the rail sector is not currently widely investigated within social science research in favour of engineering and science type research.

2.4.16 Public Sector applications

External forces which are at play in the public sector appear to be more prevalent than other industry areas as well as the influence of the agents acting as key stakeholders (Mergel, 2018; Moussa, McMurray and Muenjohn, 2018; Wang et al., 2020a). The evidence supporting the phenomenon published in 2021 suggested was an external force in itself being published by the government to disband the current industry structure in favour of which enables a different outcome.

Broader than application within the United Kingdom, 6 articles were reviewed which specifically look at public sector that generally focused in two areas of innovation adoption with one being aligned to this study and the determinants of technology acceptance (Haneem, Kama and Bakar, 2019; Propheter, 2020; Wang et al., 2020a). With the second being 'management innovation' around the organisation structure which leads to drive innovation (Kusumasari et al., 2019; Moussa, McMurray and Muenjohn, 2018; Zidonis and Nazyrov, 2020). This mainly featured around the pros and cons of having single or uniform management structures across multiple functions, in some cases shared Board or management team (Kusumasari et al., 2019; Moussa, McMurray and Muenjohn, 2018; Zidonis and Nazyrov, 2020). Once you have the right management structure with the right knowledge and attitude, the organisation is able to better collate and use data to drive innovation within public sector organisations (Mergel, 2018). The references given in this section and data sources reference technology, adoption or acceptance as a main driver and what is interesting is that the determinants align with the more traditional technologies and even IT applications but are focussed in most cases on organisational structures being a determinant in itself as it has the opportunity to accelerate or prohibit this traditional innovation approach.

In contrast to the traditional alignment of public sector innovation being associated with the successful adoption of technology, innovation is also described in the context of management as the direct output of a business in relation to the successfulness of the management structure alone (Gruenhagen and Parker, 2020). In this context and application, technology is not an enabler for innovation but this change, creates a better chance for technology adoption to succeed, potentially by creating a leadership which is

more experienced with new technology adoption (Rangus and Černe, 2019). This specifically looks at the opportunity created by management as the fundamental enabling to drive change. The suggestion from the examples given is that for the public sector to accept technological change, the leadership needs to drive the change and be seen to be legitimate in its use and application which is more than traditional industry which relies more on the individual accepting technology.

2.4.17 Comparison between consumer and organisational determinants

An interesting case study which is presented from the literature is with Solar Photovoltaic ("PV") Cells. The four studies reviewed from the data extraction suggest a need for confidence in the PV technology as a key success criteria for enabling technology adoption, but each literature article presents determinants based on their own contexts for the consumer (Abreu, Wingartz and Hardy, 2019) for the company (Walters, Kaminsky and Huepe, 2018) and also government (Goodarzi, Aflaki and Masini, 2019; Overholm, 2015) in terms of legislation. Without all of these parties motivated to adopt the technology – one could suggest that with our climate challenges that should be incentive enough – it is unlikely the rate of introduction will be suitable if any of these agents do not accept the technology to its fullest extent. What these 4 articles are showing us from the point of view of PV is that the previous typical way of thinking, that you can predict technology adoption through applying a consumer based individualistic approach. The case of PV shows that this may not always be the case due to the scale and level of industry change. This case is relevant as it suggests that some determinants are common regardless of perspective of the intended user, whereas some are unique to the perspective of another agent. The challenge between the company need and individual desire to accept technology has been seen to be a consistent opportunity to improve in all of the models and applications seen.

Whereas earlier technology frameworks generally resided around the individual, these now appear to point more towards the organistic network and influences which are apparent within the organisation and community rather than the individuals perceived ease of use or usefulness. (Slade et al., 2015). Although some determinants have the same role regardless of individual or organisation contexts such as the prevalence of financial support, some are unique to the perspective. Further examples can be seen in the following articles which are distinct to the organisation or individual;

From the point of view of the organisation (organisational determinants)

- *“Organisational size”, “organisational absorptive capacity” and “financial support”*
(Bello et al., 2018; Greenland et al., 2019; Nasirov and Agostini, 2018)

From the point of view of the individual or consumer (individual determinants)

- *“Behavioural intention”, “Social influences” and “Attitude toward use”*
(Alexandru, Coardos and Tudora, 2019; Alkawsi et al., 2021; Anugwom, Anugwom and Eya, 2020)

Naturally, the application of technology requires an approach which considers the impact of the benefits and where this is associated to make sure the right framework is being applied. Across the extracted literature, the beneficiary or requirement for technology acceptance is varied and can be seen as a summary in shown in Figure 19 showing that the organisation is the most common beneficiary from the literature pool relating to technology acceptance.

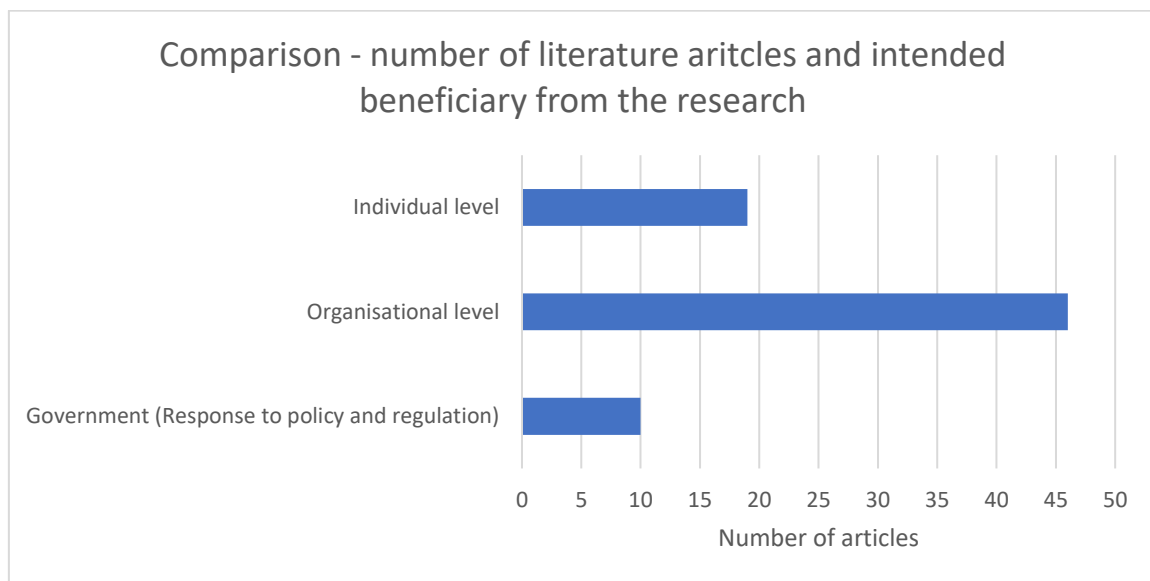


Figure 19 - Comparison of the quantity of articles based on the intended beneficiary of technology adoption

2.5 Research Objective 2 - Success

As the literature review has enabled a better and more in depth understanding of the determinants of technology acceptance, and the distinct models and determinants have been identified and evidence of them being applied. Research Question 2 looks at how

success is measured from application of these same determinants in the same context area. The research question is as follows;

“What are the factors of successful technology acceptance within the UK Public Sector Rail Industry and the applicable theories?”

Throughout the initial reviews of the literature, authors consider the acceptance of technology to be a value adding activity when it succeeds (Szajna, 1996a; Tucker et al., 2020). Some of the articles reviewed consider this as a benchmarking process comparing the pre and post measured positions (Eze et al., 2018; Haneem, Kama and Bakar, 2019) however this is certainly not consistent and 11 articles from the literature pool include a specific consideration for the level of success. Technology introduction can be costly and come with a high risk of failure, therefore when making a strategic decision to use technology, the chance of success is an important consideration (Geels and Smit, 2000).

2.5.1 Success

As per the definition, success is when technology acceptance has been completed, and value creation is achieved (Szajna, 1996a). Some of the articles reviewed consider this as a benchmarking processes comparing the pre and post measured positions (Eze et al., 2018; Haneem, Kama and Bakar, 2019) however this is certainly not consistent and 11 articles from the SLR include a specific consideration for the level of success. Technology introduction can be costly and come with a high risk of failure, therefore when making a strategic decision to use technology, the chance of success is an important consideration (Geels and Smit, 2000).

2.5.2 The ability to measure success

Many of the articles reviewed used personal acceptance as the method to determine uptake which fits in with the traditional methodology associated with technology acceptance (Davis, 1985; Edmondson and Mcmanus, 2007). For example, if an individual says that they are aware of the technology from a given question, and that they would be likely to use it, it this is seen as a positive measurement (Kuciapski, 2017) which ties back to the original “intention to use” from the TAM framework as the leading determinant (Brown et al., 2002). Often success is determined as either in use, or the probability of use however neither method discusses the effectiveness and suitability of ongoing use of the technology after it has been accepted (Sepasgozar and Davis, 2018).

The effectiveness of actual factors of success is only considered in 6 literature articles but does not go on to specifically quantify what the level of benefit is and how it is quantified (Garrone et al., 2021) which aids the alignment with the imperative and demand.

Benefits of technology adoption within a company although not quantifiable from the data extracted does relate it to market growth which leads to financial benefit (Corrocher and Fontana, 2021). What can be seen is acceptance at an individual level is different from acceptance at an organisational level, the two outcomes are different constructs which are aligned to different factors of success.

Some examples are as follows but are generally aligned to 4 groups as present in Table 9;

Technological adoption e.g.,	Factors of success	Example	Reference
Uptake of an innovative sewage treatment alternative	Operations – Quantification of the level of change – amount that it is used	% of water diverted to the new technology	(Cirani et al., 2010; Garrone et al., 2021; Hyder, Siau and Nah, 2019; Meroño-Cerdán and López-Nicolás, 2017; Nastjuk et al., 2020; Weng, Lim and Phang, 2019)
Home energy options, autonomous vehicles, and travel choices	Human resources – Individual choice to accept the new technology	% of consumers who chose to move to the new technology	(Bell and Ruhanen, 2016; Gimpel, Graf and Graf-Drasch, 2020; Luque-Martínez et al., 2007; Oorschot, Halman and Hofman, 2020; Wang and Yu, 2015)
New technology uptake as part of innovative activities at an organisation level	Financial – Increased market share or financial increase leading to competitive advantage	% increase in the market including further acquisition	(Bell and Ruhanen, 2016; Corrocher and Fontana, 2021; Emmerich et al., 2020; Hanis, Trigunarsyah and Susilawati, 2011; Hyder, Siau and Nah, 2019; Jha, Bose and Ngai, 2016; Lin et al., 2019; Meroño-Cerdán, 2017; Trianni, Cagno and Worrell, 2013; Wu et al., 2015)
Benefits of management innovation	Strategic – Aspirational success which will lead to reduction in spend or increase in output or uptake of a given solution in the future.	Combining the management team of 2 divisions will improve pace of technology adoption	(Bello et al., 2018; Cagno, Ramirez-Portilla and Trianni, 2015; Kusumasari et al., 2019; Najar and Dhaouadi, 2020; Ngai, E.W.T. Gunasekaran, 2009)

Table 9 - Examples of the factors of success at an organisational level

Regarding the literature which has been reviewed, the vast majority does not consider what success is achieved or even how it is defined. It focusses on what is 'perceived' success from an individual perspective. For those who are concerned with success or how it is measured, the data can be determined qualitatively or quantitatively but fundamentally it is still about asking a person to complete a question set to gather data.

2.5.3 Success and technology acceptance

There could be an assumption that any technology adoption is a success as long as it is not rejected in its entirety, as in undertaking this action, there must be an intended positive outcome. By considering the models which are frequently used there is an assumption made in which success could be considered from many different views, organisation, individual to shareholder (Wirtz and Piehler, 2016). This may not be the case if technology is accepted but then not used to the expected extent. Although accepted by the organisation, a lack of full acceptance by the individual may drive inefficiency which impacts the level of success. This would create an increased level of risk regarding time and investment in to the organisation as the new technology would be integrated but seemingly not appear to be performing as designed (Aleskerova, Fedorishina and Todosichuk, 2019). For some technology acceptance projects, there is a greater risk to organisational acceptance if individual acceptance is not undertaken appropriately.

TAM considers one of the main determinants for technology acceptance to be the perceived usefulness (Davis, 1989). The user perceives the technology to be useful and therefore success at the user level would relate to a higher probability of success at an organisational level. The majority of studies when applying TAM found that if the individual found it useful, then their attitude would change and hence would be more likely to engage in its use benefitting the organisation (Alexandru, Coardos and Tudora, 2019; Zefreh and Torok, 2019). What Brown et al. (2002) presented is a contradictory position where technology acceptance is mandated, the example given is in the financial sector where regulatory reporting is undertaken through specific software. Here as the technology must be used, the user's intention to use does not feature and so there is a change in the framework which prioritises the perceived ease of use as the dominant determinant over attitude towards use.

In considering the difference when technology acceptance is a choice versus when it is mandated by an organisation, the influence of the determinant's changes between

perceived ease of use and perceived benefits of use. Both determinants still exist but in applying TAM in the public sector where many requirements relate to regulatory reporting and policy, the natural and more comfortable leadership models prioritise dictatorial and directorship (Hatch, 2006, p.146) may be less interested in the individuals perceived benefit to use. If this is the case in the public sector which could be expected due to the safety critical nature of the activity, the majority of technology adoption may be mandatory and therefore it would be a priority of those introducing the technology to focus on the ease of use. In these cases, Brown et al suggests that success to the organisation can become more efficient however success for the individual translates to enabling the individual to “keep and perform their job” (Brown et al., 2002, p.283)

TOE looks at the same challenge but from the organisational perspective rather than the individual. TOE still considers success in regards to the individual and their perception of the technology, change and its environment but it measured at the organisational level (Fox, 2020). With regards to the organisation, Lin and Chang (2011) identify success as the “incremental impact of various external factors on beliefs, attitudes and intentions”. This means that to be successful, the focus must be on the individuals within the organisation rather than looking at the organisation as a whole in order to create a “behavioural intention to use”(Lin and Chang, 2011, p.427). The real benefit of enabling success lies not in articulating profit margins but focussing on the incremental improvements which will help the individual such as continuously improving the ease of use. This notion is directly contradictory to an environment and organisation such as the public or government sector where it relies mainly on instruction/command (Hatch, 2006). This could be one of the key reasons why technology adoption in the railway sector in the UK may not be as proficient as could be because the command-and-control underpinning of a government body is more focussed on organisational level success rather than success of the individual users or the direct impact on them.

2.5.4 The ability to measure success

A proportion of the reviewed articles used personal acceptance as the method to determine uptake which fits in with the traditional methodology associated with technology acceptance. For example, if an individual says that they are aware of the technology, and that they would be likely to use it, it this is seen as a positive factors (Kuciapski, 2017) which ties back to the original “intention to use” as the leading determinant from the TAM framework (Brown et al., 2002). Often success is determined as either in use, or the probability of use however neither method discusses the

effectiveness and suitability of ongoing use of the technology after it has been accepted (Sepasgozar and Davis, 2018). The effectiveness of actual factors is only considered in 6 literature articles out of 11 but these still do not go on to specifically quantify what the level of benefit is and how it is quantified (Garrone et al., 2021).

Benefits of technology acceptance within a company typically relate to market growth which leads to financial benefit (Corrocher and Fontana, 2021). Acceptance at an individual level is different from acceptance at an organisational level, the two outcomes are different constructs which are aligned to different factors of success but determinants at an individual level are focussed on the individual's choice, therefore aligning the success, business imperative and individual needs is important to achieve success.

2.5.5 Theories of success

In searching the material produced from the SLR, only 11 of the 81 extracted articles discuss success in any real terms and none gave a direct link between technology acceptance and a theory of success. To understand if there are theories of success which have an association with technology acceptance, the same databases have been searched for theories, frameworks or models but without the restriction of searching for technology acceptance first. The intent of doing this is to build on the information gleaned from the 11 examples given to further develop knowledge and understanding with the aim it can be better applied in practise. This is a furthering of the snowball method using key criteria from the first search strings. Taking the initial cut of articles, and then searching them with the search string in Appendix A.1 has offered success theories and models which are associated with technology acceptance.

As the articles had already been checked through the inclusion and exclusion criteria, the total number was much lower than an open search returning 2338 articles. A review of the titles and focus on the success models or theories further reduced the number to 186 articles in total.

The literature which has been identified and extracted relating to the success models and technology acceptance present some common contexts and industries (DeLone and McLean, 2003). The intention to use information systems in an IT context is a very common example where the two models come together and these creates further examples and application such as the use of social media within an educational setting (Chang and Cheung, 2020) as well specific services such as the use crossing technology and the decisions for pedestrians (Pal, Sharma and Jangid, 2022) but also when applying

IT systems in the public sector specifically (Zaied, 2012). These are all common applications of both technology and the measures of success to aid beneficial outcomes. This not only shows the wide applicability within an IT setting but also that the application of ISSM and Technology acceptance in this data set is not applied widely beyond IT.

The natural overlap between TAM and the Success Model and the fact that they have both been developed for the IT industry means that they naturally will have close alignment (Jeyaraj, 2020; Legramante, Azevedo and Azevedo, 2023; Zaied, 2012), but both models and the examples seen in the extraction also confirm that there is an issue in that both models assume a stagnation in the decisiveness of those engaged in the process, i.e. their thought process and attitudes do not change throughout the acceptance. (Chang and Cheung, 2020; Pal, Sharma and Jangid, 2022).

Although there are no specific examples seen relating to the railway environment, examples from the public sector and use cases for individuals with technology suggests there is a level of applicability due to the focus of the theory on the individual and their intentions. Examples such as the one presented by Hawash (2021; 2020) which specifically look at the users acceptance of electronic records is an example which is directly applicable in the railway setting due to the agnostic nature of the technology being considered.

The 186 articles are broken down across 3 success theories and models which are summarised below;

106 articles reference the Information System Success model ("IS Success Model") which was developed by DeLone and Mclean (1992). The model was constructed by consolidating previous research and learning, particularly from the 1980s (DeLone and McLean, 2003, p.10). The purpose of the model is to provide a process which shows links and associations between the dimensions which affect success specifically within an Information Systems context. These dimensions are interrelated, meaning improvements in one area can positively affect others. For example, better system quality can lead to higher user satisfaction, which in turn can result in greater net benefits for the organisation. There are 4 dimensions which affect successful impact.

- *System Quality - This dimension covers the technical aspects such as reliability, ease of use, and performance. Better system quality leads to higher user satisfaction and increased usage.*

- *Information Quality - The direct quality of the support provided to users. Good service quality has a direct correlation with user satisfaction and usage intentions.*
- *System Use – This is a measure of how frequently and to what depth the users of the system get to use. With Software systems, it is seen that the higher usage of the system has a direct link to user satisfaction and net benefits.*
- *User Satisfaction - This is the overall assessment of the Information Systems by its users. Higher satisfaction typically leads to more significant net benefits.*

(DeLone and McLean, 1992)

These 4 factors above have a direct influence on the individual impact which then impacts the organisation impact. Delone (1992) describes the outcome of the model as impact, as this can be relative and varied rather than absolute.

- *Individual impact is primarily affected by the System Use and User Satisfaction dimensions. System use is often voluntary and can be directly monitored and measured but has a moderating factor which is User Satisfaction which is less tangible but has been suggested that this plays a smaller role when the software is mandatory for company user.*
- *Individual Impact has a direct effect on the organisational impact. This association between the two is direct as the scaling of the individual directly contributes to the successful impact of the organisation.*

(DeLone and McLean, 1992)

A limitation of the 1992 model is as organisations grow larger and more complex, the granular detail to provide a measurement for the impact becomes overly complex and, in some cases, unable to be applied. It is partly due to this challenge that in 2003 the model was updated. With 10 years of being applied in different contexts and applications, the interdependencies and dependent dimensions were better understood. This growth in understanding led to a subtle change, system use became intention to use which is directly driven by system quality and “use” (DeLone and McLean, 2003) . Use is now a measured dimensions and offers a direct link with success because if users are declining that would suggest that something has changed which could be directly linked to system quality. But more fundamentally the model has been updated to combine individual impact and organisational impact to become net benefit of the system. This is because the individual impact has evolved beyond a single user and group impacts within organisations have more of a role in affecting the implementation

of Information Systems. It also recognises that the benefit of a new system may no longer rest solely at a company level, or individual but could be dispersed across varying groups (DeLone and McLean, 2003).

There are alternatives to the IS model, although these have not come through in the extended search, they are referenced. One example is a respecified IS model (Seddon, 1997) which aims to split the IS model into a process and a variance model however it is argued that in doing so, this complicates the model by creating two sets of distinct dimensions which defeats the purpose of the model in the first place. As both models are aiming to deliver similar outcomes, and with common dimensions it is proposed to consider only the IS model within the empirical study of this thesis.

There are some limitations with the IS Success model that need to be highlighted in the context of technology. The model has only been really rigorously tested in the context of software, self-reported results are not consistent with active measurements and that the measurement of results are not on a linear scale (Petter, DeLone and McLean, 2008).

Probably the most interesting limitation when it comes to technology acceptance relates to TAM specifically. This is because TAM and the IS Success model are linked as system quality is measured in terms of ease of use, and net benefit is measured in terms of perceived usefulness (Petter, DeLone and McLean, 2008, p.256). This raises concerns that there is such a limitation of factors which affect the outcome and not representative of reality. Also this means that the individual once again drives the outcome and net impact which is the opposite to what the IS Success model suggested was driving the outcome, be that group thinking (DeLone and McLean, 2003). When understanding the specific application of the IS Model and models such as TAM, 23 articles specifically look at how the two models can co-exist work together, specifically how quality and impact can be benefitted when understanding success from the context of technology (Ababneh, 2016; Chen et al., 2016; Mohammadi, 2015).

This insight could help to understand how to improve the chance of success therefore affecting the benefit to practise. The insight into the association between TAM and IS Success model is specifically linked to the association between perceived ease of use = net impact and perceived usefulness = system quality. This association is explored in 7 articles of the 23. All reference similar challenges, that the nature of a single measurement is risky, but that the correlation is a useful indicator (Cheng, 2018; Legramante, Azevedo and Azevedo, 2023; Mohammadi, 2015).

77 articles reference the Achievement Goal Framework developed by Nicholls' (1985) and is based within the field of psychology. Achievement goal theory otherwise known as motivational theory is based on developmental ideas regarding how young people move through a temporal process whereby the concept of ability is gradually differentiated from effort, task difficulty, and luck (Nicholls, Patashnick and Nolen, 1985). Although the articles reference the term "technology", there are no articles which specifically look at technology acceptance as a function or the outcome of the activity. Instead, the examples extracted are based around how adolescents respond to academic achievement (Greene et al., 2023; Kamble, Desai and Abhang, 2021; Nevo, Nevo and Pinsonneault, 2021). There is a single reference within the extracted articles to Project Success Framework (Bannerman, P. L. 2008), a framework which aims to define project success through applying a multi-layer framework. The framework comprises five levels of success criteria: process success, project management success, product success, business success, and strategic success. Project success is defined as the highest level achieved at any point of assessment, regardless of performance at lower levels. Application of the framework is illustrated with case examples of information systems projects, but the framework is applicable to any discipline. The article does not describe its association with technology acceptance or the role that technology might have to play within a typical project and therefore it is not deemed that this framework is of use within the study.

Out of the 3 identified models and frameworks, the IS Success Model is the most applicable. The reason for this is it specifically looks at the application of new IT or IS systems within an organisation or community. The Achievement Goal Framework is specifically based on the individuals' perspectives on taking up a new task. This is likely to have an effect on TAM and the behavioural intent however it is specific for a younger generation which may not be the case within the UK Rail sector. Where as the Achievement Goal Framework looks at adolescent behaviours and the Project Success framework is focussed on a project success regardless of the type of project or outcome. Although the outcomes of the Project Success Framework such as business success will be influenced by the technological acceptance, the framework is more about how to define success of a project. For these reasons, the IS Success Model is one which can be considered as part of the thesis to understand the factors which affect success.

The IS Success Model also has its challenges and limitations which must be considered when applying the model to technology acceptance projects;

- *success outcome maybe different than reality as this is reliant on individuals and their own consideration. This also means measurement can vary.*
- *success is often context specific, and therefore the role of the context has a part to play and further validation is required*
- *technology acceptance is based on the individual, whereas the 2003 version of the IS Success model is concerned around group thinking.*
- *The Success model has only been tested rigorously in the Information System context.*

(DeLone and McLean, 2003)

Although these challenges are known and have been explored, the fundamental elements of the model have been applied in many circumstances which feature new software acceptance (Ababneh, 2016; Chen et al., 2016; Legramante, Azevedo and Azevedo, 2023)) and there are could be utilised to support an improved level of success within the UK Rail Sector.

3 Chapter 3: Methodology

3.1 Research Design

Chapter 2 presented a considerable amount of information relating to technology acceptance and its determinants however presented little information regarding the acceptance of technology within the rail sector within the UK. Although the determinants of technology acceptance have been shown to be applicable in different contexts (Eze et al., 2018; Masood and Sonntag, 2020), the literature also tells us this that it cannot just be assumed that all the determinants will always apply in a different contexts and industries (Venkatesh and Bala, 2008) so any empirical study would produce novel data requiring to be investigated.

As the data is new and novel, the approach and methodology of the data collective will need to be appropriate to make sure that the information can satisfy the research questions but also has to enable the creation of knowledge and be applicable to practise.

The empirical study has been undertaken from a realist approach. The data collected is reflective of the real world and is subjective to those who perceive reality. This philosophical approach aligns to a qualitative methodology and the approach to data collective will enable the perspectives of the individuals to be directly captured and processed.

Saunders proposed a model to understand the epistemology and ontology of research to enable appropriate data collection which can enable better research outcomes. (Saunders, Lewis and Thornhill, 2019). In applying Saunders work, this would suggest that the methodology would be follow the following design elements:

3.1.1 Ontology: Relativism

With a study whose data is of a nascent archetype as it is new, and the position that data will be obtained directly by those who are involved in the process, the ontology needs to be such that will work with lived experiences and perspectives. The use of direct discussion means that the ontological approach will be relativism. This is because the information is being drawn out of lived perspectives from individuals who have been involved and is being taken by the researcher who is looking in on to the challenge. This will offer a deeper understanding of the issue and have the potential to remove individual bias also. As the study is also in regard to the technology acceptance of an organisation, relativism offers an opportunity to consider cultural practises and inclusive solutions to social problems (Saunders, Lewis and Thornhill, 2019).

3.1.2 Epistemology: Subjectivism

As individuals are going to be questioned subjectivism as an approach offers distinct advantages in understanding perspectives and interpretations. As the study is investigating the individual's relationship with technology acceptance, subjectivism offers flexibility in the questioning to enable further exploration of thoughts and comments and is useful for exploring social reality (Saunders, Lewis and Thornhill, 2019).

3.1.3 Research Philosophy: Interpretivism

In interpreting data which has been recovered in this manner suggests a interpretivist perspective as reasoning will be applied developed from the literature review to interpret the themes and outcomes (Saunders, Lewis and Thornhill, 2019, p.148). The philosophy is therefore interpretivism as the social construct being language and shared meanings will be used to access reality (Myers, 2020).

3.1.4 Research Approach: Inductive

As data will be collected which will be based on the perspective and observation of the person involved with technology acceptance, the theories presented will be as a result of the observations (Bernard, 2011).

3.1.5 Research Strategy: Narrative Inquiry

As individuals will be telling their lived experiences this will come in the form of a personal lived story. This narrative will be investigated to understand the results and alignment using a data coding structure.

3.1.6 Research Choice: Mono Method (Qualitative)

As the application of the determinants in different contexts is not always applicable and the rail sector in the UK has not been identified in the literature pool, the data is considered as nascent and therefore suits a qualitative methodology (Edmondson and Mcmanus, 2007, p.1160). Being nascent, there is a natural alignment with inductive research where data is provided through qualitative data. The reason this has been chosen is because it is a method which is most likely to result in knowledge contribution due to the ability to explore social dynamics and undercover perspectives and personal interpretations as it allows and enables ongoing open discussion triggered by the initial response (Saunders, Lewis and Thornhill, 2019). Qualitative methodology is appropriate to apply when the status of the theory development within the unique context is nascent therefore requiring in particular to apply context specific understanding and flexibility data

acquisition to enable an adaptability in the data gathering process (Saunders, Lewis and Thornhill, 2019). Extracted literature has suggested that technology acceptance within the railway sector has had limited exploration in social science then this is a suitable method to apply.

Qualitative methodology for data also aligns with what has been typically used within the extracted literature. 68% of the research reviewed uses this method of data capture in numerous different contexts suggesting the research is recognised within this field of literature. Although this would not force the decision, those using the research would be familiar with the style and approach taken to aid understanding.

3.1.7 Research Time Horizon: Cross Sectional

As the data collection will be undertaken at a specific time, the time horizon will be cross sectional. Cross sectional time horizons involve the examination of individuals (unit of measure) to draw conclusions about the perspectives of the population. An alternative approach may be a longitudinal study however this would have to take a perspective of how things change over time and without a basis to observe from which would be consistent this would not present a credible or consistent data set to investigate. (Work, 2015)

3.1.8 Research Techniques and Procedures [Data Collection] (Semi-Structured Interviews)]

The data has been captured by semi structured questionnaire; this is asking questions regarding the perspective of the interviewer. Semi structured interviews have been used as they offer a level of flexibility in the discussion, provide in depth exploration in to the topic being asked and provide a participant centred approach when the context is unique to the individual observing the phenomenon (Saunders, Lewis and Thornhill, 2019), The interviewer will be encouraged to explain what they have seen and have experienced in relation to the phenomenon which will be an event from history. This means that their perspective will be built around their memory and therefore may be distorted due to a memory being multi-layered perspective made up of senses and direct memories (Saunders, Lewis and Thornhill, 2019, p.147).

Data collected from the empirical element of the study will then be compared back to the literature which has been examined with the aim to identify where knowledge has been created, refuted or added to.

To enable the qualitative study to record as much valuable data as possible, semi structured interviews will be used allowing follow on questions to take place. This type of narrative enquiry works well to encourage further information enabling thematic identification and the building of constructs. Working well with inductive theory, qualitative method using semi-structured narrative enquiry aligns well to identifying patterns from the information (Blaikie, 2007; Edmondson and McManus, 2007, p.1170; Saunders, Lewis and Thornhill, 2019).

3.1.9 Alternatives to the philosophical approach

Realism was identified as an appropriate ontological approach for the study due to the novelty of the research taking place meaning that a robust data sample was not readily available (Saunders, Lewis and Thornhill, 2019). To create the data the reliance on personal responses would be the fundamental in this case. There are alternatives such as idealism which were considered. Idealism is the idea that the true reality is constructed by the individual, based on the idea that humans create reality (Blaikie, 2007). As in the case of the study the intent is to look in to the projects which have taken place, and to gain the perspective of those who were involved the study as to what affected the outcome. The responses collected is the perspective of those witnessing the project take place meaning that idealism is not an appropriate ontological view.

The consideration for the methodology concerning qualitative data collection was considered as whether it could be qualitative data collection using a longitudinal study however this proposal was discounted as many of the projects last beyond the period for the research, so it would mean the sample contained both recently started and finished projects with few if any within the time span of the study. This elongation of data collection could not be guaranteed to satisfy the research questions and therefore may result in limited data collected.

Quantitative data methodology was also a consideration rather than qualitative, an initial search of the data showed there to be some examples where this methodology was used but these tended to be in industry where there was already evidence that TAM as an example had been considered such as the IT industry (Leonard, De Kock and Bam, 2019; Mergel, 2018) and so there was a base level of understanding across a number of companies which could generate the level of data to find correlation, or not. In the case of the rail industry, the application of TAM is novel and so qualitative has been used.

3.2 Data Collection, information, destruction, and processing

As the data being collected will be personal, opinion based and contain specific even personal details the collection process protected the anonymity of the providers and also held the data in a structured format meaning that it can be recalled as an when it was required to be interrogated.

All data recorded is stored on a protected and password protected folder stored on “OneDrive”. The folder and its contents will only be known to the Researcher.

Data has been recorded via Microsoft products such as Excel, Teams (voice and video recording) and Sound recording software on mobile devices which has been uploaded to a secure OneDrive (Cloud computing compliant with EU Directive Regulation 2018/1725).

Throughout the information gathering phase, ongoing consideration of the information received will be undertaken to make sure that it is aligning with the research question. This will happen after each interview but to make sure that the information gathered is appropriate. At these key times, some of the information may be played back to those taking part in the interviews and the Supervisors to gain feedback on both the question process and the validity of the findings.

To protect the integrity of the data collected, the original video recordings and transcriptions from the interviews will also be retained to make sure there is backup if there is an issue with retention or corruption. Due to the size, these will remain in a cloud storage location but will be separate to the transcripts which have been coded but still only accessible to the researcher.

On completion of the research, the original data associated with the semi structured interviews will be deleted. This will include the backup which is remote to the researcher and kept on a secure OneDrive which has been confirmed with the corporate IT function.

In choosing what data will be collected through a semi structured interview process, it is important to make sure that those who are being invited to take part will be familiar with technology acceptance and have a basic understanding of the application within the UK Railway. Those being interviewed also need to reflect both the business and ideally have a level of influence for technology acceptance. There are two reasons for this influence to be a considered factor;

- *If people understand technology acceptance in the UK Railway but have no influence over how it can be successfully accepted then the value of their involvement is questionable, and their perspectives may only be historic and not relevant.*
- *To enable an improvement in technology acceptance, it is likely that simply by increasing the understanding of the topic will improve the ability to apply what has been found through literature.*

Semi structured interviews were undertaken recording the verbatim commentary which was mapped against the outcomes of the SLR. This mapping or coding was undertaken following the proposed approach by Saldana (2021) that allows descriptive findings to be relatively easy to be processed.

Data collected will be from a nascent perspective, verbatim commentary maybe misleading if the interviewee does not understand either the question or the specifics of technology acceptance. To prevent this, pilot interviews have been undertaken to improve the chance of a level of consistency in those answering to enable a level of thematic alignment. Pilot interviews enabled amendments to the question sets to improve the quality of the data collection. The development of the question set led to succinct and detailed responses which contained relevant information.

Pilot testing was deemed as robust, it identified ambiguities and where additional information and clarification were required as evidenced by the fact that clarification questions did not arise during the interviews even at different organisational levels. The pilot testing also demonstrated that for the first pilot, there were considerable secondary questions which aided the understanding, once pilot 2 had been undertaken with considerable updates to the questionnaire and introduction, there were considerably less follow up questions meaning the questionnaire was more effective. Once the interview had concluded and the transcribed text was saved, it was shared with the interviewee who had an opportunity to amend any of the commentary. Once complete, this was placed into the secure folder with the video.

As well as the video and transcription, a set of handwritten notes was also compiled which would allow cross checking of understanding to take place after the session had concluded. A single password-controlled file then held all the data together organised by the naming taxonomy to prevent inadvertent access.

For noting within the study only, one interviewee did undertake a major re-write of the transcript after having considered the discussion. Although this was not anticipated, and was unique, this was within the agreement of the interviewers where those who provided the information were able to amend or remove information at any time. The interviewee had suggested that after spending time to think about the questioning and response, they wanted to change their responses to make sure they were clear and aligned to business policy.

The data collected in this research will remain anonymous and kept for record by the Researcher until the research is concluded. Conclusion of the research is when the thesis has been successfully defended.

If specific quotations are to be used these will be requested in writing for support and agreement if information is used which could articulate the linkage back to the individual.

3.3 Semi Structured Interviews

From information recovered through the SLR process, qualitative studies had on average between 28 and 41 respondents with the median number being 32 responses, this has been used as the target number to plan interviews. Consideration has been given to make sure the spread of interviews for each role or level within the organisation is not so wide that the results do not align, where the responses are diluted by spreading the interviews across too many different functions and levels (Mason, 2010).

The intention is to choose a cross section, which is large enough to entice suitable responses, but not so large that it may bring with it diminishing returns, the intention is to reach theoretical saturation of the data and commonality but not where it becomes simply capturing more numbers, Mason, (2010) suggested that around 30 is a good sample size to plan to achieve.

To retain some level of consistency in the interviews, the focus has been on 4 organisational levels. The levels are designated by the following in Table 10 and Figure 20,

Planned Number of Respondents	Level	Responsibility
2	Executive Grade	from the CEO to Managing Director level

6	Leadership	those directors overseeing the business functions
8	Senior Management	those leading programmes and groups of projects and activities
16	Project Leaders	those within the teams who are responsible for the delivery of projects and change.

Table 10 - Proposed interviewees for semi structured questionnaires

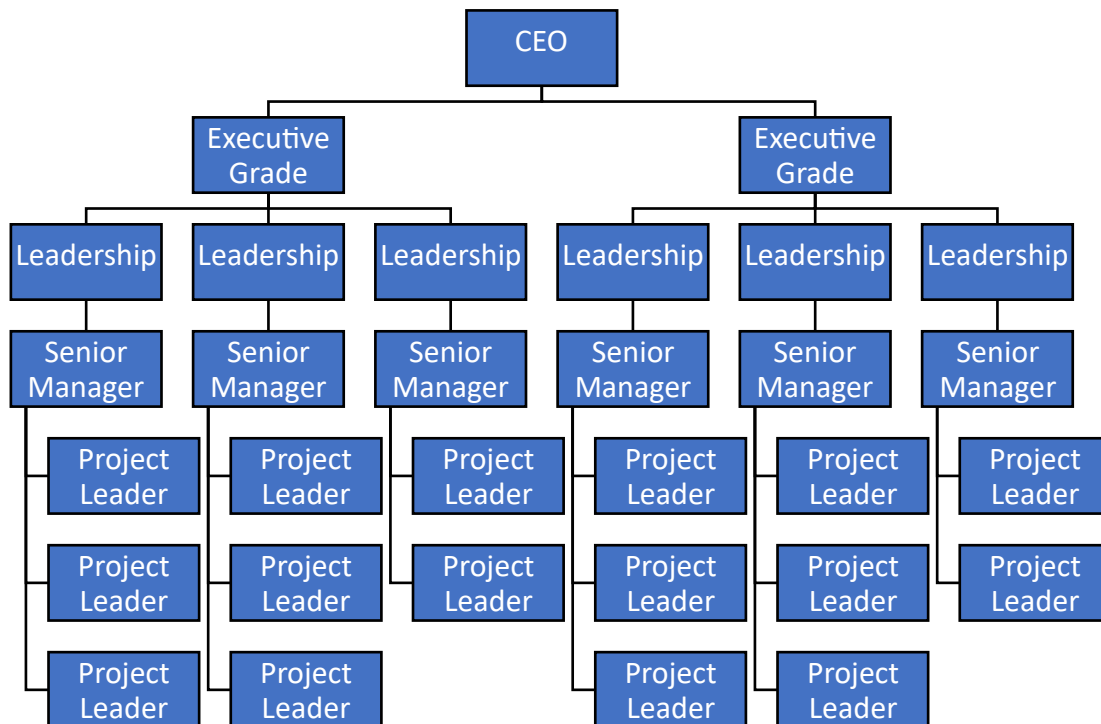


Figure 20 - Functional organogram of interviewees showing breadth and depth across the organisation

Proportional representation is appropriate partly since it is time efficient and a representation of the whole population which is over 4000-line managers. Of the 4000, a large number would not have been involved in technology acceptance projects but also many would not have direct influence of changing the approaches of large teams. The choice of which senior leads were involved did assume that there would be a level of

familiarity with the topic, however a "killer question" was included in all interviews to make sure there was experience and understanding of the topic of technology acceptance to enable the gathering of robust and applicable data. To diversify those giving evidence, Figure 20 presents the target number of respondents as a minimum with the volume of respondents in a common ratio to the population, for example 2 of 7 Executive leads, 6 of 49 Leaders creates a fair spread in each level of the business.

The sampling strategy employed for data collection is purposeful and variation sampling (Moser, A. Korstjens, 2017). Specific roles were chosen because of their influence in the organisation but those in the roles were chosen at random to diversify the data collected. It has been mentioned in the question set that the role within the business is important due to the influence it yields but also the more senior the more likely to have experienced technology acceptance at an additional level within a business. The reason for a variation approach is to increase the types of projects to broaden the opportunity to identify commonalities and themes from the projects in terms of the findings. With the context being novel, over constraining in the data collection could limit the ability to satisfy the research aims and objectives.

A one-hour interview was organised with each respondent, they were informed that the interview is in relation to technology acceptance within the railway and that they were asked to engage in a short number of questions aimed to seek their experience and understanding. The questionnaire focused on primary and follow up questions aiming to understand fundamentals about their role and understanding of technology acceptance then leading on to discussion around the research questions in turn.

Each interviewee was asked to review their commentary after the interview was concluded for validation.

The format of the questionnaire followed a set of primary and follow up questions. The question set is based on demographics and then moved on to specific content-based questions.

There are four initial questions which are required to be answered. Data presented has been used to explain who is contributing what to the report, phrases or quotations will be inserted in the thesis using the role title as a descriptor. This is intended to add a richness to the report and will enable the respondent to remain anonymous. The primary questions are based on the demographics of the respondent with an aim to gather details to support theme identification. The interviewee was asked to focus on a single project

they have been involved with which they can discuss to enable a consistent view. The follow-on questions were then based around the content of the technology-based project to enable a more detailed and in-depth exploration of the information to generate data to enable a response to the research questions.

There are two purposes to asking the question on the level of the role within the business. The first was used to support the impact assessment as to where influence can be leveraged. This was used to help to inform the business where to focus effort to deliver a level of improvement. The second is to help to understand how the business influence is aligned to the organizational level determinants proposed in the SLR.

To commence the interview, the respondent had to confirm that they consent with the interview and that they support audio transcription. This is to aid detailed information to be captured and allow the interview to flow. In doing so, they were asked 3 initial questions which are aimed to explore the background of the respondent regarding their professional career. Along with the three mandatory questions, semi-structured questions were then used to explore the two research questions as shown in Appendix C and D.

Within the primary question section, demographic information is collected:

- **the length of time of service** of the interviewer. *In the discussion, range and median of the responses will be given. Time served does not automatically determine experience with technology acceptance, but it does articulate exposure to technological change within the railway context and therefore will have a bearing on determinants such as Leadership Knowledge. The question regarding time spent in the role cannot serve to answer a question of Leadership Knowledge on its own, and specifically not the amount of experience when working with technology acceptance.*
- **role type.** *This is used to understand if there are experiential comparators between individuals in similar positions within the organisation relating to determinants and the understanding as to what contributes to a successful outcome.*
- **role grade.** *This will be used to understand the positional level within the organisation to compare if there are similarities and differences between those at a given hierarchy even with different role types.*

Following on from the demographic questions, content-based questions are posed which make up the remainder of the interviews.

Have you been involved with any projects which delivered a technological change or required a technology change as part of the project? – This question is not only for validation, but also intended to encourage the respondent to think about a technology-based project which has driven or intended to drive change. The response is a yes or no, and if the answer is no, then the discussion can explore if this is because there is a lack of understanding as to what technology is in the context of the study to enable progression of the interviews.

The core questions for the interviews were developed to be inline with the research questions specifically. The aim of this is to create the opportunity for alignment between the SLR and Empirical findings, aiding the coding process. Question 2, 3, 4 and 5 are the fundamental questions where data was captured that helped to answer the research questions. These three questions specifically required the respondent to consider technology acceptance from their perspective, had it been achieved and what were the challenges which relate to the determinants and success criteria. When considering technology acceptance activity, this typically was delivered as part of a project, a conscious and decisive activity to manage change within a given context, within the railway context these activities are typically bundled into a specific project (Regulator, 2023). Questions 1 and 6 were aimed to lead in to the questions and allow the respondent to firstly consider the project and explain the requirements to enable them to recall the memories and finally to reflect on the outcomes. Reflecting on the outcomes is aimed to allow the respondent time to reply the discussion with the aim to expand on areas that could have been improved to give an opportunity for further determinants to be identified. The core purpose of the coding is to align the determinants as well as the success criteria with the literature outcomes and findings.

As all respondents are within the Railway within the Public Sector, responses will be given within this context;

Research Question 1: What are the determinants of technology acceptance within the UK Public Rail Sector?

1. Describe a project which you have been associated with that have enabled technological change?

a. Follow up question: Can you explain your role in relation to the project? – The aim is to understand the level of direct association, examples being the leader of the project itself, leader of the team or receiver of the outcome. Each respondent is likely to have a different perspective on what is important for success.

2. What were the challenges in delivering the technology? – Aimed to understand the determinants which influence technology acceptance.

a. Can you please expand on each? – further information will be given to aid the understanding of the determinant supporting alignment to the definitions given in the SLR.

3. Was technology accepted as planned? - Likely to be yes or no, with the aim to follow on to understand if the respondent understands the reasons why this was the case with an aim to help to understand what could have been changed. This question is aimed to inform the recommendations of the study.

a. Follow up: How did you overcome challenges? – as a follow on question, a deeper discussion into the reasoning to help articulate and focus on those core items which could have made a considered difference in to the technology being accepted.

b. Follow up: How did you maximise opportunities as you progressed? – The aim of this is to start to consider and walk towards success and the opportunities the technology acceptance enabled.

Research Question 2: What are the factors of successful technology acceptance within the UK Public Sector Rail Industry?

4. How did you measure if the project was a success? – To understand success and what it means is a straight question as the factors of it will enable a better understanding of the intention and output.

5. How could the chance of success be increased if the project was run again? – Again, further digging to trying to gain information from the respondent about the true challenges of the project and how success can be maximised to help with the recommendations and also the determinants which offer the highest opportunity for success.

6. What do you believe are the most important considerations when starting a project to make sure the acceptance of technology is successful? - The final question is

aimed to enable the respondent to reflect on the discussion and consider what could be the focus to enable a successful outcome. The aim of this is to articulate further determinants which could have had more of an impact to achieve success.

For each of the questions the responses have been analysed to align them to the findings from the reviewed literature. An example table is given below of a typical data structure in table 11, due to the size of the final table this has been stored digitally and extracted elements which have been analysed have been used in the study.

							Code 1	Technology Acceptance Model				
							Code 2	TAM 2	TAM 2	TAM2	TAM2	TAM 2
							Proceeding Model			UTAUT (Kuciapski, 2017)	UTAUT (Kuciapski, 2017)	
								1	2	3	4	5
Questionnaire Number	Code	Confirmation of ethics	Confirmation of Project	Project Title	Time in Role	Role Type	Role Name	Perceived Usefulness (Davis, 1985)	Perceived Ease of Use (Davis, 1985)	Social Influences (Consumer/Peer Pressure) (Davis, 1985)	Facilitating conditions (Davis, 1985)	Individual Difference (Davis, 1985)
1	1110220900	Yes	Yes		2	B2	Business Manager			1	1	
2	1110221330	Yes	Yes		6	B3	Senior Operations Manager	1	1	1		
3	812221246	Yes	Yes		2	Executive Director	Managing Director, Route	1	1	1	1	
4	1212221100	Yes	Yes		3	B1	Health and Safety Director	1	1	1		

Table 11 - Empirical study coding table

By using the determinants identified from the systematic literature review a similar approach has been taken to the interview data, identifying the determinants from each of the questions and populating the data extraction sheets.

As part of the interview process, 2 interviewees took part in an initial trial. One was retained and is part of the data, 1 has not been included because the interview included a considerable amount of discussion around the topic which would have affected the ability to offer an unbiased level of information due to the level of learning and understanding which was required.

The first interview which was piloted took place with a Cranfield University School of Management alumni who works in the UK Rail sector. This interview discussed the positioning of the research and purpose in some detail to set the scene for the interview and then went through a wide range of questions. The aim was to determine if there was a level of understanding without having any awareness of what was going to be asked. This data, as it was partially answers and partially discussion around purpose was not included in the data set. The output of the first pilot led to definitions being included in the interview.

The second pilot, which was a timed session, walked through the questions as they were intended to be asked, amended from the first pilot. There needed to be some slight amendment to the wording especially around describing what technology acceptance “is” and “is not” but this did not change the principle of what was being asked, only the context of the response.

3.4 Data coding

Once data was captured, the data was reviewed for themes, outcomes against the research questions as well as verbatim commentary which can help to offer alignment against what has been suggested by the literature review. To support the development of themes and ideas, coding will be utilised and applied to the data. The themes will be what has been gathered from the data in the context of the UK Railway.

The method of coding chosen is commonly used in qualitative data analysis and can be done in a manual or automated way using software. For the purposes of this research, a method of coding provided by Saldana (2021) has been applied to the data because this method is widely used in social sciences due to its ability to categorise rich data sets into formats which then permit review, analysis and synthesis. Saldana describes the

opportunities for coding as well as the limitations, such as the fact that coding is “often seen as counting only” and not representative of the discussion which takes place (2021, p.22) which is why verbatim comments are also being used throughout the descriptive findings.

A process has been undertaken to identify key words and statements which can be collated and grouped to determine common factors from the interview data. Each one of these statements will be marked in the text and noted. The ideas will emerge from the discussion rather than being distinct in the text because those responding may not be aware of the literature or research which is in existence, typical of qualitative studies where the research needs to synthesise the information presented. For example, within the systematic literature review, Davis describes a user having the intention to use the technology (1989), others describe this as a technological choice (Cassetta et al., 2020; Rogers, 2020). It is expected that as the interviews continue the descriptive language and synonyms will become more consistent as to how they should be categorised.

A determinant being presented by the interviewee does not suggest a positive or negative influence or significance, neither does the quantity of common responses relating to individual determinants. For example leadership attitude could be one which accelerates technology acceptance or one which stifles it (Darko et al., 2018) and could be discussed many times. This is the reason why verbatim comments will need to be used to understand the preference and will also give a richness to the analysis and give a real association to those who will receive the recommendations, hopefully improving the chances of recommendations being implemented.

Coding does not provide all the answers and outcomes needed, as a nascent research area, there may be challenges with the language and its alignment to what is documented within the literature. Examples of this have been seen in the literature where different authors refer to very similar determinants in different ways as an example, the effects of marketing versus the use of advertisement is a real simplistic comparison to demonstrate why coding can be fraught (Chu et al., 2019; Kapoor and Kumar, 2019). As there is a limit to the literature relating to the UK Railway, it is likely that the language used in the interviews will not be in line with the literature and so may have to be interpreted to some extent which is a role of the researcher to develop an understanding and synthesis of what has been shared, and as the researcher is from the industry a level of understanding should help with industry context translation. As an example, the pilot interview presented the idea of a “lack of trust” impacting technology

acceptance. An example showing more internal organisational complexity is shown across two interview responses; “A complex organisation” (Functional Director-2504231600) directly aligns to organisational complexity, but also implicitly “had to set up many stakeholder groups to get a collective buy in to the goal” (B1-3001231600) suggests same, organisational complexity but are different perspectives.

The data collection method has been approved by the school at Cranfield university in line with the ethics policy and all data will be retained in line with the General Data Protection Regulations (Gov.uk, 2018). The “code to theory” method will be applied in this empirical study (Saldana, 2021, p.18). The coding will take the raw interview data and map to determinant and then on to the framework. The reason for doing this it to bring structure to the thematic findings so that they can be accurately compared back to the SLR extracted data. With the research being nascent, there is no guarantee that the respondents will be aware of the different determinants or models and therefore the language or response may be unique to their scenario. Being able to bring back commentary which aligns to a defined and prescribed position will help with constructing themes and better descriptive findings being produced. The coding structure for research question 1 is shown in Table 12 which was created based on the information provided throughout the literature review, this is known as A-priori coding as is used to test the data using what was found from theory (Bingham, 2022).

Code 1	Code 2	Determinant description and reference
1— Technology Acceptance Model	1	Perceived Usefulness (Davis, 1985)
	2	Perceived Ease of Use (Davis, 1985)
	3	Social Influences (Consumer/Peer Pressure) (Davis, 1985)
	4	Facilitating conditions (Davis, 1985)
	5	Individual Difference (Davis, 1985)
2— Diffusion of Innovation	6	Leaders — Attitudes towards technology (Rogers, 1995)
	7	Internal Characterisation— Centralisation (Rogers, 1995)
	8	Internal Characterisation— Complexity (Rogers, 1995)
	9	Internal Characterisation— Formalization (Rogers, 1995)
	10	Internal Characterisation— Interconnectedness (Rogers, 1995)
	11	Internal Characterisation— Size & Slack (Capacity) (Rogers, 1995)
	12	External Characterisation— System openness (Rogers, 1995)

	13	Procurement Systems — Added to DOI (Rose, T. 2019)
3— Iacovou Model	14	Financial Resource (Iacovou, 1995)
	15	Information Technology Resources (Iacovou, 1995)
	16	Perceived benefits of innovation (Iacovou, 1995)
	17	Competitive Pressures (Iacovou, 1995)
	18	Parent or Partner Company Pressure (Iacovou, 1995)
4— UTAUT2	19	Effort expectancy (Kuciapski, 2017)
	20	Performance Expectance (Kuciapski, 2017)
	21	Relatively usability (Kuciapski, 2017)
	22	User autonomy (Kuciapski, 2017)
5— Technology Organisation Environment	23	External task environment— Industry characteristics and market structure (Tornatsky L.G, 1990)
	24	External task environment— Technology support infrastructure (Tornatsky L.G, 1990)
	25	External task environment— Government regulation (Tornatsky L.G, 1990)
	26	Organisation— Formal and informal linking structures (Tornatsky L.G, 1990)
	27	Organisation - Communication processes (Tornatsky L.G, 1990)
	28	Technology— Availability (Tornatsky L.G, 1990)
	29	Technology— Characteristics (Tornatsky L.G, 1990)
6— Independent	30	Geography (accessibility) (Faizura, H. 2018)
	31	Governance initiatives— Enabling (Read et al, 2016)
	32	Organisational Incentive programmes such as Lean Management (Rose, T. 2019)
	33	Organisational Demand/ Imperative (Adner, 2002)
	34	Corporate responsibility (Ghbakhlo, M. 2020)
	35	Opportunity for experimentation (Mergel, I. 2018)
	36	Leadership Legitimacy (Damanpour, 2006)
	37	Leadership attitude (Oorschot, 2020)
	38	Leadership knowledge (Oorschot, 2020)
	39	Demographics (Cale, D. 2017)
7— New	40	New items which will be discussed for their potential inclusion

Table 12 - Empirical Study coding details for RQ1

Where interviewees raised determinants which could not be associated with the codes listed, it was recorded as potentially a new determinant.

In response to Research Question 2, the information will be collated using the same format as the determinants but using the 4 factors of success identified in the SLR. The aim here is to understand if the projects were reported as successful and how success was determined. Data from questions associated with success will be recorded in a format similar to that shown in Table 13.

Questionnaire Number	Code	Grade	Confirmation of ethics	Confirmation of Project	Project Title	Time in Role	Role Type	Role Name	Individual choice	Measurable quantification	Market share / increase uptake	Aspirational
1	1110 2209 00	B2- 1110220900	Y es	Y es	MRL Lifts	2. 5	B2	Business Manager		1	1	
2	1110 2213 30	B3- 1110221330	Y es	Y es	Operational Change to add Dust Suppression to Vehicles	6	B3	Senior Operations Manager	1	1		
3	8122 2124 6	Executive Director- 812221246	Y es	Y es	Electric Vehicle Introduction	2	Executiv e Director	Managing Director, Route Services			1	

Table 13 - Empirical study coding example for RQ2

Data recorded in table 13 can be cross referenced with the determinants as well as against the information from the literature review to demonstrate if there are core or consistent methods to determine success within the railway. Similarly, to the first set of evidence, the “1” denotes where a specific comment will be placed in the cell showing alignment to the themes drawn out of the systematic literature review.

Coding took several passes through the rich text as themes emerge and develop which will grow and change the categories and themes which is normal. The first pass through which will happen as data is collected, will identify the subcategories and start to build categories which can be aligned to the systematic literature review. As the second pass

and onward occurs, the categories will develop and can be aligned with the core themes which will be used to respond to the research questions. Figure 21 shows an example of the coding in a root and branch visual suggesting themes, sub themes, categories, and subcategories.

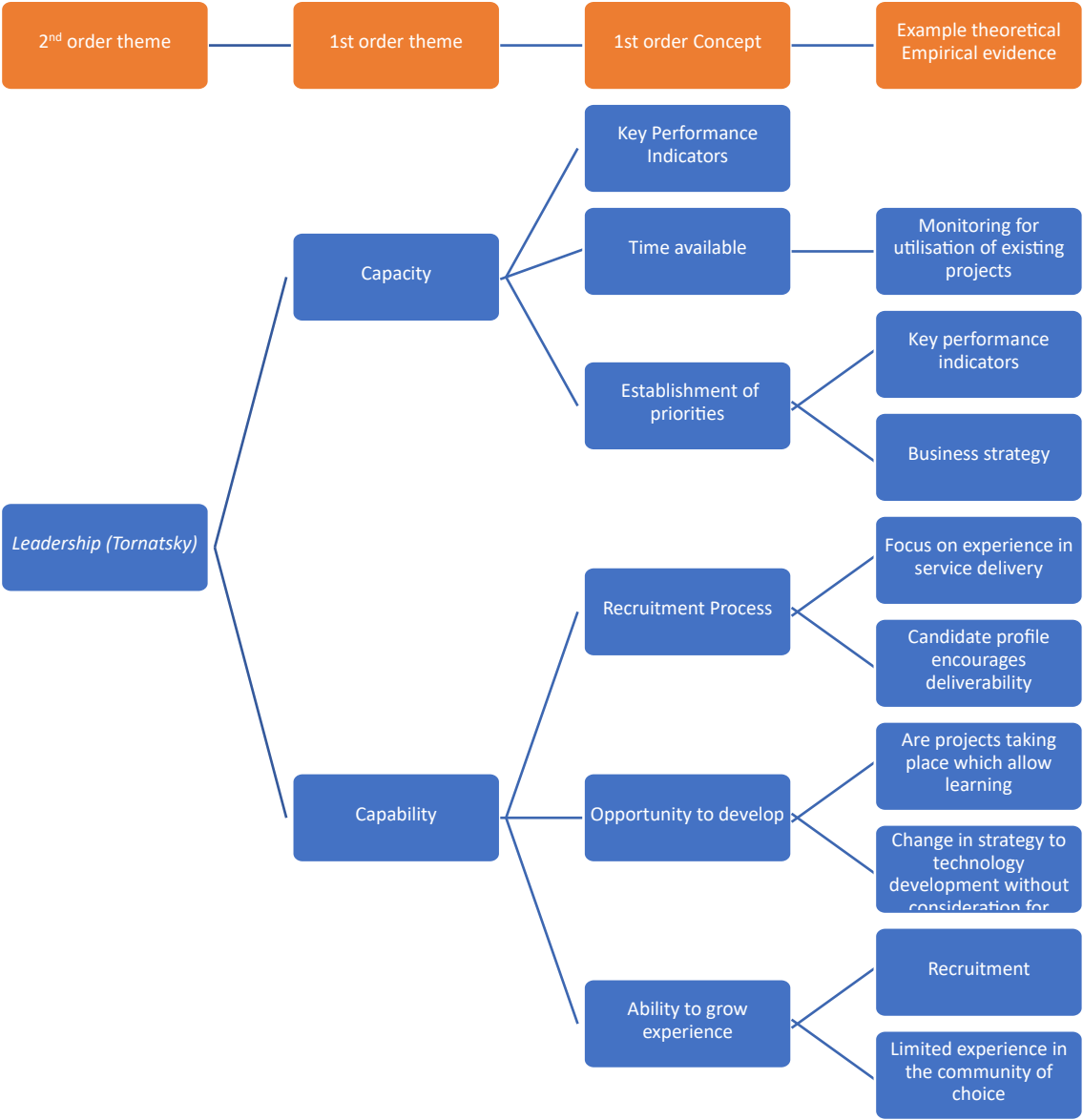


Figure 21 - Example break down of categories with theoretical responses

The coding took 2 passes to enable consistent data to be used in the data tables;

First pass: - Not all determinants were aligned to theories and models, this meant that some determinants could not be aligned to a common theory and therefore one another, in effect every code was new and unique and so the coding system needed to be updated

to include the respective framework also. This first pass identified many determinants but did not associate them to the existing frameworks and models presented by the literature. Instead, the data was aligned to the coding structure given in Table 11 and 12.

Second pass: - Although the verbatim comments were now associated with the determinants, frameworks and models, the coding structure did not show a single alignment between different models meaning that there could potentially be multiple models but singular determinants. This created an overly complex format making it impossible to interpret. Aligning common determinants such as Social Influences (Davis, 1989; Kuciapski, 2017) resolved this issue, this means that rather than one comment being aligned to 2 frameworks of which the determinant is the same, the coding structure aligned the frameworks behind the common determinant.

A total of 663 RQ1 entries and 88 RQ2 entries have been made into the table which will be used to identify themes from the data, data was able to be consistently aligned to a determinant, framework and measure of success.

3.5 Research Ethics

Cranfield University ethics procedure has been followed in its entirety which is compliant to the General Data Protection Rules (Gov, 2018). The funding organization has supported the use of the research being made open to research literature and this will be confirmed prior to completion and submission of the thesis.

The Researcher and author of the study is familiar with the Cranfield Integrity Policy Statement and Cranfield University Ethics Policy as well as undertaking the online and in class sessions regarding ethical research practices. This project specifically has approval through the Cranfield CURES process.

For the research, ethical considerations will be focused on the company, the individuals involved and how the data is treated.

There are no anticipated ethical issues at an organisational level as it was prior agreed that any research found could be used to support academic knowledge building and included to inform policy and practise. Also being a public company, unless there are sensitive commercial elements or items which fall under the GDPR regulations, the information would be open to the public domain which will support the use of the research in research literature.

To further support the ability to retain anonymity across those being interviewed, the research is looking at the considerations or themes as groupings rather than at an individual level due to the nature of the research being undertaken. These themes and groupings are presented across the research and therefore it is not anticipated that there will be emergent themes which become an ethical issue.

Individuals have had the opportunity to review their interview notes prior to being used in the study. In doing this, they will have the chance to change or provide clarification and so support the information given. Each interviewee was also explicitly advised they have given informed consent and that they had the right to withdraw at any time including the confidentiality requirements being applied.

No individual names will be used in the final report, instead the level within the organisation will be used which is included within this document. Therefore, every individual will be anonymous to those reading the final thesis.

Where there are specific quotes used which can associate back to the individual, permission has been individually requested. These individual comments are there to add a richness to the reporting.

There is a risk that the data created through semi structured interviews, being qualitative, may create its own power imbalance between the interviewer and the interviewee. The Researcher and author is a director within the company and so although it is unlikely to cause an impact on those more senior or at a peer level, those within the team may answer with responses – that people want to hear. To try and limit this natural bias, the majority of those chosen to take part in the research will be from other teams and not working directly on the same projects as the Researcher.

4 Chapter 4: Thematic Findings

4.1 Respondents Profile

As part of the narrative enquiry process, 49 individuals were invited to undertake an interview and 41 sets of data were included in the analysis. Table 14 includes all 41 data sets derived from each of the 41 interviews presenting the project they discussed, time in role and the reference code used for inclusion within the text in chronological order. The interviewees represent a cross section of the business at various levels who influence technology acceptance. To maximise the alignment between influence, time and resource availability for the interviews, the intention was to aim to interview more respondents in senior roles due to their level of influence. Turnout was much higher than expected with many more senior leaders wishing to provide information than anticipated and table 14 shows the respondents, their time in role and the project they discussed.

Respondent No	Reference Code	Project Title	Time in Role	Organisational Level	Role Name	Technological application
R1	B2-1110220900	MRL Lifts	2.5	B2	Business Manager	The change from of technology from a known organisation product to one which was industry leading
R2	B3-1110221330	Operational Change to add Dust Suppression to Vehicles	6	B3	Senior Operations Manager	Installation of water curtains to control the dust levels at a work location
R3	Executive Director- 812221246	Electric Vehicle Introduction	2	Executive Director	Managing Director, Route Services	Change over from diesel vehicles to electric vehicles across a 40,000 organisation
R4	B1-1212221100	Eastleigh Reinstatement	3	B1	Health and Safety Director	The changing of manufacturing to include safety by design and then reopening of the work place
R5	B1-1212221200	Software introduction - Management Information	1	B1	Human Resources Director	Implementation of software to manage employee data across an organisation

R6	B1-1212221300	Software introduction - Insight	2	B1	Finance Director	Implementation of a data supported decision tool for front line workers.
R7	Functional Director-1312220800	Software introduction - Civils Structures Asset Management Systems	6	Functional Director	Commercial and Procurement Director	Implementation of a data supported decision tool for front line workers.
R8	Functional Director-1312221530	Electric Vehicle Introduction	5	Functional Director	Supply Chain Operations Director	Change over from diesel vehicles to electric vehicles across a 40,000 organisation
R9	B1-2012220900	Collision Avoidance	3	B1	Construction Director	Fitment of a laser guiding system to identify objects and halt progress of a machine
R10	Functional Director-1001230900	Software introduction - Electronic Signalling Faults	6	Functional Director	Chief Information Technology Officer	Implementation of a data supported decision tool for front line workers
R11	Executive Director-1301231500	Hydrogen Trains	4	Executive Director	Chief Safety and Engineering Director	Change of fuelling source from diesel to hydrogen for railway trains
R12	B1-1601231000	Remote power isolation (22kV)	6	B1	Chief Design Engineer	The ability to remotely shut off power circuits without being directly present on site
R13	B1-1601231130	Flow Bridge	5	B1	Delivery Director	Introduction of a fibre reinforced polymer bridge rather than steel
R14	B1-1601231330	Dynamic Track Stabilisation introduction	4	B1	Engineering Delivery Director	Introducing a new mechanical method to settle track using vibration banks
R15	B1-1701230900	400KVA Power Relay Introduction	5	B1	Director of Strategy	New technology which interfaces between the national grid and railway power providing better resilience
R16	B2-2001231100	Stone blowers	16	B2	Principal Fleet Engineer	New trains which stabilise the track. This is a version 2 of what is in existence and have been upgraded to

						provide technical automation
R17	Executive Director-2501231430	Software Introduction - Asset Management Software	4	Executive Director	Chief Executive Officer	Implementation of software to manage asset data across an organisation
R18	B1-2701231330	Use of forward-facing camera video	4	B1	Director of Strategy	Installation and recording of live data from the front of a train cab and the human factor interfaces
R19	B1-2701231500	Miller introduction	7	B1	Delivery Director	New train and process to remove rail steel with milling rather than grinding to prolong the life of the rail head
R20	B1-3001231600	Condition Based Monitoring	3	B1	Engineering Delivery Director	Fitment of measuring systems to detect failure modes prior to occurrence and a change in maintenance philosophy
R21	Executive Director-302231000	Generalisation	6	Executive Director	Chief Finance Office	The application of new technology to achieve increase manufacturing yield of a given production process
R22	B1-2702231104	Acoustic Monitoring	9	B1	Strategy Director	Using technology to detect flaws using noise and the challenges around accepting a non contact solution.
R23	B3-2702231302	Safety gates on machinery	8	B3	Operations Manager	Installation electric switch out for the improvement of safe working
R24	Functional Director-170320231430	Forward Camera	4	Functional Director	Route Director	Installation and recording of live data from the front of a train cab and the human factor interfaces
R25	Executive Director-2203231300	Traffic Management System	5	Executive Director	Regional Managing Director	A simulation system to aid the planning of the railway and the associated trains

R26	Functional Director- 2203231500	Level Crossing signalling system	3	Functional Director	Director of Internal Audit	The upgrade of a detection system to identify persons on a railway crossing and halt the train service by remote
R27	B1-2803230930	Level Crossing signalling system	10	B1	Capital Delivery Director	The upgrade of a detection system to identify persons on a railway crossing and halt the train service by remote
R28	B1-3103230930	Class 153 Inspection Train	1	B1	Head of Research Strategy	A train which carries new technologies to inspect the railway and remove staff from the position of potential harm
R29	B2-3103231400	Software introduction - digital permits	5	B2	Head of Maintenance	New software to move from a paper solution to a digital form
R30	B2-604231000	Safety gates on machinery	3	B2	Principal Fleet Engineer	Installation electric switch out for the improvement of safe working
R31	Functional Director- 1704231000	Tubular Stretcher bar	3	Functional Director	Chief Engineer	The response to a railway incident and the change to a connector between a critical part of the railway tracks to prevent flexure
R32	B1-1704231300	Reliability centred maintenance	3	B1	Head of research delivery	Fitment of measuring systems to detect failure modes prior to occurrence and a change in maintenance philosophy
R33	Functional Director- 1804230904	Class 153 Inspection Train	3	Functional Director	Director of Engineering and Asset Management	A train which carries new technologies to inspect the railway and remove staff from the position of potential harm
R34	Functional Director- 1804231100	Reliability centred maintenance - Rail defect management system	5	Functional Director	Route Director	Fitment of measuring systems to detect failure modes prior to

						occurrence and a change in maintenance philosophy and the applicable change to the software systems which support
R35	Functional Director- 1804231600	Signalling System	4	Functional Director	Director of Engineering and Asset Management	Moving from analogue signal control to direct digital visibility within the train cab
R36	B1-2404231100	Bridges	4	B1	Capital Delivery Director	Introduction of a fibre reinforced polymer bridge rather than steel
R37	B2-2404231600	Bridges	6	B2	Principal Engineer	Introduction of a fibre reinforced polymer bridge rather than steel
R38	Functional Director- 2504231000	Digital Signalling	2	Functional Director	Director of Industry Transformation	Moving from analogue signal control to direct digital visibility within the train cab
R39	Functional Director- 2504231600	Railway relay	4	Functional Director	Director of Engineering and Asset Management	New technology which interfaces between the national grid and railway power providing better resilience
R40	Executive Director- 2804230930	Tactile paving	2.5	Executive Director	Lead, GBR Transition	Installation of self adhesive paving in stations rather than traditional concrete paving slabs
R41	Functional Director- 1205231400	Railway Decarbonisation	3	Functional Director	Chief Technology Officer	Reducing the carbon produced by the railway by changing technologies

Table 14 - Interview participants, project of interest and time in current role,

Roles are listed by job level within the organisation, i.e., Executive being at the top of the business and B3 being a frontline deliverer:

- *Executive Director – Company Director*
- *Functional Director – Business leader*
- *B1 – Head of business area*

- *B2 – Multi-team business leader*
- *B3 – single team/project business leader*

The unit of analysis for the empirical study is based on the individual. The reason for this is the data collection is based around each individual and their perspective of a project which is delivering change requiring a technological aspect. The 41 respondents shown in Table 14 have given a project each listing the successes and opportunities which relate to the determinants and factors for success. The unit of measure is common with a qualitative study where the respondents' responses drive a saturation in the data collected enabling themes to be produced to correlate to the extant research literature available. Furthermore, the requirement to only consider 1 project per respondent means that there is unlikely to be a confusing between projects and experiences blurring, this could mean there would be many more projects and influence of the results by those respondents who have had experience of more projects and therefore skew the results. Keeping the unit of analysis to one of respondent and therefore project will mean that gaps in the current application of the processes with the rail industry can be identified as well as opportunities for improvement.

4.2 Research Objective 1: Determinants

4.2.1 Common technology categories

The intent of providing common categories was aimed to help alignment of the themes and determinants so comparisons could be made within the railway context. Common technologies highlight immediate business priorities at a specific time. This also helps to offer comparative examples to the literature which may not be a part of the railway industry. For example if the introduction of a new bridge within the rail industry was common outside of the railway, examples of technology acceptance relating to new bridge technology in other industries could help understanding, learning and knowledge transfer. This would mean that the railway could learn from the examples used and vice versa. This would improve the potential impact of the thesis, and the direct application of the knowledge found. Although from the SLR, there was some similarity, the most common product being accepted was IT systems. The comparator proved that shared learning such as the application of TAM may benefit the railway if applied consistently.

As identified from the interviews and similar to the SLR articles, there are a number of common projects which have been identified as technology acceptance, the three most common types are;

6 respondents discussed Software introduction

R4, R6, R29, R17, R7, R10

4 respondents discussed Machinery Safety

R5, R9, R30, R23

3 respondents discussed Bridges

R13, R36, R37

Table 15 presents the subset of the results showing the most common projects raised in the interviews. The table also shows the number of determinants which were identified in each interview, the average number identified for each framework and the average per project category overall.

			First Order Theme	Second Order Theme - Framework									Aggregate Dimensions
Respondent	Project Name	Project Category	Sum of Determinant count by respondent										
				TAM	ISSM	DOI	Iacovou Model	UTAUT	TOE	Inde	Newly Proposed	Ave	
R4	Software introduction - Management Information	Software	9	2.3	2	3.7	2.3	2.2	3.0	2.7	1.5	2.5	
R6	Software introduction - Insight	Software	21										
R29	Software introduction - digital permitting	Software	18										
R17	Software Introduction - Asset Management	Software	21										
R7	Software introduction - Civils Structures Asset Management Systems	Software	20										
R10	Software introduction - Electronic Signalling Faults	Software	17										
R5	Eastleigh Reinstatement	Machinery Safety	13	2.5	3	1.8	2.3	1.3	1.8	1.5	2.5	1.9	
R9	Collision Avoidance	Machinery Safety	19										
R30	Safety gates on machinery	Machinery Safety	11										
R23	Safety gates on machinery	Machinery Safety	11										
R13	Pedestrian Bridges	Bridges	18	0.3	0	5.3	3.7	1.3	3.0	4.7	1.7	2.9	
R36	Pedestrian bridges	Bridges	21										
R37	Pedestrian bridges	bridges	21										

Table 15 - Common technology categories and the prevalence of the total number of determinants or success factors

Table 15 shows that the frameworks and determinants referenced for each project category are not common. The respondents from each interview articulate different

determinants for the same project categories. The second order theme is an normalised average for the model, this is aiming to show the prevalence from the collective respondents and Although there is not enough data to consider a quantitative assessment, it does highlight the themes which are discussed.

Table 15 shows a coloured representation of the average responses. This is aiming to normalise the responses, so it is clear to see which of the second order themes is more prevalent. This is being done to help to explore which of the theories might be most common within the industry. Table 15 shows, some projects have fundamental primary theories and determinants than what you would expect to see, for example it would be assumed to see that IT based projects such as software was the most prevalent with TAM but this is not the case and DOI is more prevalent. TAM is more prevalent with bridges, but this is not a typical project outcome which would be associated with TAM as it was develop predominantly around IT projects. Making a recommendation to use a specific theory based solely on the technological application would likely result in a failed recommendation and this table shows currently the theories are not being consistently applied across the business. This is also common that the determinants of theory are being applied in a consistent way even for similar project categories.

Table 15 also presents the comparative position between ISSM and TAM predominantly. We understand that the perceived ease of use and usefulness of technology have a direct relationship to success, but in the case of the 3 categories shown it can be seen that for bridges, the factors effecting success are simply not present. This is likely because the bridge has no real association with an individual, and is a product being delivered without a requirement for the employee to change what they are doing. However most intriguing is the fact that software introduction has less association with success than machinery safety projects. This is the opposite to what is expected as TAM is already closely associated with Software introduction and so it would have been expected to have a direct correlation, but this is not the case. Machinery Safety is more closely associated to TAM and the IS Success Model which is likely down to the fact that there is both software and hardware and the examples given all included the end user in the development of the solution, directly.

The following 3 sections discuss each type of technology which has been accepted in more depth at an individual respondent level.

As all of those who were interviewed confirmed that they were working or have had experiences of working on activities which had an element of technology acceptance to

enable success, it would or could have been assumed that out of the 41 interviews there would be an element of knowledge and understanding in relation to the models and determinants specifically, but this did not come across. The link between actual and assumed knowledge, knowledge which is taught and knowledge which is learned shows a variation in the approach and probably offers some reason as to why there is a level of variability in the responses.

4.2.1.1 Software based projects

The implementation of Software is the most common project discussed represented by 6 of the 41 interviewees. The interviews suggest that software technological acceptance has its challenges; as highlighted by R17;

*“there aren't many IT systems that that I haven't had my monkey paws on over the years involved in it. And on the very topic have obviously introduced lots of technology over the time, **have lots of grey hairs with it, lots of pain and frustration.** So hopefully I'll have an interesting viewpoint.”*

R17

In the interviews collated, there were differing views, which meant no common set of determinants was identified and therefore a variation in the level of achieved success. Five out of the six respondents discussing technology acceptance in relation to Software are not from IT based functions. This may suggest that those who are not from an IT background are less educated in technology acceptance for software based projects. An example is highlighted by R29.

“I tried to jump in without consulting and this was naive on my part. I didn't get a consensus and went far too early and should have had the fight up front, getting all the problems out and then going into it with joined up speaking - we could have done a lot more.”

R29 (No experience in IT)

However, this would need further exploration and understand because the study has not asked the question in comparison between those who work with IT solely, and the use of TAM so the evidence is not robust to deliver this outcome.

Other examples give from the interviews can infer there is a determinant which is important but it is not highlighted. An example, the following quotes reference several determinants relating to the attitudes and behaviours of people (TAM), performance expectation (UTAUT) and demographics (Cale, 2017) as highlighted by R10, R10 and R10. But behind all three quotes is a direct link to an assumption of demographics and

the impact of experience through learning which is only explicitly mentioned by Functional Director-1001230900.

“Everything usually fails and we've got so much evidence and so many lessons that show that where you get the business change right and you understand where you're changing people's ways of working, getting people to adopt technology and certainly for people who are not as au fait as you and I might think because we've grown up with technology and everything else.”

TAM – Attitude Towards Use - R10

“Kind of now mid late 50s category people generally are quite fearful of the of the technology. So you've really got to spend that extra time making sure that people are faced with it that you know they can't break it, if they break it, don't worry, we can fix it kind of thing.”

Demographics - R10

“OK, if I'm gonna move from a paper-based record to a digital record, I have to ensure that that digital record is kept in a similar way to a paper one, i.e. I can get it when I need it.”

UTAUT - Performance Expectation - R10

There is also evidence to suggest that demographics is an important consideration when purposefully recruiting staff whose role will involve technology adoption. Those new in the business are employed with the assumption that they will be accustomed to accepting new technology compared to the more experienced generation as articulated by R6.

“we don't understand what the apprentices will do in the future with technology. The work expectancy of an apprentice, you know, as they progress through their career, we don't think about it like that and about what technology they will work with. Are we sure they will be expecting to wear orange in 40 years?”

R6

For the case of determinants both the potential of new recruits and impact of an experienced generation is considered but for different projects. Regardless of age and experience, performance expectation and attitude toward use remain consistent and unchanged based on the empirical data.

4.2.1.2 Machinery Safety based projects

Contrary to software-based projects which have determinants predominately referenced from DOI and UTAUT, machinery safety technology acceptance predominantly draws on determinants derived from TAM and the newly proposed determinants. Those who referenced TAM based determinants consistently referred to the individuals who use the technology needing to be bought in to support technology change to enable success. There are two reasons which are likely for this, the hardware requires users to

understand how it works to enable the outcome but also those who responded were in a position within the business closest to the end users as the example given by R2 suggests.

“They all bought into it, wanted to make it work. And the production side of the operation, they will heavily involved in wanting to make it work. There’s a lot of people, I can’t remember at the names, but everyone was really invested in making it work”.

R2

The determinant with the most consideration for impact on success referenced by the interviewees was the suitability of the technology itself rather than the consideration of the individual attitudes or beliefs. An example given by R2 explains how the focus of the technology acceptance was around protecting the railway and how the technology would work with in the railway system than anything else.

“Highest importance was protecting the actual conductor rail rather than anything else.”

R2

A common area within machinery safety is the lack of understanding around UTAUT which is important from the commentary provided as this specific framework explores the potential performance benefits, expectations of effort, usability and user autonomy of the chosen technology acceptance which appear to be particularly prevalent to machinery safety. Regarding two examples of user autonomy and usability which have been referenced, both interviewees confirmed that the outcome was to be the same, but the method in which the same team went about solving the challenge was different. Where one party was trying to prevent inadvertent use, the other was trying to drive user autonomy, with both wanting to improve the end user buy in to technology acceptance where the following three quotes from R30, R30 and R23 present;

“You know everyone was supportive on that. And the challenge for me was to ensure that there was a process in place where this change couldn’t be abused [by the maintainers].”

R30

“We couldn’t allow normal operation of the machine in an degraded mode. That was a challenge because I think the operators in the maintainers saw this as an opportunity to [override the system].”

R30

“It came to light when [the engineer] was on site next to one of the operators when he was trying to put the gates on, the operator shouted out some obscenities about whoever designed these gates. The engineer stood aside of him, put his hand up and said that was me. From that point on that particular operator went to the engineering to seek support. Once we got to that point, it became a lot easier.”

4.2.1.3 Bridge based projects

For the example of projects relating to bridge installation, there is a lack of understanding of the benefits of TAM in relation to technology acceptance as the determinants did not reference the model or its determinants in any robust manner. The lack of this was noticeable in the interviews and reflects in the data coding outcomes as none of the three respondents discussed those who either need to install, use or maintain the project outcomes when completed. The only example presented from TAM relates to facilitating conditions. R37 discusses this point in terms of a lack of understanding in the business and how it therefore reacts very differently depending on the level the individual is at, this facilitating condition suggests that the outcome could be varied when discussing bridge technology acceptance.

“The perception of the business is it has to change for many reasons to achieve this organizational objectives. What conditions need to be in place for the business to respond at different levels? How does the frontline individual take that change. Compared to the middle management compared to the senior management, I think is extremely telling.”

R37

Further comparatives presented commonality for determinants such as the opportunity to experiment and technology availability. However, the difference being that for experimentation, one interviewee suggests that there is an opportunity to ask for forgiveness whilst the other suggests that long standing experiences and behaviours, learned values, can stifle experimentation as articulated by R37 and R13.

“Broke the rules and then ask for forgiveness afterwards.”

R13

*“Historic grounding in their beliefs in that we tried that before and it didn't work. Which has perhaps made them limited in their ability to want to take on or accept new ways of working. It might make them more reluctant **“to experiment”** going forward”.*

R37

All three parties which have been referenced in this section so far have discussed bridge technology acceptance, but all had different views on technology availability, from the software to develop the product not being available to deliver what was required, to the fact that when technology was available the demand was no longer available and finally when the technology is available, it is changing at a such a rate that materials are no

longer suitable when it comes to installation. The idea that the technology availability for what all describe as “getting a person across the railway” as the outcome can be so challenging suggests that the complexity of the situation is unheedingly prohibitive as it is changing project by project as highlighted by R13, R36 and R37.

“I mean one of the biggest challenges that I can remember that sticks out for me is is even down to I think you know again I think it's what you're talking about really is down to the software. It was to actually use and get access to the right software to be able to.”

R13

“There are some hidden critical elements of that that bridge as well that the project engineering and supply chain engineering teams have had to work through the change in order to to get that stuff sorted. So we've felt quite a little bit of pain on that on that particular.”

R36

“We've got so so many on the ground that are already awarded that the opportunity to put tech in as passed before we even got the tech opportunity

The only thing that is changing is how we believe we can get there fastest and it may be right that actually the to our project it's been going on some of those projects been going on now 3-4 years.”

R37

R36 references 4 different types of bridge, all being progressed to solve the same challenge to transport pedestrians across the railway. Only one of the bridges mentioned can be utilised as the other 3 all have underpinning technologies that are not readily available. Enabling technologies are not suitably accepted themselves meaning that time, effort and funding is being invested to accept technology which in itself is not available and is given in the example presented by R36.

“the Beacon footbridge, the Legacy footbridge, “Span-dangled” stainless steel bridges and Steel bathtub footbridge. We will encounter more problems. I think we're getting through the details as I know there was there's something crazy, about the, about the installation and there's a lot of them which need technically sorting before we move forward.”

R36

This example draws on many determinants and the issue seen within the business of a lack of structured process around technology introduction and acceptance. From technology availability, through to benefits of innovation, the business has a clear imperative to introduce bridges but has enabled 3 out of 4 projects to progress without suitable controls to focus “resource effort” on ensuring a successful outcome.

4.2.2 Organisational understanding of technology acceptance

The Radar graph shown in figure 22 and the percentages shown in table 15 and 16 denote for each determinant, out of a total of 41 interviewees the prevalence of each determinant and its associated framework. These three visuals show the responses across all of those interviewed vary substantially. The table also shows that most responses focused on determinants based on the Diffusion of Innovation model as there were repeat responses around organisational complexity, inconsistent goals and strategies and the ability to procure solutions in a collaborative manner, all of which are aligned to DOI..

The Radar diagram in figure 22 shows where determinants are not referenced to the same level between respondents, organisational incentive programmes in particular is not referenced by anyone who was interviewed. To a similar extent UTAUT is the lowest scoring model, including two of the lowest scoring determinants Effort expectancy and Relative usability (Kuciapski, 2017) as shown in table 15. Table 16 shows the same data but structured around the role type of responses. In this table you can see the responding role against the determinant.

A further theme presented by showing the data by role level is that some determinants such as Complexity, were not identified by those delivering projects, only those overseeing many projects or having a direct bearing on the influence of the business. This is similar to the fact that those delivering projects focused more on TAM related determinants such as perceived usefulness suggesting that the specific framework and determinants be applied could be sensitive to the level of the organisation it is being applied to.

Determinants of Technology Acceptance within the UK Rail Industry

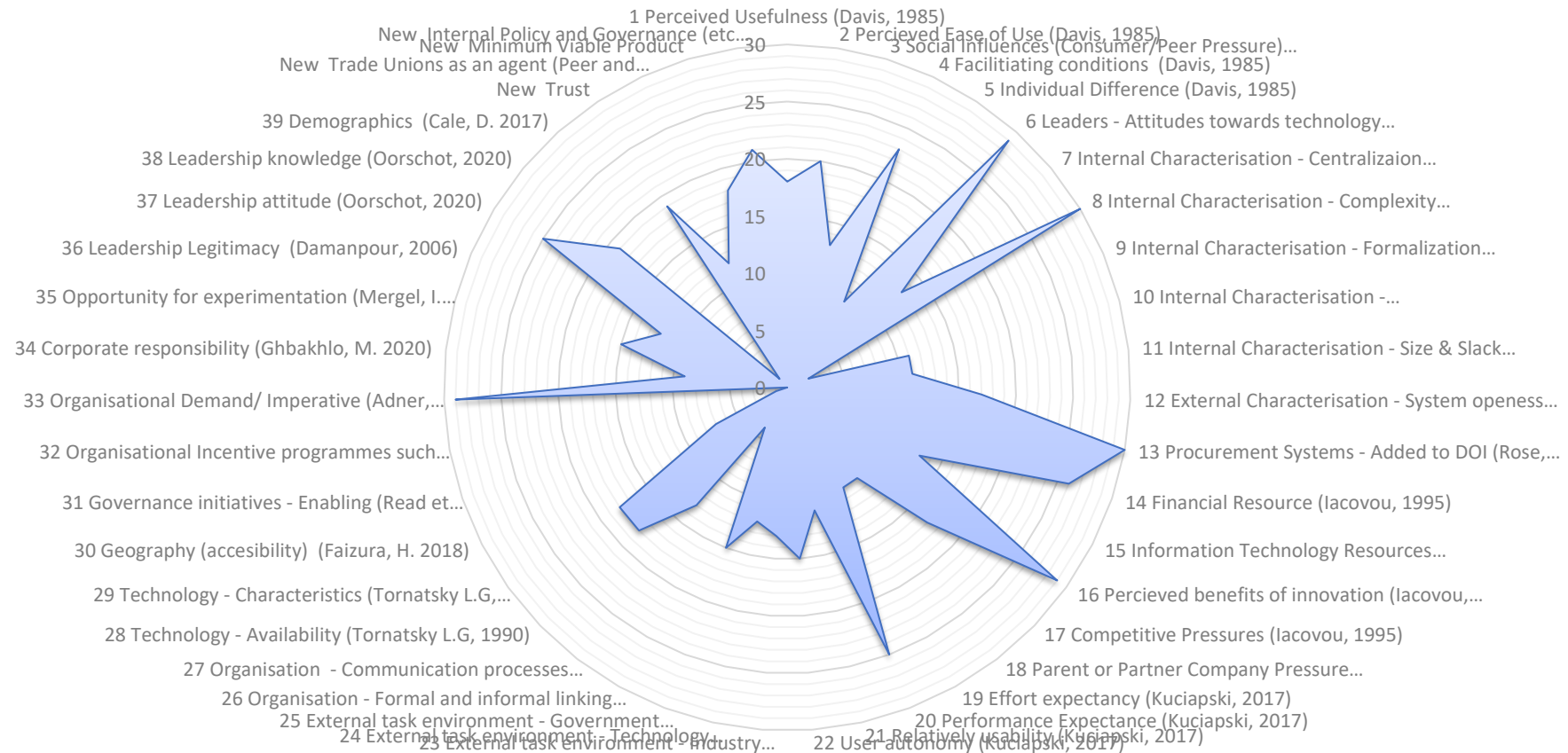


Figure 22 - Radar spread of responses against determinants

	Perceived Usefulness (Davis, 1985)																														Perceived Ease of Use (Davis, 1985)																														Social Influences Consumer/Peer Pressure (Davis, 1985)																														Facilitating conditions (Davis, 1985)																														Individual Difference (Davis, 1985)																														Leaders - Attitudes towards technology (Rogers, 1995)																														Internal Characterisation - Centralization (Rogers, 1995)																														Internal Characterisation - Complexity (Rogers, 1995)																														Internal Characterisation - Formalization (Rogers, 1995)																														Internal Characterisation - Interconnectedness (Rogers, 1995)																														Internal Characterisation - Size & Slack (Capacity) (Rogers, 1995)																														External Characterisation - System openness (Rogers, 1995)																														Procurement Systems - Added to DOI (Rose, T. 2019)																														Financial Resource (Iacovou, 1995)																														Information Technology Resources (Iacovou, 1995)																														Perceived benefits of Innovation (Iacovou, 1995)																														Competitive Pressures (Iacovou, 1995)																														Parent or Partner Company Pressure (Iacovou, 1995)																														Effort expectancy (Kuciapski, 2017)																														Performance Expectance (Kuciapski, 2017)																														Relative usability (Kuciapski, 2017)																														User autonomy (Kuciapski, 2017)																														External task environment - Industry characteristics and market structure (Tomatsky L.G, 1990)																														External task environment - Technology support infrastructure (Tomatsky L.G, 1990)																														External task environment - Government regulation (Tomatsky L.G, 1990)																														Organisation - Formal and Informal Linking structures (Tomatsky L.G, 1990)																														Organisation - Communication processes (Tomatsky L.G, 1990)																														Technology - Availability (Tomatsky L.G, 1990)																														Technology - Characteristics (Tomatsky L.G, 1990)																														Geography (accessibility) (Faizura, H. 2018)																														Governance initiatives - Enabling (Read et al. 2016)																														Organisational Incentive programmes such as Lean Management (Rose, T. 2019)																														Organisational Demand/ Imperative (Adner, 2002)																														Corporate responsibility (Ghahkhti, M. 2020)																														Opportunity for experimentation (Mergel, I. 2018)																														Leadership Legitimacy (Damanpour, 2006)																														Leadership attitude (Oorschot, 2020)																														Leadership knowledge (Oorschot, 2020)																														Demographics (Cale, D. 2017)																														Relational Engagement (Trust)																														Trade Unions influence																														Strategic approach to solutions (Minimum Viable Product)																														Internal Policy and Governance (etc Product Acceptance)																													
Executive Director	2	2	1	7	0	5	4	6	0	3	3	4	4	4	2	5	4	4	2	4	2	2	4	0	3	3	7	1	3	3	3	2	0	7	5	3	5	7	5	1	3	0	4	3																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
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Table 16 - Qty by determinant and normalised by determinant qty of respondents

Table 16 shows two different sets of figures. The first set in the upper table is the absolute response count by each individual within the respective role level within the business. These are organised by model and at a glance shows the determinants which have a higher or lower representation, for example problem formulation has a consistently low response across all role levels in the business except for the functional directors. This would suggest that as a determinant it is either unknown, not needed or only relevant to this role level.

The second data set shows the same data but normalised by the number of respondents by role level. This at a glance gives a more balanced view across the role types, for example, perceived usefulness in terms of total numbers of respondents who referenced the determinant has one of the lowest values however the normalised position was 100% in one role level. These two sets of data will be helpful to show at a glance the trends and themes.

Model	Determinant	Distribution of determinants
Technology Acceptance Model	Perceived Usefulness (Davis, 1985)	44%
	Perceived Ease of Use (Davis, 1985)	49%
	Social Influences (Consumer/Peer Pressure) (Davis, 1985)	32%
	Facilitating conditions (Davis, 1985)	56%
	Individual Difference (Davis, 1985)	22%
		13%
Diffusion of Innovation	Leaders - Attitudes towards technology (Rogers, 1995)	71%
	Internal Characterisation - Centralisation (Rogers, 1995)	32%
	Internal Characterisation - Complexity (Rogers, 1995)	73%
	Internal Characterisation - Formalization (Rogers, 1995)	5%
	Internal Characterisation - Interconnectedness (Rogers, 1995)	27%
	Internal Characterisation - Size & Slack (Capacity) (Rogers, 1995)	27%
	External Characterisation - System openness (Rogers, 1995)	41%
	Procurement Systems - Added to DOI (Rose, T. 2019)	73%
		22%
Iacovou Model	Financial Resource (Iacovou, 1995)	63%
	Information Technology Resources (Iacovou, 1995)	32%
	Perceived benefits of innovation (Iacovou, 1995)	71%
	Competitive Pressures (Iacovou, 1995)	41%
	Parent or Partner Company Pressure (Iacovou, 1995)	24%
		14%
UTAUT2	Effort expectancy (Kuciapski, 2017)	24%
	Performance Expectance (Kuciapski, 2017)	61%
	Relatively usability (Kuciapski, 2017)	27%
	User autonomy (Kuciapski, 2017)	37%
		9%
Technology Organisation Environment	External task environment - Industry characteristics and market structure (Tornatsky L.G, 1990)	32%
	External task environment - Technology support infrastructure (Tornatsky L.G, 1990)	29%
	External task environment - Government regulation (Tornatsky L.G, 1990)	37%
	Organisation - Formal and informal linking structures (Tornatsky L.G, 1990)	10%
	Organisation - Communication processes (Tornatsky L.G, 1990)	32%
		14%

	Technology - Availability (Tornatsky L.G, 1990)	44%	
	Technology - Characteristics (Tornatsky L.G, 1990)	44%	
Independent	Geography (accessibility) (Faizura, H. 2018)	5%	18%
	Governance initiatives - Enabling (Read et al, 2016)	2%	
	Organisational Incentive programmes such as Lean Management (Rose, T. 2019)	0%	
	Organisational Demand / Imperative (Adner, 2002)	71%	
	Corporate responsibility (Ghbakhlo, M. 2020)	22%	
	Opportunity for experimentation (Mergel, I. 2018)	37%	
	Leadership Legitimacy (Damanpour, 2006)	29%	
	Leadership attitude (Oorschot, 2020)	61%	
	Leadership knowledge (Oorschot, 2020)	46%	
	Demographics (Cale, D. 2017)	5%	
New	Trust	46%	11%
	Trade Unions as an agent (Peer and Leadership)	29%	
	Minimum Viable Product	44%	
	Internal Policy and Governance (etc Product Acceptance)	51%	

Table 17 - Percentage of determinants cited by interviewees as a total of the maximum amount

Although table 17 gives some indication of repetition of cited determinants within the interviews, it does not denote significance or influence (Saldana, 2021), as this would require more detailed investigation, an alternative methodology and a different line of questioning. The intention of sharing Table 16 is to help to inform that there is a level of variability in the responses across those being interviewed of their knowledge and understanding relating to technology acceptance.

The following section is organised by the respective models presenting the different determinants as referenced in the empirical study. The theories and models are presented in chronological order, aligned with the systematic literature review

Each section includes at least 2 tables. These are set out to show the number of responses against each determinant as well as examples of the data sets used to align references to first and second order determinants.

4.2.2.1 Technology Acceptance Model

Table 18 shows the number of responses against each of the determinants of TAM by role level within the organisation. Table 18 is an example data table showing direct responses and their alignment to first order themes, table 19 follows on with specific examples of alignment of direct references to the determinants.

The table shows the B2 level were the most prevalent responders with this model although “individual difference” as a determinant was the least referenced by consistently all levels within the business.

Row Labels	Sum of Perceived Usefulness (Davis, 1985)	Sum of Perceived Ease of Use (Davis, 1985)	Sum of Social Influences (Consumer/Peer Pressure) (Davis, 1985)	Sum of Facilitating conditions (Davis, 1985)	Sum of Individual Difference (Davis, 1985)	Total	Number of Respondents
Executive Director	2	2	1	7		12	6
Functional Director	5	6	6	7	6	30	12
B1	6	8	3	6	2	25	16
B2	3	3	2	3	1	12	5
B3	2	1	1			4	2
Grand Total	18	20	13	23	9	83	

Table 18 - Qty of identified determinants of TAM2 by Role Level

Relevant Framework : Technology Acceptance Model (Davis, 1983)						
Interview Reference	1st order concept		2 nd order themes (Determinants)		Second Order Theme (Frameworks)	Aggregate Dimension
R3	Everyone is an expert because they own a car and understand its use	→	Perceived Usefulness	→	Technology Acceptance Model (Davis, 1985)	What are the determinants of technology acceptance within the UK Public Sector Rail Industry?
R23	Its not just about the processing, but also the location of the valves to support identification of the water level because the minor stuff we could shrug our shoulders but the operators need to use it every day so we have to make it as easy as possible as this is really important to the guys using it daily.	→	Perceived Ease of Use			
R23	The operator shouted out some obscenities about who designed these safety gates, to which the engineer put up his hand, said that was me and enabled the discussion to be had	→	Social Influences (Consumer/Peer Pressure)			
R25	one of the reasons this has drifted because of the industry structure and really wont change until GBR kicks in. Its really difficult for the industry to make the right decisions.	→	Facilitating conditions			
R10	huge numbers of groups of individuals who all want their own things	→	Individual Difference			
R37	I think that even interweaving nature of our culture and the systems		System Characteristics			

Figure 23 - Response examples within the data structure for TAM2 determinants

There is frequent consideration for common goals and outcomes but also the perspective of the leaders is sometimes varied. In the interviews some have taken the position to push forward and remove barriers whilst others advocate conformance to process, this is shown at all levels across the business and organisational levels within the organisation when considering facilitating conditions as presented by R37, R13 and R38;

"We're not an organization that we were active or proactively working with."

R37

"The software was not allowed to be used on the system which we need meaning we could not develop"

R13

"It's like it's not the, it's not the crafted environment where the best ideas come out. It's just not"

R38

From the three quotes given, the conditions of the business to facilitate technology acceptance are lacking. And this was a common position, not for all, *"sometimes you win, sometimes you lose, but you gotta' go for it, I think. And. And we did go for it"*. (R11)

The suggestion by an executive level interviewee is that the conditions in the business can be right to deliver technology acceptance – if this is the case then either the governance of how to enable an outcome is not consistent or understood if comparing this position to that of the 3 references presented prior. To make technology acceptance even more of a challenge, the conditions for progression of a project can be proactively inhibited by virtue that there are some rules which have to be applied regardless of authority and financial commitment as explained by R7. The suggestion that the facilitating conditions are working to slow or stifle progress.

“Should a £100M project need to have the same controls as a £10k project?”

R7

All interviewees discussed the need to make sure the end user has a level of involvement, this is alignment predominantly to TAM, however, only one of the interviewees talk about perceived ease of use and usefulness as described within TAM.

“Perceived ease of use - We do try to make things as easy as possible for the end user, easy as possible”.

“Perceived usefulness - So they are they’ll disconnect the pipe while it’s still got water pressure in it.”

R23

Although R23 references both ease of use and usefulness, there is no commentary around why both elements are important or how they link together. In other interviews, respondents do accept that projects are less likely to succeed without individual input and buy in of the end users so there is awareness of the importance of both but there does not appear to be a clear understanding of TAM as a model and therefore it is not applied as intended.

“They are the experts, we know what we need, why do we think we can do their job?”

R35

“Local leadership from someone who understands the problem “

R28

“Working with an end user who has got an idea, and wants something and willing to invest some skin in the game is the approach we have taken”.

R8

A further common consideration is that the ability to engage, influence and inform regarding technology acceptance is the size, complexity, and geography of the organisation. This has a number of effects where potentially the demand can change as well as the influence of the

individual Almost half of the respondents described an added complexity with the fact that the trade union also plays a major part in influencing the team this will be discussed in Section 4.2.3.2. This presents a dynamic where the position of trade union representatives and the trade union themselves do not buy in to the technology or the process in which it is being applied and influence both management and end users directly.

Looking into two of the examples shared from the study, Collision avoidance (technology-based hardware and software which prevents a vehicle-to-vehicle collision) (R9) as well as the Class 153 (automatic rail switch inspection) (R28) implementation. Both projects suggest that ease of use is a very important factor which was consistent, but social influences applied in different ways either helping or hindering the opportunity for success.

“Take them on the journey is a bit cliché, but they need to be involved in the working group from the start to understand why we need this technology. This is the background to it and actually it is gonna make it safer and easier to use for us and our colleagues. if you have them as part of the project that's scoping it out and you have key people, then yeah it can work. If you just impose it after you've developed it and the product is selected, then you just get a clash.”

R9

“Kept the end users of the data that was being generated involved through the project. I know a lot of projects will claim to do that, but I suspect this project would doing it in a much more hands on way. I know for example they Every couple of weeks they were putting up another demonstrator of what the kit was going to generate and then asking for some quite detailed feedback on was it going to do the job the end users required?

And then going away and tweaking it. So there's a pace about it as well, but it was the fact of their ability to respond to feedback they had given the credibility by the end users who then got more engaged in.”

R28

Two projects, both looking at how to make technology easier to use but one team are against its implementation due to their collective approaches towards it where as the other can see how it can benefit them and therefore support the development. Even with other determinants apparently being supported, a single determinant can suggest that the work to accept is more difficult to achieve as the Ease of Use has shown in this case.

4.2.2.2 Diffusion of Innovation

Table 19 shows the number of responses against each of the determinants of Diffusion of Innovation by role level within the organisation. Table 20 is an example data table showing direct responses and their alignment to first order themes.

Table 19 shows the Functional Directors and B1 level were the most prevalent responders with this model.

Row Labels	Sum of Leaders - Attitudes towards technology (Rogers, 1995)	Sum of Internal Characterisation - Centralisation (Rogers, 1995)	Sum of Internal Characterisation - Complexity (Rogers, 1995)	Sum of Internal Characterisation - Formalization (Rogers, 1995)	Sum of Internal Characterisation - Interconnectedness (Rogers, 1995)	Sum of Internal Characterisation - Size & Slack (Capacity) (Rogers, 1995)	Sum of External Characterisation - System openness (Rogers, 1995)	Sum of Procurement Systems - Added to DOI (Rose, T. 2019)	Total	Number of Respondents
Executive Director	5	4	6		3	3	4	4	14	6
Functional Director	9	2	9	2	6	3	6	9	26	12
B1	13	5	11		1	3	6	12	22	16
B2	2	2	4		1	2	1	4	8	5
B3								1	1	2
Grand Total	29	13	30	2	11	11	17	30	71	

Table 19 - Determinants of DOI, Qty of responses by Role Level

Relevant Framework : Diffusion of Innovation, (Rogers 1983)					
Interview Reference	1st order concept		Second Order Theme (Determinants)	Second Order Theme (Frameworks)	Aggregate Dimension
R3	The biggest in mind has been [Leadership attitudes] in terms of the hassle, pain and ultimately benefit.	→	Leaders - Attitudes towards technology	Diffusion of Innovation, (Rogers, 1995)	What are the determinants of technology acceptance within the UK Public Sector Rail Industry?
R10	individual signal boxes all want their own thing rather than recognising the need to collectively change	→	Internal Characterisation - Centralisation		
R6	Because we run with 5 regions, and we are a central team that provide the services to 5 almost different functions it makes it difficult to achieve all needs.	→	Internal Characterisation - Complexity		
R4	You need to start by finding out really what you need to solve. Don't just go off assuming you know what the determinants are	→	Internal Characterisation - Formalization		
R3	it takes so much time, almost 8-10 months longer than it would do in other industries due to the time to bring everyone together and connect across functions and departments.	→	Internal Characterisation - Interconnectedness		
R3	Really is not time to take a step back and to reflect on what needs to happen	→	Internal Characterisation - Size & Slack (Capacity)		
R36	open to the market to drive the right value and we have to have our eyes open to that.	→	External Characterisation - System openness		
R41	It's also really about that relationship with across sector, with the supply chain	→	Procurement Systems - Added to DOI (Rose, T. 2019)		

Table 20 - Response examples within the data structure for DOI determinants

Diffusion of innovation generally is defined as to the speed and level of uptake of innovation across a community (Rogers, 1983). This framework was the highest referenced framework of the study and had elements which were at both extremes, from problem formulation which had 2 references to leadership attitudes, complexity and procurement systems all had some of the highest level of references.

Procurement systems was mentioned by over 70% of the respondents. Although mentioned as a challenge to technology acceptance as can be seen by R7 and R25;

“when things come to me from a technology perspective that I will challenge quite hard as to whether this is the right thing for the business”

R7

“procurement and delivery piece is quite rightly seen as a big piece of nervousness”

R25

or an opportunity as shared by R37 and R1

The benefit is procuring from the industry. The data is there to prove that the more energy efficient, the more reliable and the supply chain can get the parts easier. Parts are manufactured for the whole life cycle of the assets.

R1

“the supplier needs to cut their own niche, it’s our business to buy”

R37

The fact that so many of the respondents comment on procurement systems would suggest it is an important factor to enable technology acceptance success within the organisation. From a commercial perspective the need to implement technology is often *“too late and rushed”* (R7) to make sure the commercial strategy is appropriate with many trying to circumnavigate the rules, but also this is argued that the commercial policy is inflexible, does not offer an agile approach and is overly time consuming when *“you know what you need”* (R38).

Complexity of the organisation presents itself as both inter-organisational relationships and interorganisational accountabilities. These two perspectives provide a distortion of responsibilities, essentially who should be doing what and presents confusion and frustration

“condition based monitoring is probably the one that’s caused the most frustration - we’re definitely lagging behind other industries. At one point, the engineering aspect was being delivered by someone in my team. Then it moved to another team and stopped.”

“The biggest frustration in this team is about people in the wider team who cannot see the opportunity of the system. “

R20

“This is especially prevalent when one team comes up with an idea, and others are then responsible for its delivery”

R29

“Network Rail probably don't have the mechanisms to support the delivery of tech and that are easily accessible, so there's always some sort of barrier or some sort of thing you have to stage. You have to get past regulation, you've got to get over and there's those in private sector. But I think we've got more mechanisms to kind of processes to follow, think sometimes you don't even know what the right process is to actually get over the fact that you might have to take a few boxes to get past the contract and it has to go somewhere in central and then they have to sign it off and then someone else doesn't know where that goes. So it's all those steps that are not clear. “

R24

Examples given are presented by individuals who are accountable for the services which they provide, and technology successfully accepted provides them a solution to one of their own challenges. Others in the wider team are impacting the ability to deliver the outcome. This complexity caused by relationships and also blurred accountabilities causes a tension. The organisational tensions do not exist when you consider teams delivering improvements locally are more likely to succeed as given in the example which follows as stated by respondent R28

“Success factors was the delivery team. They had the mindset to just bring a different approach to the way. That part of Network Rail, we're doing things because we made sure we have the expertise to work through engineering requirements, commercial and contractual within the team”.

R28

Formulation of the problem scored as one of the lowest across all the determinants. Breaking down technology acceptance challenges into subsequent parts and then formalizing a plan was not explored to any extent, really understanding what needs to happen appears to be an area which could be explored further by the business. If we consider the highest referenced determinant is the “imperative/demand” the organisation has an absolute need and requirement to do something, but this may result in the problem statement being undeveloped and therefore a lack of certainty of how to solve the constituent parts. This could have an association with many other of the determinants discussed because if there is not a full understanding of the problem, how can success be enabled. One reference suggests that this may be why projects are often stopped before conclusion.

“You probably expect that some will succeed and some will fail, and those that you fail, you fail as quickly as you can to minimize the costs and that's the nature of what we do. And you gotta be quite philosophical about it.”

R11

“We're not understanding the problem. The customer needs really need to be captured before we actually deliver anything “

R24

Whereas another reference suggests that projects are continually delivered without really understanding what is trying to be solved.

In order to spread the knowledge of technology acceptance across a group of people, system openness allows communication to proliferate through changing perceptions and affecting outcomes. Again there are different views of how impactful the system openness is within Network Rail to allow the proliferation of knowledge and information and one suggestion is that the system is closed, intentionally whereas the other extreme is that within days 10,000 people can be enabled to change how they work.

“I think it's culture that Network Rail. I don't think I understood it like this initially, but the not being able to offer products to Network Rail because of the blockages that have been caused by individuals.”

R1

“we had this absolute urgent burning platform of we had to find an effective way for 10,000 office space people to work from home. And that's. Yeah, it's tempting to think that was a software solution, but it wasn't just a software solution. It was planned to figure out how they were going to work.”

R40

For the Diffusion of Innovation which predominantly is focused towards the transition of an individual and group of individuals to accept technology similar to TAM there is a lack of consistency in approach however the majority of determinants for DOI are being referenced.

4.2.2.3 Technology Organisation Environment

Table 21 shows the number of responses against each of the determinants of Technology Organisation and Environment by role level within the organisation. Table 22 is an example data table showing direct responses and their alignment to first order themes.

Table 21 shows that the most common responses are around technology availability and characteristics, whilst the prevalent respondents are the functional directors in regards to this model.

Row Labels	External task environment - Industry characteristics and market structure (Tornatsky L.G, 1990)	External task environment - Technology support infrastructure (Tornatsky L.G, 1990)	External task environment - Government regulation (Tornatsky L.G, 1990)	Organisation - Formal and informal linking structures (Tornatsky L.G, 1990)	Organisation - Communication processes (Tornatsky L.G, 1990)	Technology - Availability (Tornatsky L.G, 1990)	Technology - Characteristics (Tornatsky L.G, 1990)	Total	Count of Respondants
Executive Director	4	2	4		3	3	3	13	6
Functional Director	3	3	7	1	3	6	6	23	12
B1	6	6	4	2	4	5	6	21	16
B2		1		1	2	3	3	9	5
B3					1	1		2	2
Grand Total	13	12	15	4	13	18	18	68	

Table 21 - Determinants of TOE, Qty of responses by Role Level

Relevant Framework: Technology, organisation and environment [TOE] (Tornatsky L.G, 1990)						
Interview	Reference 1st order concept		Second Order Theme (Determinants)		Second Order Theme (Frameworks)	Aggregate Dimension
R26	An attempt to widen the supply chain market to bring in new technology failed due to the market structure	→	External task environment - Industry characteristics and market structure	→	Technology, organisation and environment [TOE] (Tornatsky L.G, 1990)	What are the determinants of technology acceptance within the UK Public Sector Rail Industry?
R23	Documentation to support the technology came after it has been introduced, this should have been there before.	→	External task environment - Technology support infrastructure			
R16	Work to a very strict <i>imposed assurance regime</i> and we work to it from A to B because we are told that's the right thing to do and its strict so even a minor deviation from it takes a hell of a lot of effort.	→	External task environment - Government regulation			
R9	There isn't a buy in at both macro and local levels, therefore no clear link to across the organisation	→	Organisation - Formal and informal linking structures			
R9	Whilst there was some level of communication, it was not consistent and although there was a process for spoken work, this was not aligned to the paperwork.	→	Organisation - Communication processes			
R11	We came up with the idea 12 months earlier and the original concept was to take the "XXXX" Rail battery train that already existed and then	→	Technology - Availability			
R11	So whilst this sort of new technology is fascinating to play with and it clearly has a niche place on some lines	→	Technology - Characteristics			

Table 22 - Response examples within the data structure for TOE determinants

TOE is the oldest of the models which looks at technology acceptance at an organisational level and is the most referenced by the interviewees. Technology Availability and Characteristics are the most prevalent determinants discussed in the interviews, almost half of all of the respondents who were interviewed referenced Technology Availability and Characteristics.

The availability of technology and the characteristics of the organisation play a part in the success of technology acceptance which was also seen in the example of the bridge technology acceptance and given by R37 and R27.

“for a four years, I wanted to get live reporting, not just out of the business, but I wanted to augment passenger journeys around it. When we set those early principles, we made some decisions but the Technology did not have the capability at that time.”

R37

“from a route engineer East Coast perspective, it's not his problem that the product wasn't ready. Umm so, so so implementing new technology does course tension”

R27

With the suggestion that the business did have an imperative as following on by R37 –

“Got business support for the vision and yes we got the buy in”

R37

Although the business had a clear demand through the business processes and therefore the characterisation, the lack of available technology meant that it needed to be further developed to achieve the outcome. This suggests that the company had a plan and a need for what it wanted to do but did not have an understanding of problem formulation (DOI) or technology availability (TOE) and therefore the characteristics of the business did not enable the right outcome to be achieved.

Informal and formal linking structures provide structure and clarity which enable effectiveness when it comes to technology acceptance in particular a formalised hierarchy to enable technology acceptance (Baker, 2018, p.5). Where this comes in to its own is seen in the following commentary where R14 is also suggesting how improvements maybe made;

“organisational conditions and building associated linkages and bring organisations together where the learning is already in place and use this to encourage lessons to be shared and enable technology to be accepted”

R14

What comes with existing linking characteristics between Network Rail and the supply chain is a relational dynamic which can drive or hinder technology acceptance from the responses given. 25% of those interviewed discuss this specific point however the focus is predominantly raised at a director level as we can see from R27 and R14 as well as the link to procurement and supplier relationships.

"We have to create the conditions for the suppliers to work together to create innovation and opportunity. "

R27

"...organisations are massively oversized for what we need them to do and the suppliers are motivated by what they wish to do."

R14

As the target for the interviews was predominantly aimed at those across the business who are influential in relation to technology acceptance, this means that the majority of those interviewed also have a level of seniority, so will have a clearer view on understanding the association between technology acceptance and the organisation itself. Examples given by R7, R25 and R41.

"not breaking the law, breaking regulation, getting value for money from our sort of managing public money perspective."

R7

"first stage is because riding a better regulation arrangement"

R25

"department point of view and politician point of view."

R41

Compared to those who are at the knife edge of delivery such as R23 and R1 who are not focussing on the organisational determinants due to the need to focus on the delivery of their technology acceptance project specifically.

"It was sort of black and white if that makes sense to you. You know, the operators are really impressed the system is available, works is it's brilliant. It does really make a big difference"

R23

"where again hampering our ability to get the best products that we could actually get"

R1

The opposing prioritises given between the two groups suggests that the view on technology determinants is dependent on the level within the business which requires the technology to be adopted. The results as presented in Table 22 do show a stark contrast that the prevalence of commentary from the more senior of the interview offered more recognition for the determinants of TOE than those who are closer to the direct delivery. The difference suggests that those more senior are more likely to reference TOE determinants at an organisational level than determinants which are close to individual parties, and this may not be a surprise due to the strategic nature of the role.

4.2.2.4 Iacovou Model

Table 23 shows the number of responses against each of the determinants of Diffusion of Innovation by role level within the organisation. Table 24 is an example data table showing direct responses and their alignment to first order themes.

Perceived benefits of technology and financial resources are identified as the most discussed determinants of Iacovou model shown in Table 23. Organisational level determinants are predominantly being discussed by senior levels within the business and those in a band 3 role only discuss financial resources and perceived benefits of innovation.

Row Labels	Sum of Financial Resource (Iacovou, 1995)	Sum of Information Technology Resources (Iacovou, 1995)	sum of Perceived benefits of innovation (Iacovou, 1995)	Sum of Competitive Pressures (Iacovou, 1995)	Sum of Parent or Partner Company Pressure (Iacovou, 1995)	Total	Count of Respondents
Executive Director	4	2	5	4	4	19	6
Functional Director	6	5	10	3	3	27	12
B1	12	5	10	8	3	38	16
B2	3	1	3	2		9	5
B3	1		1			2	2

Grand Total	26	13	29	17	10	95	
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Table 23 - Qty of identified determinants of Iacovou Model by Role Level

Relevant Framework: Iacovou Model, (Iacovou, 1995)						
Interview	Reference 1st order concept		Second Order Theme (Determinants)		Second Order Theme (Frameworks)	Aggregate Dimension
R23	Opportunity to save money just wasn't take up	→	Financial Resource		Iacovou Model, (Iacovou, 1995)	What are the determinants of technology acceptance within the UK Public Sector Rail Industry?
R6	it is and it means that people don't realize the effort and the resources it takes and more just to do some things and they don't realize the costs involved and they don't realize the time involved.	→	Information Technology Resources			
R23	It really does, the users are really impressed, they didn't think it could be done and so there were clear benefits	→	Perceived benefits of innovation	→		
R5	Their comments and opinions were treated as fact meaning a robust justification...when developing their own solutions.	→	Competitive Pressures			
R17	There's not a real game share basis, its not that there bad...they are then actually rewarded regardless of the consequence for the system.	→	Parent or Partner Company Pressure			

Table 24 - Response examples within the data structure for Iacovou Model determinants

Although a common response in table 25, the determinant - financial resources - featured in 70% of the discussions of which two examples are shown below by R40 and R37.

"it's always been we find money when it's the right thing to do...but actually the point being is money matters."

R40

"we had a supplier introducing a new a new system and it didn't work, and there were a number of people within the business that didn't want to. Therefore we put the money and effort into our own system"

R37

A suggestion that money was committed and partially spent but further funding was made available to deliver an internal application and focus for resources from finance was put back on to the project. In discussion there was also a concern that costs often where not balanced against time and quality as reference by R40 ...

"stopping this project because we're not gonna deliver a quality outcome, I don't think it would have had the same reaction, "

R40

...of the final product and in many cases the control around cost to enable the desired outcome maybe flexed as the end date commitment could take priority as shown by R27

"they'll deliver on time. I've got 8 schemes that are all due to be delivered in or around the end of the control period and the priority is to deliver on time. "

R27

The reason for this pressure to keep to time was evidenced to be driven often by political need;

“Secretary of State for Transport goes there last two weeks ago stands at the end of the platform and says this will be delivered next year!”

R27

This proposition, that political need is more important as a driver than cost and quality has the potential to affect how the determinants in the Iacovou model are applied, and swaying the decisions toward away from financial pressures to almost a game where money has no value in the progression for delivery.

This is the likely reason why financial resources are not discussed as a concern, because the pressure is focussed on the delivery to time and quality. One of the interviews suggested that innovation was sometime curtailed *“and those that you fail, you fail as quickly as you can to minimize the costs”* (R11) to prevent excessive costs however the perspective from those delivering projects is one where cost does not appear as important as successful delivery.

Financial resource was not the only determinant, which was reportedly influential within this model, perceived benefits of technology come out with the majority of the references within this model, 29 out of 41.

“either reduce time or or it could reduce numbers of people to do something. Usually a really good benefit of the technology”

R19

“And what happened was, you know, the “boardroom concept”, the benefits were oversold. Both in terms of technological benefits and timescales and cost of implementation at the working level. “

R27

“That's why technology works well. You've got a problem to solve because people will get on and solve the problem because they can see like the benefit before they even start. And that's what they're kind of chasing.”

R33

The perceived benefit of technology is likely to have an impact on determinants such as the attitudes towards use as this determinant also scored high in the responses. The perceived benefits of the technology make it easy to sell if people can associate a benefit of the outcome, this is applicable for both individuals and the organisation, meaning finding or articulating the perceived benefits of technology well is likely to get a project off the ground and also for users to buy in to it. However, there is also the opposite when projects do not achieve their proposed benefit;

"It might make them [Leadership] more reluctant to Embrace Change going forward. Because they know how hard it can be and when it goes wrong, that tends to land on their laps in terms of rectifying. The perceived benefits are do not outweigh the experience of failure."

R37

The perceived benefit of technology therefore is important for Network Rail to consider, not only is it common from the respondents, but the impact of it can have lasting effects on future projects.

Parent company pressures and trade partner pressures are referenced less in this model by the respondents, likely as it has been explained the railway is a monopoly and so the same organisation driving the delivery to time is also the same organisation applying the pressure so is unlikely to succeed at driving innovation and technology acceptance if they are focussing on specific projects delivered by political desire. The only parent company would be the department for transport, who as we have seen want to see more technology accepted (Shapps and Williams, 2021, p.5), but also put pressure on to achieve project completion dates which is inhibiting freedom of technological development, leaving teams opting for what they know best as a less risk.

"Secretary of State for Transport goes there last two weeks ago stands at the end of the platform and says this will be delivered next year. No, that's not what I've committed to at all"

R27

"in that kind of environment, the last thing I want to be doing, even if it's worth it, is introducing an opportunity for my supplier to say, ohh, you've changed the scope, , you're asking to do something different. Yeah, just deliver what we know. We're going to deliver and do it on time."

R27

This also has an effect on competitive pressures as it can be seen from the responses that not only does competition not have its intended impact in Network Rail but also this passes through to the supply chain.

"Our supply chain was actually more reluctant to change than Network Rail because they already had their processes set up. They don't want to find new process and techniques. They didn't want to have to change. I would have thought the supply chain would have been more challenging due to competition. "

R37

The rigidity of the organisational processes would appear to having an impact beyond Network Rail through its supply chain.

4.2.2.5 Unified Theory of Acceptance and use of Technology

Table 25 shows the number of responses against each of the determinants of UTAUT2 by role level within the organisation. Table 26 is an example data table showing direct responses and their alignment to first order themes.

Table 25 shows that Band 3 responses are the lowest for UTAUT2, only referring to effort expectancy however performance expectation was cited by the majority of B1 level respondents.

Table 25 - Qty of identified determinants of UTAUT2 by Role Level

Row Labels	Sum of Effort expectancy (Venkatesh, 2003)	Sum of performance Expectance (Venkatesh, 2003)	Sum of Relative usability (Venkatesh, 2003)	Sum of User autonomy (Venkatesh, 2003)	Total	Count of Respondents
Executive Director	2	4	2	2	10	6
Functional Director	2	7	5	5	19	12
B1	2	12	1	7	22	16
B2	2	2	3	1	8	5
B3	2				2	2
Grand Total	10	25	11	15	61	

Interview	Reference 1st order concept		First Order Theme (Determinants)		Second Order Theme (Frameworks)	Aggregate Dimension
R17	There are not loads of compounding factors, at the heart we don't see it [technology acceptance] as business change therefore do not plan for the effort.	→	Effort expectancy		Unified Theoru of Acceptance and Use of Technology (Kuciapski, 2017)	Research Question 1: What are the determinants of technology acceptance within the UK Public Sector Rail Industry?
R23	Once the team had seen the technology performing,, they said it was the best thing they had seen as it performed beyond expectation	→	Performance Expectance			
R9	Real issues around how the technology could be used by the users. Even though its was purpose designed...there was still a concern about its usability and what could happen.	→	Relatively usability	→		
R9	I wouldn't have let the project continue with the right level of support from the authority although this created a challenge when it came to developments required by the users.	→	User autonomy			

Table 26 - Response examples within the data structure for UTAUT2 determinants

The notable determinant to be referenced by the interviews in UTAUT2 is the performance expectation. Numerous references have been given of teams who expect technology to

succeed, and some who expect it to fail due to previous experiences but sometimes, others also support the expectation and that means that projects will be encouraged to drive forwards as those around have confidence in the technology being accepted which is what B1-16011231330 is expressing.

"We have seen with our latest bridge, the French railway now coming over and are seeking to order 37, I think. Off what we understand the performance will be."

R14

This level of confidence is interesting as for Network Rail, the expectation of technology delivering robust outcomes is considerable, and reported as one of the more important determinants to achieve but as mentioned there is not always a confident approach as shared by R6 and Executive Director-1201231500;

"Could oversell it [technology acceptance] as the panacea to all problems"

Executive Director-1201231500

"Some technology is viewed isn't viewed in in potentially a positive manner is because the program at that time, wasn't very open and transparent around where the technology was. So and because of that and because people put an awful lot of time into it and unfortunately it failed, it meant that it's meant that they actually don't want to invest that kind of time going forwards."

R6

The three most senior individuals interviewed both call out technology expectations explicitly in their responses at an organisational level. This is because the expectation of performance of technology acceptance is intrinsically linked to the performance of the rail industry and the ability to drive efficiencies, R17 specifically references also the industry paper for reform which calls out technology as a pillar required to enable industry change (Shapps and Williams, 2021).

What is also supported by the responses to UTAUT2 is that those determinants which have more of an effect on the individuals accepting technology – relative usability, effort expectancy and user autonomy are all scored comparably low with less than 25% of all respondents citing these determinants. This would suggest that there maybe are not the levels of engagement which would be suggested as required by Venkatesh to achieve acceptance (Venkatesh et al., 2003). Determinants which affect the specification and design of technology solutions such as user autonomy should be a primary consideration as they have a direct effect on TAM determinants as they have a direct influence on the behavioural intention to use and useability of the solution.

“There's no such thing as a technology project. There was always a business project that maybe have a technology work string to help enable it. And every time that we turn that thing around and we think it's a technology project and forget the importance of business change. ”

R10

“we are overrun with technical people who don't really value business change. If I look at where we sit, guess what all my experience elsewhere has been that those are the two things that required as a business imperative to make technology acceptance happen. People invest heavily in the business change. And most of the places where we stops where we struggle with technological deployment, it's largely because of those two factors, particularly the latter.”

R17

The suggestion is from the extracts in particular from R17 is that business change is not “applied” in practise, the knowledge and understanding of how to engage with business change is devoid from the process to accept technology and this is evidenced by the distinction between those at an organisational level not focussing on the individual and vice versa as seen above. Comparatively to R10 whose outcome is to achieve technology deployment, R17 is supported by R6 who agree that the imperative needs to be a business change outcome where those involved can be aligned behind a common goal, of which the technology is only part of the solution.

“In this industry, in a crisis, we are superb and I'll probably question you know, there aren't many organizations who can respond in the way that we do when we hit a crisis. And it's what's interesting in a crisis. What is it about a crisis that allows us to do the extraordinary. One is there is a very clear goal. In across as everybody is absolutely, 100% focused on what that the end goal is you, you don't get any usually differentiation without some misunderstanding, this is business change.”

R6

UTAUT2 is aimed at technology acceptance at an organisational level however it is clear that the decision made will directly affect other determinants which drive business change and technology acceptance. It also appears with UTAUT2 that there is a separation in understanding between application of controls and processes at the organisational level and how this engages those directly delivering technology meaning they have a lesser understanding of the importance.

4.2.2.6 Independent determinants

Table 27 shows the number of responses against each of the independent determinants by role level within the organisation. Table 28 is an example data table showing direct responses and their alignment to first order themes.

Row Labels	Geography (accessibility) (Faizura, H. 2018)	Organisational Incentive programmes such as Lean Management (Rose, T. 2019)	Opportunity for experimentation (Mergel, I. 2018)	Governance initiatives - Enabling (Read et al, 2016)	Organisational Demand/ Imperative (Adner, 2002)	Corporate responsibility (Ghbakhlo, M. 2020)	Leadership Legitimacy (Damanpour, 2006)	Leadership attitude (Oorschot, 2020)	Leadership knowledge (Oorschot, 2020)	Demographics (Cale, D. 2017)	Count of Respondents
Executive Director	1		3		7	5	5	7	5	1	6
Functional Director	1		3	1	9	1	4	8	7		12
B1	1		7		9	3	3	8	6	1	17
B2			2		4			2	1		5
B3			1								2
Grand Total	3	0	16	1	29	9	12	25	19	2	

Table 27 - Qty of identified independent determinants by Role Level

Relevant Framework: Independent Determinants						
Interview	Reference 1st order concept		Second Order Theme (Determinants)		Second Order Theme (Frameworks)	Aggregate Dimension
R17	And if your in Scotland, if try to replicate what XXXX has created then you will likely fail	→	Geography (accessibility) (Faizura, H. 2018)	→	Independent Determinants	→ What are the determinants of technology acceptance within the UK Public Sector Rail Industry?
R7	People who want to do things in an agile manner, which is something we obviously try and enable	→	Governance initiatives - Enabling (Read et al, 2016)			
NA		→	Organisational Incentive programmes such as Lean Management (Rose, T. 2019)			
R9	The criteria to enable the project needs to make sure that it is mandated on site with the reduced risk rate removed from the technology outcome.	→	Organisational Demand/ Imperative (Adner, 2002)			
R41	Evolve from where we are today and really get value out of the solutions that have been developed for the for the future. But it makes sure it's much more sustainable going forward.	→	Corporate responsibility (Ghbakhlo, M. 2020)			
R9	Being of the resistance to change, also the resistance to retest when amendments are made to	→	Opportunity for experimentation (Mergel, I. 2018)			

	improve due to the awareness work was still required			
R25	I say all that is really doing and this first stage is because riding a better regulatory arrangement with more information to signallers and control in order to prioritise which trains should run in to recover the running, identify defects in to the train plan and we've really got no where near this. This is the holy grail and its all inline with the train crew diagrams	→	Leadership Legitimacy (Damanpour, 2006)	
R26	Kind of a botched attempt towards introduction in my mind and so as [they] caught the flack from it.	→	Leadership attitude (Oorschot, 2020)	
R3	They have their own cars and can drive and so therefore feel they are experts on how to [deliver technology outcomes]	→	Leadership knowledge (Oorschot, 2020)	
R10	Kind of now mid late 50s category people generally are quite fearful of the of the technology. So you've really got to spend that extra time making sure that people are faced with it that you know they can't break it, if they break it, don't worry, we can fix it kind of thing.	→	Demographics (Cale, D. 2017)	

Table 28 - Response examples within the data structure for independent determinants

The independent determinants are those which have been created as a consideration, or in a specific context which do are not considered as part of an existing model or framework. These may not be applicable in the context of the Railway in the UK however they are just as likely to be considerations where the Railway in the UK can learn from other industries and geographies.

Organisational Incentive programmes such as Lean Management (Rose, T. 2019)

The determinant which was not mentioned by a single respondent. With the level of those responding across the business, it would be known if a programme was in place and so it can only be suggested that incentivisation programmes do not exist in the context of technology acceptance.

Governance initiatives - Enabling (Read et al, 2016)

One reference was categorised as governance initiatives, in particular those initiatives which enable and that was given by R7 –

“People who want to do things in an agile manner, which is something we obviously try as a company and enable throughout processes”

R7

The functional director in this case sharing that the company overall is of a mindset where it tries to enable flexibility in how they work to enable technology acceptance. But with a single respondent it is not clear how successful this is.

Demographics (Cale, D. 2017)

A second independent determinant which only had two respondents refer to it is demographics as referenced by R10 and R6. In an industry where the unique service provision is to move

passengers this potentially could have had more association with the need for technology acceptance consideration.

“Kind of now mid late 50s category people generally are quite fearful of the of the technology. So you've really got to spend that extra time making sure that people are faced with it that you know they can't break it, if they break it, don't worry, we can fix it kind of thing. ”

R10

“we don't understand what the apprentices will do in the future with technology. The work expectancy of an apprentice, you know, as they progress through their career, we don't think about it like that and about what technology they will work with. Are we sure they will be expecting to wear orange in 40 years?”

R6

The respondent here is referring to the fact that age can create a concern and nervousness to consider new technology. And therefore, any technology acceptance programme needs to be prepared to support those individuals through the process which has some association with freedom to experiment.

Geography (Haneem, Kama and Bakar, 2019)

Geographic limitations affect the ability to implement change and technology acceptance. Two respondents have differing views (R17 and R39) on this where one suggests its unlikely to work and the other suggests, it does everywhere else outside of the UK so what is stopping it working.

“And if you're in Scotland, if try to replicate what XXXX has created then you will likely fail”

R17

“the geography difference, the language barrier, the cultural barrier. Yet they still seem to deploy technology. That can adapt and overcome all of those things to delivery technology.”

R39

However both respondents are talking specifically about their project and this maybe why there is a difference in the opinions. The Executive director was referring to two parts of the same organisation whereas the functional director is making reference to separate geographies outside of the company where the same success factors can be found driving an increase in market share, in reality two different determinants which can be both affected by geography. The potential consideration from this is that the geography may be less important where those delivering the project share the same outcomes and needs and organisational alignment maybe more important to consider.

Corporate responsibility (Ghbakhlo, M. 2020)

The responsibility placed on the company is referenced in relation to technology acceptance due to the fact that in delivering the associated changes, there are benefits as discussed by R41 beyond the technology itself such as an improvement in sustainability.

Evolve from where we are today and really get value out of the solutions that have been developed for the for the future. But it makes sure it's much more sustainable going forward.

R41

Projects in their own right such as the hydrogen and battery powered trains as well as cases where jobs are being created in areas of low social mobility are also referenced which is expected for a public company. Three examples are specifically discussed by R40 and R41.

"The thing is that you know it wouldn't necessarily see that, but you know, another bit the other parts of social value might be yeah, if it's up in parts of country remote parts of countries about levelling up is about you know, creating jobs and you know, and I know that's one of the things that I know I've seen other business who look at that and going you know if we look at a development there or guess what it's now created 100 jobs or 150 jobs actually for the local community. "

R41

"You know, and all kinds of economics around that area and social deprivation actually, by doing that, you're suddenly create this, you know, this growth in in a particular area, which actually it's good for the local people."

R40

"The community and for government with taxes and everything else, you know there's a much bigger picture and it all adds up into something actually quite positive but we yeah."

R41

And these examples maybe intrinsically linked to success as they would help and support a business case where value is not only necessarily financially driven due to the only stakeholder which the government.

Leadership Legitimacy (Damanpour and Schneider, 2006)

The first determinant from the SLR in chronological order that specifically looks at leadership requirements as a determinant of technology acceptance. Leadership legitimacy would be able to place a level of credibility behind a project, receiving an instructor from a leader would have a direct impact on the behavioural intention to use as suggested by .

"difference between a leader understanding the process to go through for business change. Versus a leader creating an imperative to deliver an outcome "

R28

"effort you that had to go through to find the legitimate rationale from a leader made it much harder to reopen"

R17

Legitimacy as evidenced can make technology more acceptable to the business or more challenging based on the perceptions of the leaders. The company process to enable investment also requires approval from a leadership level, the majority interviewed 34 are band 1 or above and these individuals will have direct authority to approve investment in technology acceptance projects and so will be understanding of their own direct influence on projects and therefore within Network Rail it is seen that leadership legitimacy will play an important part in technology acceptance success.

“And if you don't lead from the top and if you personally don't accept the technology from the top and you won't support it, you won't deliver it.”

R6

Opportunity for experimentation (Mergel, 2018)

“Two parallel experiments, the two big inter city lines in the UK, one against the other to deliver volume and revenue.”

R17

The railway does experiment, this is referenced and confirmed both implicitly and explicitly.

“For the first of type projects aren't always successful. You got to you got to create a safe environment to be able to innovate. High output was always the national testbed for new products, so I think we did, we did that pretty well.”

R27

At the same time, the end users are invited to take part in the experimentation which also helps to build confidence and the intention to use the technology when accepted.

“So you need lots of Guinea pigs and you need the very best people”

R6

It was not surprising that experimentation as a determinant was consistently discussed and from the same point of view, that it is happening and visible across different levels of those who gave information. In isolation the determinant doesn't always mean that technology will be accepted and the evidence given in the study would suggest that this is the case.

“You probably expect that some will succeed, and some will fail, and those that you fail, you fail as quickly as you can to minimize the costs”

R11

Leadership knowledge and Leadership attitude (Oorschot, 2020)

Leadership knowledge and attitude are interlinked and discussed as such. The first is the understanding specifically of the technology being accepted and the second is approach to delivering the technological change. In the study, the predominant respondents are leaders in their own right and so the language does change.

"I still I do believe in the power of leadership because I see it and I experience it, you know. From my experience of having done lots of things similar to this, it's the only room I've managed to create where the mood and attitude is very different. There's lots of tensions just under the surface that can come out, but we've created a culture which really understands."

R38

From one of the leader's perspectives, when taking part in previous projects, similar roles within the industry prior have failed to create cohesion where there is a common belief from the leadership to deliver technology acceptance. It is not clear the effect this had on the technology acceptance and successful uptake, but the sentiment presented suggested it didn't encourage the project forwards.

"They didn't see its their accountability. So his challenge to them was you talk about this decentralization. But this is a good example when you're not really pulling it? If an RMD sets that example what does that say as a example further down? Now this is about leadership culture that I'm now talking about, and attitude towards. You always need the most senior person to make the decision"

R40

As a different perspective, the intent here is that the leader shows the attitude which enables the teams below to do the right thing and accept technology. R40 is not suggesting that this is the right way to operate, but that it is seen in Network Rail as the norm which poses an interesting point, that the only time that a leader can be seen to be knowledgeable and have the right attitude towards technology acceptance is when they have personally have gotten involved in each project.

Leadership Knowledge is specifically referred to and in a positive way, consistently for those who responded. As well as the fact it helped to move projects forward it also didn't have to be a team or hierarchical individual who takes the lead but someone who can bring the right people together to deliver and outcome. This is an interesting perspective and doesn't commonly align to what is understood as a leader within a command-and-control orientated industry and described by R40 and R33.

"that the person delivering is respected, knowledgeable and he's owned it. The fact that the project started out with understanding about what is important."

R40

"I mean it's like any form of change, isn't it? I'm a bit of a passionate believer in multi level leadership. Nobody dictated that it was necessary to improve, but they just recognised then it needed doing and therefore bringing those different people together was the way in which to get those things done and they were not the leader of the team"

R33

It is consistent that leadership knowledge is helpful when enabling a team to deliver technological change but from the point of view that the right leader is chosen who may not be hierarchical by role but still has the ability and influence to deliver the right outcome.

Organisational Demand/ Imperative (Adner, 2002)

29 references were made from the interviews relating to organisational demand and imperative. The most prolific of the identified determinants suggests that there is clarity around the business need for technology acceptance to take place seen clearly from R17 and R11.

"my experience elsewhere has been those are the two things that there's a business imperative to make it happen"

R17

"Current politics is about the pressure put on NR and the demand to do things, whereas actually from our CEOs position he's almost giving that foresight beyond a parliament."

R11

Similarly from other responses, the constant drive for achievement of imperatives means a loss of focus on what is actually important as shown by R38 and R40.

"The Railway is phenomenal and people love it because it provides so much focus, but It's horrible when you wake up and say, what's important today, everything's important. Can't focus. "

R38

"chronic problems we have in our industry is we don't focus; we don't focus and we don't realize that focus means saying no to a bunch of things"

R40

And in even more extreme cases causing money and time to be wasted to achieve the demand if in fact it doesn't align to the business needs from the very outset as reiterated by R24.

"Doesn't always align to the business needs, so we just do it again so that it does"

R24

This is a suggestion that the industry has a drive to deliver what is needed but in some cases at any costs and often failing in its attempts. We have heard earlier in the paper that there is a process to remove failing outcomes, but what is suggested here is that they are simply replaced by a further attempt suggesting the drive for achievement of the imperative may blind those who are part of the project from delivering the actual benefits of the technology acceptance.

Although Organisational Imperative is the number 1 referenced determinant in the study from those who were interviewed, there is a view presented that too much focus can lead to an outcome which does not achieve the corporate goal, and those involved can see this is the case but are either unable or unwilling to do anything to change as the business is focussed on delivery.

4.2.3 Context specific determinants

In the case of the UK Railway, the following 4 new context specific determinants are referenced by between 30 and 50% of the respondents so have a level of influence. Each one will be discussed in turn, to understand if they are able to be proposed as an addition to the existing models, stand alone or are supportive to an existing determinant.

Table 29 shows the number of responses against each of newly identified determinants by role level within the organisation. Table 30 is an example data table showing direct responses and their alignment to first order themes.

Row Labels	Internal Policy and Governance (etc Product Acceptance)	Relational Engagement (Trust)	Trade Unions influence	Strategic approach to solutions (Minimum Viable Product)	Total	Count of Respondents
Executive Director	3	3		4	10	6
Functional Director	4	7	3	4	18	12
B1	10	4	6	8	28	16
B2	3	4	2	1	10	5
B3	1	1	1	1	4	2
Total	21	19	12	18	70	

Table 29 - Qty of identified context specific determinants by Role Level,

Proposed new determinants						
Interview	Reference 1st order concept		Second Order Theme (Determinants)		Second Order Theme (Frameworks)	Aggregate Dimension
R3	Why don't you just let us get on with it?	→	Relational Engagement (Trust)	→	Proposed additions	What are the determinants of technology acceptance
R3	We give the TUs a very broad involvement in decisions.	→	Trade Unions influence			

R7	minimum viable product, what's the minimum you can develop to give you an output in some form that will tick the box of what you're trying to do?	→	Strategic approach to solutions (Minimum Viable Product)		within the UK Public Sector Rail Industry?
R16	It would never work, and even if it did it doesn't have product approval so who would want to even try to land their kit.	→	Internal Policy and Governance (etc Product Acceptance)		

Table 30 - Response examples within the data structure for newly proposed determinants

4.2.3.1 Relational Engagement (Trust)

An element that came out of 19 of the interviews was the need to work together, collaboration but even more than that was a prevalence of the need for trust, which could also be described as silo thinking. This played out in several projects where organisational dynamics and history affected the ability of teams to work together to often deliver an agreed outcome. One key example was the statement that *"we are experts from the industry, why don't 'they' just trust us"* R1 which was replicated in the other party suggesting that *"we need to challenge the industry approach...they have very different drives than we have, theirs is profit"* R37. These two examples show a frustration whereas one is internal, and one is how the business sees external supply chain. There should not be a surprise that a commercial company exists to make profit as that's what sustains the business but this could be a factor and a personal opinion which inhibits technology progression and acceptance.

The idea of ownership also came out where projects were being delivered by other parts of the business to those who came up with the idea. A view was shared that the best way to deliver a project, was to deliver it locally within the team it originated as that created ownership and therefore an imperative to succeed because it was difficult to *"trust others would do what is needed"* R28. Where projects were delivered by other teams as an example, those which were national tended to lack local buy in and fail (R32). The idea of trust behind allowing a part of the business to do what it was set up to do, and to have the best interest at heart was not a common outcome that was shared. Trust is referred to in the responses as having a part to play in successful technology acceptance featuring in 46% of the discussions with two examples from R1 and R2 below;

"From lack of knowledge, trust. I think that's trust within the team cause we're failing still. I think it'll take time for people to trust to get some further wins."

R1

"The engineer stood aside of him, put his hand up and said that was me. From that point on that are particular operator went to the engineering for support."

R2

Trust relates to the direct interactions between those involved in delivering the technological outcome however noted by some that the project is not specifically about the technology, but more about the business change enabling teams to work collaboratively in a different way but to solve a common problem as suggested by R17

“This is business change, it is a technological solution to a business problem”.

R17

Referred to in the interviews as trust but also known as legitimacy, the respondents referenced several different actors and how the relationship between any of those listed could delay or even stop a project from progressing and achieving technology acceptance.

- *Employee to Employee when in different teams and different goals or needs*
- *Project initiator to Project Lead*
- *Project Leader to Local influential lead – known to the team*
- *Project manager or deliverer – Someone who is directly responsible for delivering the activities*
- *Project sponsor – Oversee and coordinate the projects activities and enable the benefits to be realised*
- *Trade Union and working locally with employees*
- *Trade Union and working in an official capacity with the managers*
- *Trade Union sitting as part of the regulatory process*
- *Corporate policy makers*
- *Corporate policy requirement authorisers (Product Acceptance/Commercial/ Finance/Trade Union)*
- *Manager or team leader – directly associated with the team enabling technology acceptance*
- *Manager or Leader – detached from the process of technology acceptance but responsible for the strategy*

Across the interviews, comments which suggest there is internal competition *“I can do it better myself”* were spawned by projects being conceived but then taken away to be delivered by other teams (R2) and that *“it works much better when they listen”* (R23) were common. A general dis-trust in some functions with others *“my project team with the Southern Regional program manager we're working really well. It's really good. It's good if we can keep it going but its still early days* (R32) and also individual to individual *“I think it'll take time for people to trust us”* (R1). And although not an outright destructive effect on a project, there was mentioned a direct and coordinated lack of engagement as it was being delivered in one team over the other by R37.

“we engage them early on and because there was that slight misaligned wasn't misalignment. But what where we've I suppose we parted ways to some extent. the separation of their involvement led us to a position where the business became unwilling to adopt the technology because, yes, the team weren't happy.”

R37

With so many individuals and teams involved the relationships between parties and actors will be a key enabler or inhibitor to technology acceptance, just as much as the ability to work without silos and build positive inter team relationships. This is probably the reason why those projects which appeared to have delivered against their remit were referenced as those which remained local in their own silo, enclosed and had respected local leadership who carried influence, because everyone involved trusted one another and teams are constructed around a common goal and outcome.

4.2.3.2 Trade Union

Trade Unions were referenced in 12 individual respondent interviews.

Leaders, individuals, and teams are all named within the research undertaken. But one group of actors which came across strongly in a 1/3 of all the respondents was the trade union, and there is a considerable power and influence this group of individuals poses in affecting technology acceptance. In some cases, the trade union member undertakes a pseudo role as a manager or leader (R26), in others it's a member of the team and in some extreme cases are informing business strategy in favour of their membership (R6). This often is having unintended consequences in the progression of technology acceptance projects and in some cases a detrimental impact on the success. This has not been investigated further as it is not part of the original research questions but for purposes of the findings, there is a role which must be played and for the trade union that covers three purposes.

- *Supporting individuals locally,*
- *Representing and informing a team and*
- *Holding a strategic influence on the outcome of a project*

This suggests that the Trade Union relationship and involvement must be considered to impact all 3 elements which means it must be a fundamental consideration even if not a determinant in its own right. To show a relationship between trade union influence and the success of technology acceptance, there could be a direct association with two determinants already in play, attitudes toward use, and incentivisation but this would need further investigation and research to confirm and potentially evaluate.

“Yes, if we went on really interesting journey with the unions. So we've engaged, you know, engaged in right from the very start. That's one of the reasons why I know XXXX so well. And we've taken on

that journey with them, with us, so they understand the technology and we put it into very simple terms we employed.”

R6

In the cases which have been given to the study, the trade union is presented both as a determinant and an actor within the respondents. The reason for this is that the trade union plays many parts when it comes to technology acceptance. The internal governance within Network Rail requires trade union engagement when technology is being introduced and this can create challenging dynamics if for example a team is reticent to accept *because I've not done that consultation stage first, it wasn't a massive success* (R6).

The reason trade union bodies have been left for now as a determinant is that Leadership, as a group, feature as determinants in their own right due to the level of influence which is purveyed. From the interviews given, it appears in many cases trade unions have more of an influence on the individuals within the team than the leadership, and this dynamic has a major impact on the ability to accept technology which has been seen in the evidence obtained.

“To prove the technology there was a the approval bodies and stakeholders within Network Rail and who had some conflicting views. And then there was the trade unions and the users. So with a resistance 2 things really resistance to change and also concerns around how the technology is being used. Obviously as far as we were concerned and the design and everything, it was a purpose was to design the Union and some of the users were concerned that it was being used for other purposes.”

R6

“So we've engaged, engaged in right from the very start. And we've taken on that journey with them, with us, so they understand the technology and we put it into very simple terms we employed.”

R9

Discusses the relationship with the Trade Unions no differently than that of an executive leader, and part of the process to enable a supportive approach is to gain acceptance in the same way as if the Trade Union was a company leader.

The determinant relating to the Trade Union is the development of understanding as to the attitudes towards acceptance which the Trade union may have which are different to those of the individual and business.

4.2.3.3 Strategic approach to solutions (Minimum Viable Product)

Minimal Viable Product was referenced by 18 individual respondents.

Minimum viable product (“MVP”) is by definition a product “with enough features to attract early adopter customers and validate a product idea early in the development lifecycle” (Leonard, 2023). In terms of the responses, MVP was used extensively to describe an approach to a final solution

“Existing station through to final product with site compound being built and existing bridge being demolished - I also see people looking at the price tag and saying what a fantastic profit margin for the organisation who's delivering your footbridges. Do you really need that to get him a minimum viable product footbridge in the ground? In a cost efficient. Renewal space. The appetite, the willingness to innovate, is different to what you possibly see in a multibillion # enhancement project“

(R24).

In some cases, MVP was described as per the given definition above, but the context of the discussion was not aligned to what was being portrayed, *“we try and get above 70 well we never get below 70, we get above 70 pence per pound in the ground and our calculation”*s (R36) meaning that the imperative was clear but the application differed. In all cases the sentiment was clear, to deliver an effective solution, with the lowest cost to enable the outcome as the imperative however the reality rarely achieved the levels of success.

“I think really the first thing think about is, is the sort of minimum viable product, what's the minimum you can develop to give you an output in some form that will tick the box of what you're trying to do?”

R7

In the context of the research, MVP should be considered as method to develop the imperative and an approach to governance initiatives rather than a standalone detriment. This is because the process for governance should inform the outcome as a direct result of “building on the lessons of the past to inform the outcome”(Read et al., 2016b).

MVP is an organisational process which enables enough activity to be undertaken to enable local support without wasting resources. Referenced by almost half of the respondents, it was suggested this process is a requirement and enables compliance to the corporate strategic goals. The aim, to reduce cost whilst taking a product to market in the quickest possible way to achieve the benefits. The market in this context being the operational railway.

“minimum viable product, what's the minimum you can develop to give you an output in some form that will tick the box of what you're trying to do?”

R41

4.2.3.4 Internal Governance Process (etc Product Acceptance)

Product Acceptance was referenced by 21 individual respondents and *“is a necessity to achieve a level of performance as set by policy”*. (R14). Product acceptance is the *“regulatory approach to permit new products on to the railway”* (R20) and is an internal governance requirement enabling Network Rail to discharge legal duties.

Although it has been mentioned regarding internal governance initiatives which enable technology acceptance, within the interviews, 6 of the respondents referenced specifically an internal governance requirement which was inhibiting technology acceptance

"It would never works in a real way before and hasn't got the product approved, who just wants to, you know, land their kit. You're gonna evidence its benefits, even if it is from another application. You gotta prove it works and influence to prove that it works to prove that doing that is better than sticking to the norm."

R15

"I think for two years and why? Because they're still asking what's the technology, its still in product acceptance is there it's still after 2 years."

R9

Product acceptance is the process at which a new technology interfaces with the existing railway, and is of a technical nature (Rail, N., 2023). whereas trade union involvement relates to the engagement with the individuals as singular entities and also as a collective (Gov.uk, 1992). In the case of the Product Acceptance process, which is being referred to, those who have commented understand that the process is required but see the process as a burden, slowing down the time to accept and not being often a non-value-added activity except where the outcome is achieved;

"was very different in the their previous industries to what it was in Network Rail and they found that the product acceptance was a lot harder, slower in rail as opposed to what it would be in other industries for the same products."

R9

"I govern the product acceptance for acceptance for remote condition monitoring. I am responsible for the compilation and the use of the aerial survey. I'm responsible for the implementation of all predict and prevent technologies within Network Rail as well as the implementation of the new Civils technology suite. Of which are progressing well"

R6

Product acceptance is a legal requirement for an infrastructure manager to undergo when managing the risk of the operational railway (Regulator, O. of the R. and R., 2021). This process was referred to by many, as a practise which can slow or prevent technology acceptance with little more reasoning as to why. Understanding the legal aspects, product acceptance needs to understand the inherent risk with the railway system and work to reduce it to a level which is as low as is reasonably practicable where in the case of technology acceptance it appears its application is in some ways seen as a challenge as it is unique to the rail industry.

“how are we ending up product approving stuff that's just adding 5% value and actually 80% pain that's about the value of the process”

R35

“Forcing that kind of stuff through leadership is all about it isn't it? being able to Influence the right level to say that I understand what the (PA) process says, but here are the practicalities of what we're actually trying to achieve. And you might not realise it, but actually some of the decisions we both make - let's just apply some common sense here”

R36

As with any process understanding how to correctly apply it can mean it is successful or not and therefore the challenge with Product Acceptance as it is unique to the railway may lie in the base understanding of how to apply.

4.2.4 Technology acceptance is a function of business change

There has been evidence of the linkage between imperative and success not only by the fact that each and every case where imperative is reported as a determinant, there is also a measure of success – 29 of the interviews described the association in particular all of the Executives below (2501231430, 2203231300 and 2804230930) interviewed described the association.

“The premise that technology is difficult to introduce the railway can be difficult to induce. The railway I that's the support of the statement and what I want. What I done that. Where it's becoming a big issue and it's worked on and I suppose it's 20 more. Lots of little things rather than the one single big thing that comes to mind cause I've because I've sort of run businesses fundamentally the there's been projects or things(tech) that have been part of the business development”

R17

“The business change. There is necessary to support it. And without, without some jumping up and down technology doesn't work and its so much of what we do.”

R25,

“we really struggle with delivering business change”

R40

But what is also common in these same interviews is that there is a discussion around technology acceptance being a part of business change and not the other way around. What is being shared by the executive respondents is that technology acceptance can only be a part of business change and on its own is unlikely to succeed. A view that because the

company has an engineering focus, the engineers often fix problems which may not be aligned to the business need. *“We are overrun with technical people who don't really value business change - at the heart of it is we don't see this as business change. We see it as a technological fix to a problem”*. (R17)

An example of this approach to projects discussed by the executive leaders was seen in the responses. Collision Avoidance was presented as a project which had not been completed and suffered from some challenges to complete. *“all the technical work, scope it, it was to design out the risk and that was its intention but the purpose as a project ... should have been to implement change with the teams, and to understand why there was resistance”*. (R9). This perspective on Collision Avoidance as a project articulates well the requirements for business change closely associated the demand underpinned by technology acceptance.

4.3 Research Objective 2: Success

Success in terms of the SLR presented some consistency in terms of how it was considered. The four areas can be seen in Table 31 as well as the two types of success as discussed in the empirical study. There are two main outcomes from this section which are;

Success factors are predominantly based around risk (coercive factors) and governance (normative factors) (Discussion literature was finance and market) – institutional theory

Technology acceptance factors of success are not aligned to a tangible business requirement and are often disassociated to the end user – Public versus commercial

4.3.1 Factors of success

Different to the SLR where the minority discussed successful outcomes (15%), the specific questions as part of the interview meant that each respondent confirmed what they determine as successful outcomes. Table 31 summarises the outcomes quantifiably however the table does not show influence but merely enables themes to be identified. Table 32 and 33 both present data structures which have been populated with examples from the interviews. Table 33 is specifically those whose success is defined in the railway context by the respondents of the empirical study.

	SLR success factors					Empirical success factors	
	No measure of success	Human Resources - Individual choice	Operational - Measurable quantification	Financial - Market share / increase uptake	Strategic - Aspirational	Corporate risk model (Safety, Reputation, Finance)	Regulatory compliance
Executive Director	0	0	0	4	3	2	2
Functional Director	0	4	4	5	1	5	4
Band 1	0	0	5	6	0	10	7

Band 2	0	1	1	2	0	4	3
Band 3	0	2	1	0	0	2	2

Table 31 - Qty of identified determinants of Iacovou Model by Role Level

Success Criteria				
Interview	Reference 1st order concept	First Order Theme (Determinants)	Second Order Theme (Frameworks)	Aggregate Dimension
NA	Individual cannot determine the method of success	→ No Measure of Success	Success Criteria	Research Question 2: What are the factors of successful technology acceptance within the UK Public Sector Rail Industry?
R32	the frontline guys using the technology are saying that that technology is better than what they did before.	→ Human Resources - Individual choice		
R32	on returning investment, so how much did you spend on that product and what are the benefits that are being realized, so the return on investment	→ Operational - Measurable quantification		
R24	Success is about market share	→ Financial - Market share		
R11	ultimate success is decarbonization of the railway	→ Strategic - Aspirational		

Table 32 - Response examples within the data structure for factors of success

Interview	Reference 1st order concept	First Order Theme (Determinants)	Second Order Theme (Frameworks)	Aggregate Dimension
R32	achieving product acceptance	→ Coercive - Corporate risk model (Safety, Reputation, Finance)	Proposed additions	RQ2
R31	regulator particularly interested in the new technology	→ Normative - Regulatory compliance		

Table 33 - Response examples for the factors of success for new items referenced by the respondents

"If the factors of success were summed up by the comments, it would be that we are really bad at deploying technology."

R17

Taken from the executive director, the perception is that Network Rail could improve in its ability to deliver technology acceptance. This is not only limited to the top of the organisation as it can be seen from those within the organisation too such as R18

"I think we've got a lack of confidence in technology adoption. I think if I was sitting in the chief and someone came to me and said we're gonna spend. look at some of our big projects and you sit there and go, we're gonna spend £600 million on XXXX. To me, that's a huge number. We've asked the benefits in the room, you know, it's just it's just a lot of things, a bit misaligned. And I sit back and go 600 million that's a lot, you know, and actually."

How do you how do you really know that you're gonna? You're gonna get the benefit of that, what is success from £600M?"

R18

Considering the two above references, successful outcomes needs to improve if Network Rail wishes to change its delivery. The responses from the interviews from the business did show some alignment and all the four types of success were identified from the SLR. Market share however was not defined as growth in an external competitive market, but the change from doing one process or activity to another such as the example given by R1, R3 and R8.

"Success is when more projects are delivered using different product types than what we use today."

R1

"technology was a very proven and working very successful with other suppliers in other fleets, moving to this model benefitted. But unfortunately, Network Rail weren't were less aware. How many vehicles we have is significantly lower than it was, vehicles we rent is significantly lower than it was because of course before people enter vehicle."

R3

"Success is the way we set up the program was very, very different than any national program in the past and that was that was done deliberately because it wasn't in a good place. It didn't have a good reputation. "

R8

This internal competition was repeated throughout the respondents suggesting a tension when delivering new technology within the organisation where a new process competes with the existing process. Not to be unexpected and the reason why the determinants around personal choice featured with a high level of influence because existing practises need to be overcome to enable technology to be accepted. However, when the results are normalised by the respondents an improvement against regulatory compliance or improvement in corporate policy compliance stand out.

What is telling from the data regarding success, is that a successful outcome is often aligned to that of the organisation, but very infrequently if at all to that of the individual or team. Only 2 of the interviews discussed success as relating to the acceptance of the individuals at an individual level. Interestingly both individuals are the frontline delivery leaders of their respective projects as demonstrated by R23 and R2.

"the operators fully bought into the scheme"

R23

"I couldn't fall any of the involvement from the start. The innovation team, the senior team where we wanna call it, running away with the idea we can make this work. The involved people from the ground, from the off which? Which made it a success that it was personally"

R2

This difference in articulation between organisation success versus individual success would mean it may be difficult to share with all employees what success means to them for a nationally led activity. There maybe further reasoning behind having corporate level successful outcomes since the activities discussed in each interview are generally supporting commercial, financial, and technical compliance at a corporate level and so established by the corporate entity. The concern is that corporate successful outcomes are not translated to align with individual need which may provide a challenge when you come to apply DOI and TAM based determinants.

Discussed in the Plan for Rail, revenue is an important driver for industry success (Shapps and Williams, 2021), yet industry market share is not referenced except by one of the business leaders who actually suggests that market share is not the most useful for rail;

"I would be deeply sceptical about obsessing about market share, particular transportation business where you know, it's not like you think about it's not. It's not like most parts of retail where you have no, you have no ability to yield manage."

R17

In favour of a more applicable outcomes which is

"We've separated our biggest revenue decisions from our biggest cost decisions. You'll take revenue decisions that harm your cost, position and cost decisions that harm your revenue position? And in that latter case, the driver of stuff that will harm your revenue position? We have to focus on revenue."

R40

As this metric is not being commonly used in favour for one of compliance, it is difficult to articulate how each team delivering a project would be engaged unless the incentive was to make their own role that bit better for themselves. As the technology acceptance can be directly associated with a common goal such as revenue growth, the outcome *so actually strategic workforce planning should be the go-to method rather than you know engagement and reduction and heads* (R38) can be varied from the original intent depending on how each individual team sees the opportunity. If we couple this fragmented nature, detached from a common purpose *"no wonder it's difficult to gain alignment"* across the company. (R25). Figure 23 offers a visual example of this can be seen in a proposed view of how an individual goal can sometimes be unique to the company goal.

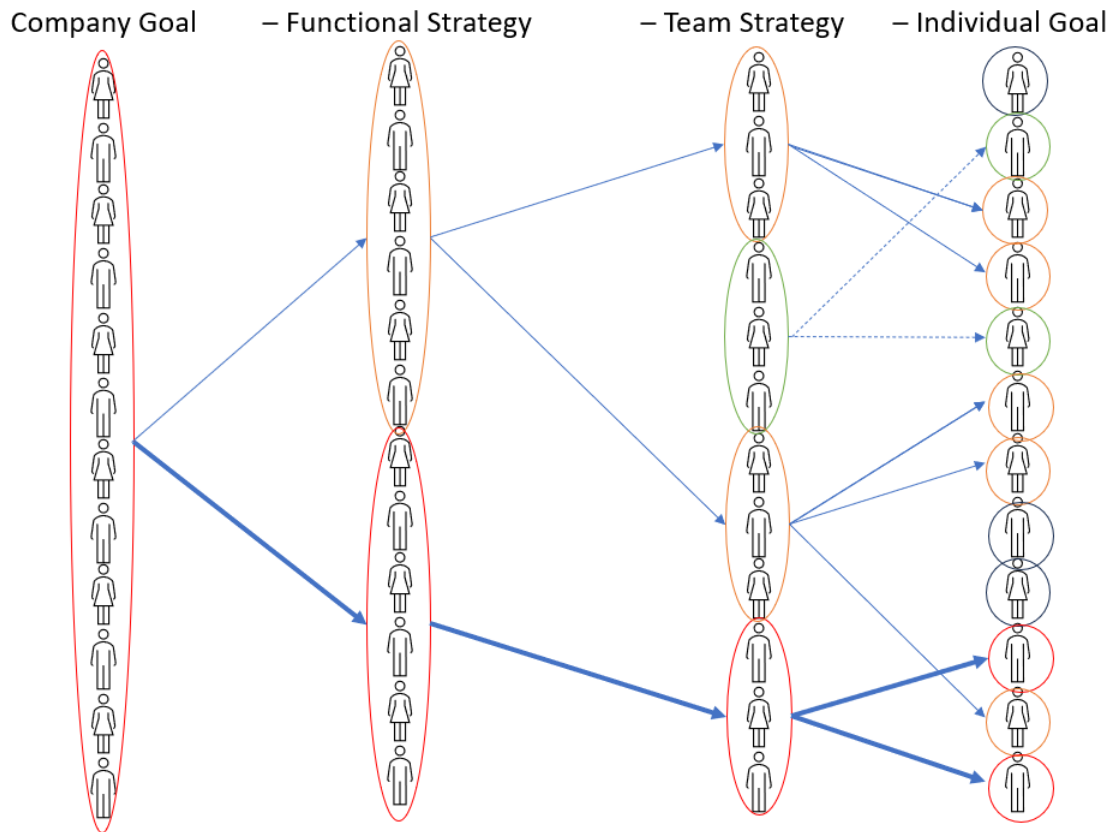


Figure 24 – Exaggerated illustration of the alignment between individual local and common company goals

The corporate strategy is developed and considered as robust, but Figure 24 shows that as you cascade a common message, teams can amend this based on their own perceptions and experiences. The larger the project, the more levels and variations which can lead to individuals having their own views and potential outcomes. Business change is there to provide cohesion across the business enabling technology acceptance to take place and so should not be underestimated as we have seen individual groups can derail a project even where this can benefit the individual more readily than the corporation.

4.3.1.1 Individual choice

TAM DOI and UTAUT focus in on the individual and the need for individual acceptance and yet, the interview has seen repeatedly that the outcome of technology acceptance is focussed on a corporate goal which is not often associated with an individual goal and a reason why the Trade Union influence features heavily in the interviews. There is an immediate example of conflict between corporate and individual choices for example if the technology is likely to reduce the need for a sizable workforce as articulated by R10

“Now, in this day and age, you know levels of redundancy in that type of technology is fairly straightforward”

R10

this is in direct challenge with the goal of an individual worker which is likely to be to retain their role amongst any other drivers. Technology often is being implemented to reduce cost as evidenced by R9 and R18, in the railway that often is associated implicitly with the number of resources to do an activity the comparative between the technology and reduction in roles is made whether true or not.

“it was a purpose was to design an anti collision but they the Union and some of the users in particular were concerned that it was being used for other purposes to”

R9

“This isn't about reduction and we have to be really sensitive around that.”

R18

4.3.1.2 Market share

As Network Rail is a public body, at arms length from the government and as already presented in 4.3 that market share isn't a suitable measure, growth or uptake as a function of a successful project is more suited and was articulated across 69% of the respondents as shown in the example give by R20;

“The right people, the right, the right goal, that it's actually got people. People can see the benefit to it. People are brought into achieving it when it's this type of project and are prepared to use.”

R20

Although this is not a true example of market growth, the inward-looking nature of the organisation appeared to base many of its requirements on changing itself for its own corporate good and the satisfaction of normative pressures. A core and common measure of success for projects run by the organisation is the uptake of its own people, R24 explains, but as a measure this is not aligned to the overarching outcome of the technological solution.

“And actually I think it was kind of a pilot. And I think it was relatively successful. But the individuals who were subject to that change will have multiple other things that they need to learn to do at the same time as well. Not everyone prioritised the time.”

R24

Unpacking this proposition and determining the reasons why is key to understand how to improve, because certainly the measure of success for those in receipt of the project, is not whether they take it up but what they will be getting out of it.

4.3.1.3 Aspirational

From the SLR, aspirational success is described when an organisation was taking a risk, doing something which may come true and benefit the business (Bonnin Roca and O'Sullivan, 2020; Prester, Erceg and Kumić, 2016). Enabling technology (Read et al., 2016a) or new software opportunity were examples presented as cases where aspirational success would lead to longer term direct success in terms of market share or customer uptake.

Within the railway, the responses from the empirical review suggested that often the solution to the problem potentially could be better formulated (discussed in section 4.2.2.2) and therefore the problem could benefit from being better understood before it is too late. This suggests that a lot of the projects are starting off with an aspiration of a successful outcome that would enable better outcomes which could have a low chance of successful acceptance. Aspirational projects would normally be associated with corporate high-risk decisions. Aspirational projects also have a tendency to oversell potential benefits associated with the regulatory or strategic compliance rather than understand how the project could be successful from an MVP approach as presented by R24.

"I've just done a projection with XXX and I can't get to the same outcome. looking at how we manage proposed benefits, how do we stop letting everyone spend as much money as they want and no processes in place to track against the benefits."

R24

Having aspirational technology acceptance projects without robust outcomes would likely result in benefits rarely being achieved, money and time wasted, and successful projects being oversold yet underdelivered as seen in the example given by R25. Fully understanding the problem, formulating a solution and being clear on the demand should limit the risk of exposure

"the length of time often means that the benefits are diminished the longer things go on for. hundreds of millions of potential investments. Its kind of forgotten, why did that project go wrong? There was great ambition and great intent, the fact that someone been seconded from the top suggested that it was starting off from the right perspective, but obviously that drifted as it was not understood, and the structure was not there"

R25

With no guarantee of a successful outcome, it has been seen that there is potential to simply start again if these miss the target outcome and so the potential to spend money and use time inefficiently as can be seen from the following examples from R6 and R39.

"I would have done differently. Making sure that everybody knew that I created an opportunity which doesn't create a benefit, and they have to create the benefit from the opportunity I presented."

R6

"I will affect all of this stuff. And I said, well, I don't need that, but because it fit all the freight trains and I was like, I don't need it. I don't need it. Its not the risk I am dealing with today"

R39

4.3.1.4 Achievement of risk reduction (coercive factors)

From the discussions had in the study, the achievement of a reduction in the system risk such as the example from R12 was prevalent as an outcome which was beneficial to the organisation.

"doing automatic earthing, so you know you'd have switches on there that would once it's isolated, confirmed isolation. You can then you know lock our earth on to on to the red line. it's all earthed. You could almost do that where you know where we've got any issues you could put those at various locations. the measure of success would be very, very quick confirmed isolations and earth."

R12

The example talks about the ability to isolate the power from any way and confirm that is the case robustly which reduces the whole system risk which can also be seen from R9.

"if you're to define success criteria, no, don't think it's there where we want it to be. Yeah, the. The certification is there which is what we are working towards, but the full operational use is not, the hardware is fit. The software's proven to work, but the full rollout and operation across the worksites is not complete and therefore the risk still exists."

R9

Even with the investment time and effort this example given presents that still the risk has not been reduced and is still in existence. Although there is an agreed outcome by all parties across the business and Trade Unions the outcome to reduce system risk has not been achieved. There appears to be in this case a concerted effort to do the right thing and achieve a common outcome, but the business and team appear to be unable to deliver the outcome for whatever reason, which could be an example that individually the outcome is not one which has been truly committed to.

4.3.1.5 Improvement in regulatory compliance (normative factors)

When considering the common projects such as machinery safety from Section 4.2.1.2 a common outcome for all the projects here is to achieve an improved level of compliance with regulation as can be seen with the examples from R30 and R23.

"I don't think money can be used as a reason not to do something if it's a legal requirement, isn't it? Yeah, you can't say I'm not paying all that."

R23

"The level of success was on ensuring that the software changes would be done safely, and that the OEM could prove that. So that was a measure of success. And then the other part was that we had a process in place where the system couldn't be abused by the operators."

R30

Being a public arm's length organisation, and an industry which is regulated as Safety Critical is not surprising that compliance with regulation is frequently referenced (Regulation, 2007). What can also be seen from the three examples given is that the success of the technology acceptance is insular in its outcome, benefitting the individual or the team alone and not linked to the industry strategy explicitly (Shapps and Williams, 2021). This means that it is unlikely that others can be engaged in the technological change because it is distinct to the team only and in a different silo of the organisation.

Network Rail should consider if the intended outcome of projects is correctly balanced against corporate needs versus normative pressures.

4.3.2 Successful outcomes associated with determinants

As considered when refereeing to aspirational success in section 4.3.1.3 the alignment of a robust outcome is important for any technology acceptance project which has a level of aspirational success. Commonly across many of those interviewed the factors of success and outcomes are not often aligned with the requirements of the technology acceptance or those who are needed to undertake the implementation, predominantly the end user as seen in the powerful statement by the R17.

"The ability of the organization to really share with people how well we're doing is quite blunted, and therefore we've never developed that sense of, you know, that sort of skill set, which is really allows people to work well in silos."

There's never really a feeling that they're contribution towards a set of outcomes.

R17

The clear distinction that any business change should have a common outcome which all involved can relate to, a way to benefit the individual and the corporation is important and was discussed but appears to often not be the case meaning the outcome of technology acceptance is detached from the determinants evidence by R17 and R37.

"Actually if people invest heavily in the business change, and everyone contributes to a shared common outcome. And most of the places where we it stops is where we struggle with technological deployment, it's largely because of those two factors, particularly the latter."

R17

“That's because the biggest business models are different, aren't they? Their drivers are different. They're the things that are that, you know that behaviours align to. Those drivers are always going to be, how do I maintain my profit margin? “

R37

The examples shown of which there are many more often have an outcome which is not aligned to the determinants that are being focussed upon which have all been discussed in this section. The implementation of technology to;

- *reduce system safety risk is seen as an opportunity to reduce staffing levels, - R9*
- *new software to improve the working regime of signalling staff is there as a way to reduce activity and is untrusted - R10*
- *fitment of forward-facing cameras to reduce line side survey and improve system safety risk is removing jobs. - R18*
- *Remote isolation switch off being unfunded as there is limited system benefit for the organisation - R12*

These are all cultural aspects which suggest the problems being solved have not been considered to the extent of the corporate needs and also individual requirements and goals. There are some examples, one in particular from R36, where the success does align to the strategic directive of the company which is supported, and cases where the strategic outcome does align to the determinants being focused upon.

“With it being the new tech bringing the the new tech operating as it should do, and being able to share the lessons for that take across the business to make sure that it's bought into and obviously fulfilling the remit which is taking a person with reduced mobility from one side of the railway to the other side of the railway in a in a reasonable amount of time”.

R36

4.4 Objective summary

Data collected through the empirical study has been broken down into themes. These themes articulate the findings from the semi structured interviews and can be used in to inform the response to the research objectives in the context of the UK public sector railway.

The findings presented in this chapter are:

Research objective 1;

- *Common types of technology acceptance are taking place in the railway, software is the most common being accepted which means that the industry might learn from other projects and industry context areas..*
- *The understanding of technology acceptance and its determinants across those interviewed is mixed and inconsistent. The available research appears to be unknown to those delivering technology acceptance and certainly not being consistently applied.*
- *New determinants are presented which stand out firm for those who have shared their perspectives and should be considered in line with the existing determinants identified from the SLR.*

Research objective 2;

- *Achievement of success relating to technology acceptance within the railway within the UK public sector is normally either based on the achievement of normative or coercive pressures, rather than market forces and growth.*
- *Technology acceptance is often separate to business change meaning that the focus is on the technology and not making sure it works properly to achieve the business benefit*
- *Success for those directly delivering projects is generally aimed towards the individual whereas those overseeing projects which deliver technology acceptance is focused on the achievement of corporate outcomes.*

The Emotional impact of leading technology acceptance projects is a theme which has been identified as this has the ability to affect a number of the determinants and should be considered specifically for the potential impact it may have on the associated determinants.

5 Chapter 5: Discussion

This chapter discusses the findings in comparison to the data from the systematic literature review.

5.1 Research Objective 1: Determinants

With 663 discrete determinants recorded from the interviews, an average of 16 per respondent and a maximum of 39, it could be considered that there is considerable knowledge in this field within the contextual area. The following table (34) presents a comparison between the findings and the systematic literature review.

Research Objective 1: What are the determinants of technology acceptance within the UK Public Sector Rail Industry?

Objective	2nd Order Themes from Data Structures	Findings from Literature	References from Literature Review
What are the frameworks and determinants of technology acceptance applicable to the UK Public Sector Rail Industry?	Common types of technology acceptance are taking place in the railway, software is the most common technology being accepted and applying the existing models is likely to help understanding through increased knowledge	TAM is the most referenced of the technology acceptance models which was developed with a focus on IT hardware and software (technology) acceptance.	(Davis, 1985)
	The understanding of technology acceptance and its determinants across those interviewed is mixed and inconsistent.	The application of technology acceptance models has been tested since 1985 and have proven to be able to help the understanding of the suitable determinants. Applying more than 2 models to the same technological change is not recommended as the number of determinants makes it difficult to manage the level of variable.	(Lee, Kozar and Larsen, 2003; Sepasgozar and Davis, 2018; Venkatesh, 2008)

	New determinants are presented which stand out for those who have shared their perspectives and should be considered in line with the existing determinants identified from the SLR.		Additional to the existing research
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Table 34 - Comparison between the findings and SLR outcomes for Research Question 1

5.1.1 Common technology categories and comparable determinants

Software delivery and acceptance as a technology project category has been presented the most from the extracted literature (17 articles [27%]). TAM is the most common framework referenced in the extracted literature (23 articles [36%]) which was developed for software and hardware introduction, the empirical study also saw software as the most common technology category with 6 distinct projects out of the total 41 respondents. It is suspected this is the case for two reasons, TAM and DOI which developed the initial understanding into technology acceptance where the first models to be released in research studies and focussed on IT software and hardware meaning their origins were associated with IT firstly. This was at a time when IT products were seeing an increase in development and the market growth of products drove a digital age of change (Rose, 2016) – making people more aware..

There are some consistencies between the references to the determinants from the empirical study and the SLR outcomes, as an example, organisational demand from both the SLR and the interviews has come to the same extent high in the level of responses and references. Market competition did not heavily feature from the interviewees but did feature frequently in the SLR, which is probably because as the infrastructure manager, there is no competition for Network Rail due to the fact of being a public body. However, there is a competition for revenue and demand for the services the company provides (Shapps and Williams, 2021) so although this is not a market force, the need to either increase revenue or reduce costs is an important driver for success. If an organisation is unable to articulate the true benefit of delivering technology acceptance, it is difficult to then determine when this is successful and probably a reason why the 4 success categorisations from the SLR have needed to be expanded to reference success criteria which are either driven by the company's internal strategic outcomes or show an improvement in compliance to government policy.

Although table 35 offers some considerations in to how the SLR compares to the outcomes of the empirical study in regard to determinants, it is important to remember that the SLR is made up of many contexts and industries, whereas the semi structured interviews focus on the rail context only. This is important to distinguish because as seen from the SLR, the context of technology acceptance can have an effect on the prevalence and influence of the determinant. This may mean that the rail sector does only have a small number of determinants which are of influence compared to that of agriculture or mobile software applications which impact a larger demographic and therefore have more variables to enable success (Fronimaki and Mavri, 2016).

SLR Determinant	% of articles	Interview determinant	% of interviews
Leaders Attitudes towards technology (Rogers, 1995)	13%	Internal - Complexity (Rogers, 1995)	73%
Policy/Regulation	11%	Procurement Systems - (Rose, T. 2019)	73%
<i>Organisational Demand/ Imperative (Tornatsky, L.G. 1990)</i>	11%	<i>Organisational Demand/ Imperative (Tornatsky, L.G. 1990)</i>	71%
Perceived Ease of Use (Davis, 1985)	10%	Perceived benefits of innovation (Iacovou, 1995)	71%
Social Influences (Consumer/Peer Pressure) (Kuciapski, 2017)	10%	Leaders - Attitudes towards technology (Rogers, 1995)	71%
Behavioural Intention (Enjoyment/Motivation) (Kuciapski, 2017)	9%	Financial Resource (Iacovou, 1995)	63%
Market (External Organisational Competition) (Tornatsky, L.G. 1990)	8%	Performance Expectance (Kuciapski, 2017)	61%
Perceived Usefulness (Davis, 1985)	7%	Facilitating conditions (Davis, 1985)	56%

Table 35 - SLR Vs Empirical study, common determinants

Table 35 shows a comparison of the most prevalent determinants from the SLR and the empirical study. Each determinant has the same definition and so this table is only there to show the proliferation in the extracted reference materials compared to the outcomes of the interviews.

Information which can be seen from Table 35 summary;

- *The there is a different level of response between determinants presented in the interviews than what is shared from the literature in terms of prevalence.*
- *Demand and organisational imperative are in a similar position in terms of references and responses. Suggesting that this is of key importance where the rail sector has this as a robust requirement similar to the SLR references.*
- *Perceived Ease of Use (Davis, 1985), Social Influences (Consumer/Peer Pressure) (Kuciapski, 2017), Behavioural Intention (Enjoyment/Motivation) (Kuciapski, 2017), Perceived Usefulness (Davis, 1985) are all high scoring from the SLR but not reflected within with the same level of proliferation within the empirical study. This suggests that in the railway context, these are either of lesser importance or less commonly considered. .*
- *What is unique for the rail sector compared to the SLR is procurement systems (Rose, Manley and Widen, 2019) and financial resources (Kuciapski, 2017). These were referenced higher than the quantity for individual and leadership based determinants, suggesting that they play a more critical part in the railway than the literature responses would suggest.*

Both technology types and determinants suggest that Network Rail may benefit from applying the models in full, to understand if the determinants included within them can benefit a successful outcome. It is also evident that having more focus on the consistency of application for the individually focussed models such as TAM and DOI would be likely to offer a level of improvement. Comparison between the literature pool and empirical study outcomes is that these are different and that Network Rail responses are not aligned to that of what has been presented by the SLR.

5.1.2 Organisational understanding of technology acceptance

From undertaking the empirical study which consisted of 41 interviews the responses given did not align to that which was presented by the SLR. The consistency in responses regarding determinants, models and frameworks and application is seen to be varied across all role types. This section discusses the responses further.

Leadership legitimacy and Leadership attitude, stand out as being highly referenced for their impact.

Surprised at how I had to go round another loop to bring those on board and have multiple Leadership discussions and presentations to get them to see this was basic common sense.

R3

I'm not convinced that the leadership bit helps that much? Because we have an organized, you know we have a frontline organization that don't really listen especially to their leaders.

R8

This is likely due to the inherent command style of organisational structure (Hatch, 2006). The commonality in response to leadership also relates to “organisational demand” and the association with success. The most common type of successful outcome for the company was in regards to achievement of the strategic outcome or goals of the company which are set by the leadership. This may suggest why these 3 determinants and success are aligned by the majority of the respondents

It was an area that we didn't address as well as we could and it just meant that it we played catch up a bit in terms of trying to get some of the key route leaders on board, interest in the frontline staff got it more than there leaders did, but we had to get them on board...otherwise it would fail.

R31

So whatever level leadership comes from, somebody will have grabbed an idea to chase it through to threshing cause they're really passionate in it. The organisational leadership bit is about creating the environment in which people can succeed in doing that, no matter who they are or where they're what their position is.

R33

Opposite to those highly referenced leadership determinants, organisational incentives and demographics did not feature highly in the interviews. This could be due to the fact that there are not incentivisation programmes accessible to the organisation but also that demographics do not feature in the types of technology being implemented. It could be argued that these both could play an important role because TAM and DOI both feature the attitudes and intention (Davis, 1989; Rogers, 1983) to use as fundamentals of technology acceptance and both of these would be influenced by the demographic and also incentivisation programmes would affect the behaviours (Read et al., 2016b).

TAM and Iacovou Model are presented from the interviews as the two models which have the most common determinants referred to by the business. Even as the most prevalent theories, there are still more than 48% of the determinants within Iacovou and TAM which were not referenced. This supports two hypotheses:

- *there is a limited amount of research knowledge available within the rail industry regarding the available research or.*
- *There is a further consideration that the models don't align to the railway context at all and the better outcome maybe to apply the determinants solely which have the greatest effect and so the business should consider the determinants in isolation – which would be unique considering the literature commonly applied sole frameworks in given contexts.*

The main shareholder of the Network Rail organisation as mentioned is the Department for Transport, and the Department for Transport published the papers suggesting the industry, therefore Network Rail which is the centralised monopoly to the industry had to improve technology acceptance to create a more efficient model (Shapps and Williams, 2021, p.5) and the study has shown that Network Rail does not apply models or determinants commonly and consistently which is different than the research has shown where research works with organisations to implement the frameworks and test the outcomes (Dahiru et al., 2020; Ta and Prybutok, 2018).

The lack of correlation between the business approach and the literature would suggest there is a difference in understanding and this study has identified what is known in the context. An improvement in understanding could be something which is investigated to understand if there is a gap in the corporate knowledge and understanding and what effect this could have. Creating awareness can only work to aid the organisation in the opportunity to deliver more in terms of technology acceptance.

5.1.2.1 Technology Acceptance Model

Technology Acceptance Model focuses on the individual's uptake of technology acceptance and is based around two core concepts, the usefulness of the technology and also the intention to use (Davis, 1985). Within the Empirical data which was recorded there is no evidence to suggest that TAM is being applied as it was designed and subsequently tested over many years. The reality only two of those interviewed called upon all of the determinants which are part of TAM although no direct examples of an understanding of the underpinning research knowledge and understanding, some examples to draw out are from Functional Director 1001230900:

"before we get anywhere near the technology guys, I've got a great idea. These are the benefits I think, we can do is a we can remove the sheet of paper. - Usefulness

I can save hours of people having to go through paper to find the right decision because I can just look it up electronically. – Ease of use

I think it would have had a greater chance of success because you would have had advocates then who would say, yeah, do you know what I get that? – Influence

Boss, that's a really dumb idea and it's a really dumb idea For these reasons, then you might get into a different debate about it. – Conditions

We all have different perspectives. We're not always gonna be right. We're not always gonna agree. – Individual differences"

R10

The majority of SLR articles in the study apply TAM in full, i.e. testing all of the determinants to understand the impact, in some circumstances not all of the determinants apply to the same extent. TAM suggests that if the individual finds it useful, then their attitude would change and hence engage in its use *"As a general rule, the stronger the intention to engage in a behaviour, the more likely should be its performance"* (Ajzen, 1991, p. 181).

Not one of the respondents in the study referenced the Technology Acceptance Model, and with there being a large variation between each persons responses to the determinants it is suggested that the level of understanding within the business may benefit from being improved. That said, there are examples in the SLR which specifically suggest that not all of the determinants are always useful in each context. A further challenge exists when individuals are not clear on the difference between how outcomes can be affected by different determinant. The example given by R23 does not recognise that there is a difference between usefulness and ease of use. This could be an issue when trying to apply the Technology Acceptance Model to its fullest extent as many literature articles show differing outcomes when one of the determinants is less prolific and understood then the other especially where some articles suggest that both are equal in importance (Dogruel, Joeckel and Bowman, 2015; Lin and Chang, 2011).

Brown (2002) found that where technology adoption is mandated on the individual, such as in the financial sector to undertake regulatory reporting, the user's intention to use does not feature and so there is a change in the framework which prioritises the perceived ease of use as the dominant determinant. If this is not considered, the manifestation could create unintended consequences such as an impact on the attitude towards use which would affect the chance of success. Brown (2002) doesn't suggest that intention to use disappears completely, but actually reduces to a point where it isn't a deciding factor and, in this circumstance, there is a case to say that Brown is pointing out that the strength of the determinants within the frameworks are changed based on the context and application. It was shown from this study that TAM can still apply with single determinants being minimised (Brown et al., 2002, p.290). This would suggest in certain contexts, determinants influence can be minimised. In reviewing the responses to the empirical review, there is no suggestion

that technology acceptance is forced or mandated even in cases where it makes a positive impact on safety such as given in the examples by B1-2121110900 and R7.

“there's a clear recognition that actually this technology can make the workplace safer. But then the users, are resistant to the change “

R9

“I think where the mandate comes out, you just don't get, you just don't get the buy in because it feels like we're saying this is the only way and there's very, very few occasions when this is the only way.”

R7

The public sector within the UK, still operates predominantly in a command-and-control style and therefore direction and instruction is more commonplace than facilitative leadership (Hatch, 2006, p.146), in a command-and-control style of authoritarianism, those leading would tend to instruct and mandate change. In this case, most of the technology adoption may be mandatory and forced and therefore it would be a priority of those introducing the technology to focus on the ease of use to create successful adoption. In these cases, Brown suggests that success to the organisation can become more efficient however success for the individual translates to enabling the individual to “keep and perform their job” (Brown et al., 2002, p.283). By considering the proposition by Hatch (2006) that as a command-and-control organisation in the public sector, there could be a higher level of acceptance if there was a mandate, but also that Brown (2002) describes the view that this creates a forced uptake could affect the attitudes towards use and therefore successful technology acceptance. Which is probably the reason why this was not attempted in the interviews given as shown by R9

“the decision will be made and we move on, but we haven't.”

R9

What the section has shared is twofold, the variability of responses from the empirical review suggests that there is a lack of understanding as to which determinants have the greatest opportunity to positively affect technology acceptance. Although there is a possibility that you don't necessarily require all determinants within TAM to be applied in a regulated industry, TAM needs to be better understood in the business and the business is likely to benefit from a level of consistency in the approach towards technology acceptance.

5.1.2.2 Diffusion of Innovation

The diffusion of innovation model is the widely referenced in the interviews. But parts of the model are still lesser known or applied in the business such as problem formulation. Referenced by two individuals only;

“what were we trying to solve, what we what were we trying to, you know, essentially change and we isolated it down to the users, those that had the the challenge, those that were faced with the continual problems and they fixated on the solution and the technology followed.”

R34R34

“if you go around the business you find different routes, different delivery units and different sections have a different perception of what you know what good looks and a different solution to the problem for them and what's a benefit to me”

R41

Understanding how to solve the problem is a key determinant from the reference literature materials and also has a direct link with getting buy in from the end users as they also have a part to play in understanding the challenges and therefore the solution.

“An innovation presents an individual with new means of solving problems. But the probabilities of the new alternatives being superior to previous practice are not exactly known by the individual problem solvers. Thus, they are motivated to seek further information to cope with uncertainty”

(Rogers, 1983, p.xix)

Rogers (1983) is pointing out the natural desire of an individual to solve a problem and therefore to become engaged in a solution which is also supported by others (Ajzen, 1991, p. 181). In comparison to the two examples present from the interviews, one is supportive and one is at odds suggesting that the business has no consistent to determine what right outcomes should be, as there are two opposing views, meaning much there is a potential to undertake much more problem formulation than is needed and a waste of effort and resources.

This wasted effort is also reflected upon by one of the respondents. R11 discussed the need to recognise *“how quickly to enable a project to fail to minimise the costs”* which would imply that there is a process to recognise ineffective problem formulation in the same way Rogers (1983) presents the same careful consideration

“awareness of the need for an innovation, decision to adopt or reject the innovation, initial use of the innovation to test it and continued use of the innovation” (Rogers, 1983, p.165).

Problem formulation is therefore not only coming up with a solution, but making sure it is robust and will enable an outcome. This would help Network Rail in its ability to be successful when developing solutions to problems if it was being consistently applied.

In an opposite position to problem formulation, procurement systems was referenced by 30 out of 41 respondents. The determinant was proposed to be added to DOI by Rose due to the influence this has on the ability to accept technology (Rose, Manley and Widen, 2019). For procurement to take place in the company, as it is a public body, the same rules exist for any utilities company operating within the UK and Europe. Meaning that strict rules exist to enable fairness and create competitiveness. But this regulation also means that there is a rigorous and repeatable approach to tendering and so a transparent process must be followed sometimes meaning that the designer of the technology may not always be the provider of the solutions if there is a different way to enable the same outcome (Gov.uk, 2016).

“Procurement is a big piece of nervousness. there were several companies involved as they were competing with each other and one has the best system, so contractually, how would we award?”

R25

“commercial and procurement rules and there's there's all sorts of kind of other stuff that probably slows us down”

R24

Consistently procurement is presented as a risk from the interviews whereas the purpose of procurement systems as a determinant is there to develop relationships with the supply chain to deliver technology acceptance and *“influence the diffusion of innovation”* (Rose, Manley and Widen, 2019). The lack of flexibility is appearing to limit the business ability to procure the right solution and adding time and risk leading to an unknown outcome such as the example given.

“Procurement policy is determined due to government regulation, rather than to suitably deliver the needed outcome”.

R13

If procurement is consistently a barrier to technology acceptance this should be specifically considered as to how enable a process which supports technology acceptance and not hinders as this is the opposite to the intended purpose.

5.1.2.3 Technology Organisation and Environment

The determinant for perceived ease of use and intention to use are shared between TOE and TAM, they both achieve a level of individual buy in to the problem outcomes (Davis, 1985) although one focuses on the individual and the other on the organisations influence on the individuals. There is an association between TAM and TOE by the fact that the development of TOE was aimed to synthesise the existing models which included TAM (Baker, 2018, p.11). In comparison to the responses given by the empirical study, determinants of TOE were less prevalent than that of TAM with formal linking structures being referenced the least and technology availability and characteristics being spoken about but by less than 20 respondents of the 41. Interestingly Baker (2018) suggests that TOE is the “most prominent and widely utilized theories of organizational adoption since its development” however the response by Network Rail suggests it is the least known of all of the frameworks. Yet as a public company, governmental regulation is a factor of TOE and yet only identified by 15 of the respondents and out of these 15 some are suggesting improvements to regulation rather than being an enabler.

“government could incentivize through regulation”

R38

This position doesn’t align with the strategic imperative for the undertaking of this study and the fact that the government in the UK is suggesting technology acceptance is a pillar of a future industry strategy (Shapps and Williams, 2021) and then regulation being seen as not encouraging technological change. What is common in the interviews is the position that technological projects are being delivered predominately to achieve regulatory compliance.

“You have to get past regulation; you've got to get over and there's those in private sector”

R24

The interview outcomes suggest that in the UK Rail Sector, the organisation is more likely to prefer demonstrating regulatory compliance, as a measure of success rather than market or financial growth.

“The project was there to reduce the airborne Respirable Crystalline Silica around the machine...success was everyone making it work and that’s what made it.”

R2

Interestingly, and why this reference has been used here, the success is seen as the inclusion of the team with the solution rather than the compliance improvement which in terms of the SLR would be the organisational success. This is maybe where there is a disconnect between

the determinants of TOE and understanding, those who are leading projects are associating the outcome with the uptake of the end user due to the effort required rather than that of the organisation as its goals automatically align to regulation being public. This could be a reason why TOE is a lesser considered model regarding technology acceptance.

The more senior the role, the more likely there was consideration of the determinants relating to TOE, but none stood out as having a priority influence. This could be an area that is understood as experience grows, and perspective changes to the organisational rather than individual projects and hence the increase in prevalence with seniority within the business. In terms of respondents, an average of 4 times more of the determinants were identified by those in senior roles in the business than those delivering the projects directly. This is aligned with the purpose of TOE which is specifically those looking at technology acceptance at a firm level - how the firm context influences the adoption and implementation (Baker, 2018, p.11). This potential environmental challenge is maybe why there is little response as the determinants in this framework, focuss more on the technology itself than the environment it is being introduced to and the organisation which needs to accept it. It may be a concern that the recognition of the environmental and organisational challenges is recognised at a senior leadership level and not local to those trying to implement the technology.

For TOE it can be seen that the organisational determinants are most common with those at a senior level within the business although the model seems not as well understood and applied as potentially it could be and determinants such as regulation have the potential to be considered as to how they benefit technology introduction where the requirement is enabling a minimum type of solution.

5.1.2.4 Iacovou Model

Iacovou Model is only referred to by one of the papers from the SLR (Oliveira and Martins, 2010) but is much more common in terms of the empirical responses. Similar, to TOE responses have been predominantly provided by senior leaders within the business rather than those delivering projects directly, functional directors stand out in terms of their responses against the determinants of Iacovou.

The first determinant of the model is around financial resource, the discussions are all around the requirement to invest but there is little if any position that suggests the availability of funding is restricted. This is at odds with the need for the industry to save money and create efficiencies (Shapps and Williams, 2021, p.53). Not one out of the 26 respondents who reference financial resources appear to need more money although some do present the need to be more efficient suggesting that the industry knows there is more work which can be done.

“How your cost increase because you can't get the access so then you can look for disruptive access and try and bring that back and try and get the cost back down again.”

R36

Although the pressure appears to be to create efficiencies to offset cost increases rather than restrictions around financial fluidity.

“if you're handing it over to someone else, say this is the next best thing, they kind of look at it and go, yeah. And I am not really sure if that's really gonna fit, you know, but it's the next thing and expensive. You know what's the next thing - I've got it on order.”

R41

Repeatedly those within the business see the opportunity to create efficiency rather than reduce cost of their projects and delivery, it seems from the evidence given that financially, funding is often available for technology even where it maybe costing too much eroding the benefits.

“So I don't think that we've been constrained from a financial perspective, but we manage our teams and force people to manage budgets “

R33

A low occurrence determinant is parent company pressure. Network Rail does not have a parent or partner company to generate pressure, real competition does not exist due to it being the sole owner of the mainline railway network pressure is generated by the stakeholder. This means that this determinant may not have a level of impact or relevance in the acceptance of technology and it also maybe the reason that the achievement of normative and coercive factors feature heavily as a measure of success which is discussed in chapter 5.3. It may also be the same reason that the strategic outcomes for rail discuss revenue of the industry as important because that is the market which the railway is operating in (Shapps and Williams, 2021, p.54). What is an important consideration, and it aligns with the fact that the then transport secretary not only endorsed the Plan for Rail but also named it, was because the government as the singular shareholder in Network Rail is interlinked with the outcome of the railway. The company strategy is there to directly enable government outcomes, so the company is inextricably interlinked with the desires of the stakeholder, and this creates coercive pressure to comply with the regulation.

“Advances in technology, deployment and more appropriate regulation will be instrumental to achieving this in an affordable way” (Shapps and Williams, 2021, p.88)

The government in effect saying that to accept technology, the regulation needs to be more appropriate, and this will help to enable a more affordable transition.

5.1.2.5 Unified Theory of Acceptance and Use of Technology

UTAUT2 was the lowest of all of the models being referenced. This was due to those facing the delivery of technology did not discuss the determinants of UTAUT2 to the same extent as other models. The predominant respondents of UTUAT2 were at a director level and Band 1. If we consider the data presented in table 25, and we normalise the number of responses by the quantity of those within the role, you can see that in order of organisational hierarchy for those in director levels;

- *Executive - 1.67*
- *Function - 1.58*
- *Band 1 - 1.375*
- *Average UTAUT2 Respondents by role*
-

This shows that there appears to be a higher prevalence of discussion by those who are more senior in the business. This is an interesting position because we also are aware that leadership enables information and ideas to be cascaded from the top of the business (Oorschot, Halman and Hofman, 2020), so if the leaders are familiar with the 4 determinants of UTUAT2, then it would be suggested that the leadership knowledge would be important to pass important information through the business. Yet as a Band 3, who are leading projects, Performance Expectation, Usability and User Autonomy do not feature in their responses compared to the Individual Effort Expectancy which should feature as they are directly linked to the individual or end user acceptance.

“We know we would have to put the effort into solving the problem”

R23

User autonomy does have a higher level of prevalence at a senior level within UTAUT2. The reason for this may be down to a realisation that the individuals will need to take the technology on in order for it to work, but at the same time, there are a considerable number of actors who are influencing the autonomous choice to accept the technology.

“power and support and autonomy to solve the problem”

R26

and often it is user autonomy which enables technology acceptance to happen and allowing people to make their own decisions based on the information they have to hand whilst focussing on a common output.

“I think Making technology introduction a success. Requires a very simple and easily understood purpose. We often make things overly complex and therefore not easily understood by some of the key people that we need to Get on board and be ambassadors for change. It was kind of if you got a problem you need to solve it. And you almost had that level of empowerment to solve things. You

know, yeah, there was rules. Yes, there were standards but I guess some of the rules and some of the standards have been tightened because people either overstep the mark or just ended up in a bit of a disaster. But no, I mean, no one said, oh, you're gonna break type approval by swapping out that resistor."

R26

Examples where autonomy to do the right thing has helped to accept technology in a more organic way would also suggest that if an individual has the authority to make a decision they would be more likely to have a positive attitude towards use and also behavioural intention to use which is directly comparable to the research literature.

"A high autonomy should have an impact on the perception of the effort needed for their convenient utilization and expected performance thanks to their use of their skills." (Kuciapski, 2017, p.1061).

UTAUT2 was developed as a conceptual model to consider usability and autonomy as new variables when considering the existing literature surrounding technology acceptance (Kuciapski, 2017, p.153). Although the model is less referenced by those who took part in the empirical study, the areas mentioned are important as usability and autonomy are associated with individual acceptance that has been seen to be important within Network Rail. The suggestion would be to consider how the determinants of UTAUT2 could be applied in practise, but not specifically as part of the model due to the relatively diverse responses throughout those interviewed.

5.1.2.6 Independent determinants

5.1.2.6.1 Geography

Geography did not play a major factor in the study, primarily that those interviewed are all part of a national company delivering nationally. Therefore, this would be unlikely to be visible in the outcomes unless there were geographic differences relating to the technology acceptance.

5.1.2.6.2 Governance Initiatives (incentivisation)

Governance initiatives (incentivisation) to encourage technology acceptance was only mentioned by a single respondent.

"they've got a intention to use, which is what the business can incentivise."

R7

There was no further references in the empirical study which support individuals from doing more, over and above their role to enable technology acceptance or any incentivisation programmes that can help inspire teams to do more.

the stronger the intention to engage in a behaviour, the more likely should be its performance" (Ajzen, 1991, p. 181)

The examples verbally given discuss teams on the frontline needing to buy into the process and technology which influences the ability to accept. This ranges from those who are fully supportive of the activity, those who require a lot of effort, almost to cajole “buy in” with no evidence presented for more visible incentives such as remunerative and recognition and those who are self-motivated, with autonomy to do what’s right.

“probably there's an element I would say of a reluctance for some people to potentially want to recognise that the technology was the improvement”

R9

“People you want people who are keen to be on board which we had”

R2

“it was kind of if you got a problem you need to solve it for yourself.”

R39

The ability to associate incentivisation with attitudes and behaviours toward use are not part of the study but are connected as the incentivisation will have an effect on other determinants and should be considered further. This could be an area in which Network Rail focusses to understand how incentivisation may help teams to improve, competitions, individual rewards can affect the attitude towards use and the intention to use and so this could be an area of future practical focus.

5.1.2.6.3 Organisation Imperative or demand

Throughout the SLR, “demand” was presented as a core requirement to drive technology acceptance (Oredo, Njihia and Iraki, 2019; Rogers, 1983; Yusuf, Xie and Trondsen, 2015). Demand is the reason why a business often needs to change from either a logistics perspective (supply and demand) or market forces often due to customer requirements (Ehrenhard, Kijl and Nieuwenhuis, 2014; Santa et al., 2010) or change in government policy forcing a change in corporate approach (Alexandru, Coardos and Tudora, 2019). Demand presented in the context of the SLR explained a change which needed to happen within the company, that drove a need to accept new technologies in order to achieve a successful outcome, most often market share (Hall and Kahn, 2002).

Regarding the empirical study responses, demand is not created from the same perspective as the SLR. Across the respondents, imperative/demand is the most common of all the determinants with 71% of the semi structured interviews presenting it, however, it did not relate to customer need or market share. Instead, demand is associated with achieving internal strategic outcomes or meeting existing compliance with governmental policy.

5.1.3 New determinants

5.1.3.1 Relational engagement

Throughout the SLR, trust was noted as something which was a requirement to be gained as part of the process of technology acceptance however did not feature in any of the frameworks. Trust was described as an association between the user and the technology, to achieve the outcome for example mobile banking and the use of applications to enable financial transfer (AlKailani, 2016; Chee, Yee and Saudi, 2018; Chou, Li and Ho, 2018). These examples did not look internally at the structure within teams and their relationships and the impact this has on the ability to deliver technology acceptance.

The suggestion from the literature review is that trust has a direct bearing on the individual actions, attitudes towards use (Davis, 1985) but also the legitimacy of the leader involved to bring together the team to enable a successful outcome (Damanpour and Schneider, 2006; Rao, Chandy and Prabhu, 2008). Another association with the SLR is that the effects links across the organisation has an effect on the interconnectedness of the business to enable technology to effectively be diffused (Rogers, 1983). This would have a direct bearing on the levels of success being achieved. These connotations of the importance of trust have been replayed within the semi structured interviews where trust between individuals, teams, projects and leaders all play an important part as the examples from R30, R41 and R17 show, but this is not the same as to the SLR where trust can help technology acceptance

“From lack of knowledge, a lack of trust. I think that's trust within the team cause we're failing still. I think it's I think it'll take time for people to trust what we're saying”

R30

“that is just purely a maturity and trust problem”

R41

“If you said a very clear you have a clear agreement and people just keep popping up all over the place, not trusting”

R17

Having a challenge with internal relationships which impact the chance of successful technology acceptance, it is unsurprising that projects to look to someone more senior to instruct movement and progress (R37). This comes back to the natural command and control style of organisational structure within a UK public sector organisation and although may be successful to getting the project moving forward, will further erode the level of trust across teams.

It could be argued these are not determinants, and are elements which are at play within other determinants, for example trust as a relationship construct compared with collaboration and centralisation (Rogers, 1983) could be argued as a function of the organisation alignment and outcomes however the respondents were firm that this was something which needs special attention to help with the chances of success and hence these have been termed as a determinants which need to be considered if technology acceptance is to be successful. The closest determinant currently within a model is interconnectedness which is part of DOI. This determinant is based on those within an organisation who have deep interpersonal relationships which enable communications to be effective, spreading the positive work of technological change to aid acceptance.

Part of the reason to really understand interconnectedness is trust which was referenced throughout the study. Trust is the relationship between the work force and the leadership, Oorschot (2020) describes this as leadership legitimacy however 'trust' in terms of the empirical study is inter-team related, where both teams are required to deliver an element of the technology for it to be successfully accepted. The existing frameworks cover certain elements of relationships discussed implicitly such as the relationship between leaders and end users, and end users within a community but this consideration raised within the interviews talks about a relationship where there is reliance on another part of the business. There is a potential where interconnectedness of the organisation is expanded to specifically include the robustness of the interpersonal relationship to enable a common outcome and purpose. This would further support the current definition of interconnectedness which is solely around the proliferation of communications and further benefit DOI framework.

5.1.3.2 Trade Union Body influence

Leaders, individuals, and teams are all named within the research undertaken. But one group of actors which came across strongly in a 1/3 of all the respondents was the role of the trade union. In some cases, the trade union member undertakes a pseudo role as a manager or leader for example directly to those implementing as a leader as the approach was one of resistance as described by R26 - resistance to change and concerns around how the technology is being used. For others it's a member of the team and in some extreme cases are informing business strategy in favour of the membership (R6).

"And then you've got the unions. Unfortunately, with technology, change just to working practices and much of the digitalization of technology in that require of. Results in changes and what people do meaning we have to consult."

R6

This often is having unintended consequences in the progression of technology acceptance projects and in some cases a detrimental impact on the success. This has not been investigated further as it is not part of the original research question but it should be considered that there is a role which must be played and for the trade union that is one which is local to the individuals, able to inform a team and often strategic enough to influence the outcome of a project which means it must be a fundamental consideration even if not a determinant in its own right. To show a relationship between trade union influence, there could be a direct association with two determinants already in play, attitudes toward use, and incentivisation but this would need further investigation and research to confirm and potentially evaluate.

In the cases which have been given to the study, the trade union is presented both as a determinant and an actor within the responses. The reason for this is that the trade union plays many parts when it comes to technology acceptance, internal governance requires trade union engagement when technology is being introduced and this can create challenging dynamics if for example a team is reticent to accept.

From the interviews given, it appears in many cases trade unions have more of an influence on the individuals within the team than the leadership, and this dynamic has a major impact on the ability to accept technology which has been seen in the evidence obtained

“then you kind of need to get through like the myriad of union leaps etcetera. Even with the Director as such an advocate for it, its late.”

R6

“In one respect, their [Trade Unions] role is to challenge and to assure themselves, but I think they were probably less on bought on than the senior stakeholders well. There’s a clear recognition that actually this technology can make the workplace safer for their members. But then as you move further down, Trade Unions are more resistant to the change.”

R9

“We have to do numerous sorts of demonstrations and trials with different levels of the unions to show them and to give the confidence and reassurance that what the technology was being used for when there was a clear, but, that’s not how it’s perceived further down the organization and that’s where it becomes difficult.”

R9

As challenging as it maybe the trade unions play a clear and instrumental part in technology acceptance. Their role as a colleague but also a leader in the business with the interests of the teams core to their being. However, the values of the Trade Union and the business are sometimes at odds which has been evidenced above. The challenge appears to come when

the trade union is dominant in its views which could be help with improved engagement early on in the problem formulation stage of technology acceptance.

Trade Unions cannot be a determinant, they play a part in the process the same as a leader or end user but are an association between the employee and employer and the following figure (24) shows. Considering the relationship other than this, for example one where the trade union is between the leadership and end user is probably why R6 struggles with technology acceptance because the relationship has been allowed to morph in to one of control and separation between the organisational hierarchical lines. This is different than what is portrayed by R9 and so rather than a determinant, it is proposed that the Trade Union should be recognised as an actor within the process who has specific needs which must be addressed to enable progression and successful technology acceptance. A visual representation of the three-way relationship is portrayed below in Figure 25, arrows show bidirectional engagement as there is no evidential hierarchy.

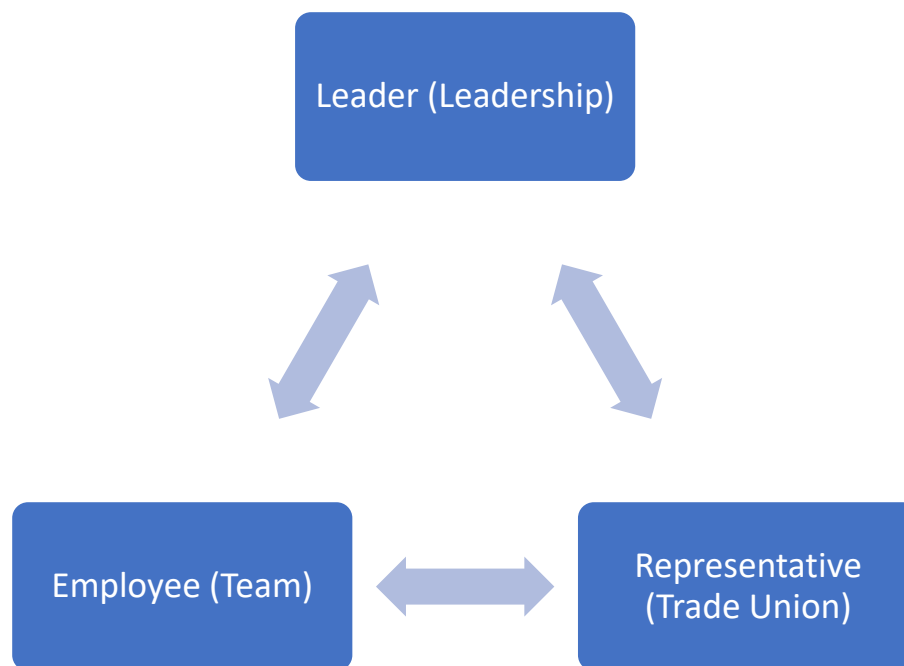


Figure 25 - Leadership, Employee and Trade Union Relationship

The level of influence of this relationship could be investigated as a future topic for study. Looking at the 3 interpersonal relationships may shed some light on what an appropriate level of balance within the UK Rail Sector is relating to the 3 actors.

5.1.3.3 Strategic approach to solutions (Minimum Viable Product)

Minimum viable product (“MVP”) is by definition a product “with enough features to attract early adopter customers and validate a product idea early in the development lifecycle” (Leonard, 2023). In terms of the responses in particular from R7 and R36, MVP was used extensively to describe an approach to a final solution.

“But I think really the first thing think about is, is the sort of minimum viable product, what's the minimum you can develop to give you an output in some form that will tick the box of what you're trying to do? I'm I really challenge quite hard on the project to say. Is this necessary for you to get the the bare bones of what you're trying to deliver? And dealing to deliver all of this in one package. Or he can you break it up into into a modular form.”

R7

In some cases, MVP was described as per the definition, but the context of the discussion was not aligned to what was being portrayed as described by B1-240423100

“successfulness at the favour if delivering for John or Sue who are out tonight working and as have we got this turmoil where you know or everything's focusing up and not actually the individual that benefits from an MVP point of view completely loses out. The finances are important to kind of articulate cause it's gotta be. From a more holistic point of view, you know, we're trying to run a railway which doesn't allow costs to run out of control.”

R36

meaning that the imperative was clear but the application differed from this narrative. In all cases the sentiment was clear, to deliver an effective solution, with the lowest cost to enable the outcome as the imperative however this rarely achieved the levels of success. In the context of the research, MVP should be considered as a method to develop the imperative and an approach to governance initiatives rather than a standalone detriment. This is because the process for governance should inform the outcome as a direct result of “building on the lessons of the past to inform the outcome” (Read et al., 2016b).

MVP is an organisational process which enables enough activity to be undertaken to enable local support without wasting resources. Referenced by almost half of the respondents, it was suggested this process is a requirement and enables compliance to the corporate strategic goals. The aim, to reduce cost whilst taking a product to market in the quickest possible way to achieve the benefits as suggested by R27

“looking at the price tag and saying what a fantastic profit margin for the organisation who's delivering your footbridges that they get to give you a, you know, a few £100,000 worth of video add-on as well that they take a nice healthy profit on. Do you really need that to get him a minimum viable product footbridge in the ground?”

R27

The market in this context being the operational railway.

In the context of the SLR, the process of applying MVP is a governance initiative where being effective is aimed to improve the company position. This means that MVP is not considered as a determinant in its own right.

As the opportunity for success from the empirical study suggests there was a high prevalence for organisation compliance (over 50%) as well a high response to the determinant around regulatory compliance (37%), the organisation needs to make sure that that governance does not stifle technology acceptance in favour of compliance with what exists. It was reported that projects are required to meet the same levels of compliance regardless of their risk, value or impact and so local projects cannot justify benefits to align with corporate goals meaning the level of effort is disproportionate to the success and therefore sometimes not undertaken. This compliance led culture is not aligned with the MVP approach which can be seen in references from R24 and R37 and so has created a tension with the ability to deliver.

“They'll be different changes happening being kind of implemented to the same or impacting the same people but being done by different teams across the business and still be things happening at route level at kind of team level within the route. But then there might be some regional change, there might be some national change, there might be standard change all of these different things impact people and it kind of just builds up I think to being too much just to be compliant.”

R24.

you know MVP is what is the problem you're trying to fix, whereas they're always looking for perfection

R37

A positive incentive therefore could be to understand if the value of delivering compliance itself is aligned to the same company or regulatory requirements that the projects are themselves being measured against(Read et al., 2016b).

If considering that MVP is an organisational process which delivers an outcome that enables authority of spend to be released, this would class it as a governance initiative (Read et al., 2016b) where being effective is aimed to improve the company position rather than a determinant in its own right but likely as a new process it is being described as a process in its own right. Therefore it is suggested that in the context of the Railway, MVP is not a standalone determinant in its own right, but a subset of a process which would be aligned to Governance Initiatives as there are other process which also must be complied with.

5.1.3.4 Internal Governance (etc Product Acceptance)

Although internal governance initiatives which enable technology acceptance have been discussed, within the interviews, 6 of the respondents referenced specifically an internal

governance requirement which was inhibiting technology acceptance, product acceptance a requirement of internal governance, one of the references is given by R9.

“Probably a two year time period, I think for two years. Because they're still, they're stuck. What's the technology there in the product acceptance is there, it's still and unchanged.”

R9

Product acceptance is the process at which a new technology interfaces with the existing railway, and is of a technical nature (Rail, N., 2023). whereas trade union involvement relates to the engagement with the individuals as singular entities and also as a collective (Gov.uk, 1992). In the case of the Product Acceptance process which is being referred to, those who have commented understand that the process is required but see the process as a burden, slowing down the time to accept and not being often a non-value-added activity except where it works this can be seen as the difference in opinions between the R11 and R27.

“We found the train paths and the timetable and got the engineering approvals for the train and it all came together with the conference. “

R11

“he taken the bridge through to an approved design, and it was off the shelf, but as a supplier it was unproven”

R27

The respondents suggest that often with hindsight the suitability of the processes could be better, similar to that of engagement with commercial regulation (R7) which has already been discussed in an earlier chapter.

Product acceptance is a legal requirement for an infrastructure manager to undergo when managing the risk of the operational railway (Regulator, O. of the R. and R., 2021). This process was referred to by many, as a practise which can slow or prevent technology acceptance with little more reasoning as to why. Understanding the legal aspects, product acceptance needs to understand the inherent risk with the railway system and work to reduce it to a level which is as low as is reasonably practicable where in the case of technology acceptance it appears its application is in some ways seen as a challenge as it is unique to the rail industry.

“To the to the transmission companies and the pipe service companies do the same. I'll be really surprised if the two, by the way, I'll be surprised if National Grid out something like our product approval.”

R35

As with any process understanding how to correctly apply can mean it is successful or not and therefore the challenge with Product Acceptance as it is unique to the railway may lie in the base understanding of how to apply it.

In the case of the literature, internal governance and process did not come through as a determinant, or as a challenge to overcome as a comparison to the interviews which saw product acceptance as something which could be a challenge to achieve. If those in Network Rail believe this in part to be the case and product acceptance has the ability to slow down technology acceptance then it should be an area to reconsider how it applies otherwise it may affect both determinants such as attitude towards use (Rogers, 1983), perceived benefits of innovation (Iacovou, C. L., Benbasat, I., & Dexter, 1995) and leadership attitude (Oorschot, Halman and Hofman, 2020) because it is also the leadership whom require the application and control of interval governance processes.

Product acceptance is a context specific requirements which influences determinants within the UK Rail sector only. This is due to the safety critical nature of the industry where the risk appetite of the system is rigorously controlled, but always with the position that it is needed

“I know the nuclear industry probably have something very, very, very, very rigorous.”

R35

As Product Approval is a requirement of the regulations and so although is a concern as to the successfulness of technology acceptance by those responding, it is a common activity within the rail industry and also others such as nuclear as mentioned. This means it is context specific and although should not be a determinant in its own right, for the railway it should be a subset of governmental regulation and a part of TOE (Tornatzky, Fleischer and Chakrabarti, 1990).

5.1.4 Frontline delivery agents' experiences

Within the findings section, Chapter 4.3, DOI, UTAUT and TOE all had a lower level of responses from frontline delivery agents than those at a senior business level. This was not immediately obvious when taking part in the interviews but afterwards, the themes suggest that there was a larger number of references for those who were more senior within the business specifically for these models.

Front line managers, classed as a B3 for purposes of evidence collection did not recall most of the determinants. This could mean one of two things, that only a small number of determinants are important and provide a level of influence or that there is a lack of knowledge and experience in technology acceptance. Table 36 shows the determinants which are the

most prevalent for front line managers compared to the responses of the most senior in the business. The table is normalised by the total number of respondents which shows that for example facilitating conditions, there are around 15 times the number of responses from the senior managers of the business compared to those on the frontline delivering projects. This is a consistent picture across all of those determinants in table 36. This offers a chance to witness the difference perspectives from the business and could articulate one of the challenges where leadership believe the challenges are different compared to those of the people delivering the projects.

Determinant	B3 and B2 resp	Exe and Func Director
Facilitating conditions (Davis, 1985)	0.43	7
Leaders - Attitudes towards technology (Rogers, 1995)	0.29	7
Internal Characterisation - Complexity (Rogers, 1995)	0.57	7.5
Perceived benefits of innovation (Iacovou, 1995)	0.57	7.5
Organisational Demand/ Imperative (Adner, 2002)	0.57	7.5
Leadership attitude (Oorschot, 2020)	0.29	7.5

Table 36 - Font line manager Vs Director determinant influences (normalised)

Prevalent determinants for the front-line managers also resonated with the rest of those interviewed but not to the same extent. For example, influence of trade unions and internal policy compliance requirements such as “product acceptance” featured more the closer to the delivery of the technology. This is an interesting perspective showing a direct opportunity in terms of considerations for success. What this suggests is, the more senior in the business, the less visible the actual frontline challenges to succeed in technology acceptance.

This section has seen that although there are some consistencies with the SLR, the majority of the time there are variations in both individual, role level and organisational responses to technology acceptance which are different to the SLR. The section shows how a small number

of determinants are common and robust, including being presented in the same way but the majority are distinct to the person or project being discussed.

5.2 Research objective 2: Success

Success in terms of the SLR presented some consistency in terms of how it was considered by the research articles. The four areas can be seen in Figure 26 and table 37 as well as the two types of success as discussed in the empirical study.

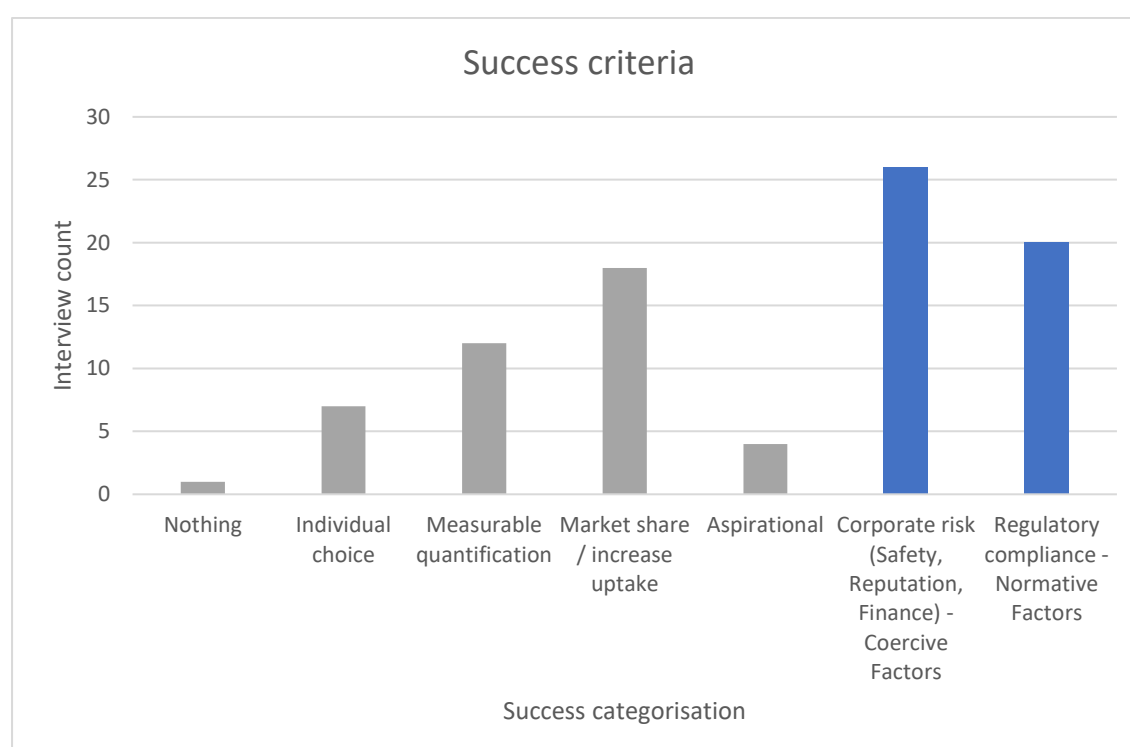


Figure 26 - Interview output - success categorisation

Thesis Objective	2nd Order Themes from Data Structure	Findings from Literature	References from Literature Review
What are the factors of successful technology acceptance within the UK Public Sector Rail Industry and the applicable theories?	Achievement of success relating to technology acceptance within the railway within the UK public sector is normally either based on the achievement of normative or coercive pressures,	The literature presented 4 outcomes for success which can be seen in table 25. These did not feature in relation to the UK Rail Sector.	Operational - Cirani et al., 2010 Human Resources - Bell and Ruhanen, 2016 Financial - Corrocher and Fontana, 2021

	rather than market forces and growth.		Strategic - Bello et al., 2018
	Technology acceptance is often separate to business change meaning that the focus is on the technology and not making sure it works properly to achieve the business benefit	The extracted literature did not discuss business change; however the search strings did not include business change. But the literature does include elements such as social influences, technology support and leadership attitude which do feature as a function of business change.	Social Influences (Consumer/Peer Pressure) (Davis, 1985) Leaders - Attitudes towards technology (Rogers, 1995) External task environment - Technology support infrastructure (Tornatsky L.G, 1990) Leadership attitude (Oorschot, 2020)
	Success for those directly delivering projects is generally aimed towards the individual whereas those overseeing projects which deliver technology acceptance is focused on the achieve of corporate outcomes.	The literature which associated success to the models only focussed on the determinants of the model and did not consider this perspective. This means that this is a new to the study outcomes.	NA

Table 37 - Comparison between the findings and SLR outcomes for Research Question 2

5.2.1 Factors of Success

To enable the successful adoption of technology, the driving determinants are perceived ease of use and perceived benefit depending on whether the adoption is through ones volition or mandatory (Brown et al., 2002). Boston Consultancy Group surveyed in 2005 executives who suggested that organic growth through innovation, which is one where all see the perceived usefulness as a consistent value across the whole company as the driving factor to financial success and market growth and therefore profit (Group, 2005). Across the literature, success is generally aligned to a benefit of the individual, organisation, or both.

The main methods in which success is measured from the literature extracted is covered in the following areas;

- *Strategic - Acceleration of achievement or strategic goals (Cagno, Ramirez-Portilla and Trianni, 2015; Najar and Dhaouadi, 2020; Ngai, E.W.T. Gunasekaran, 2009)*
- *Marketing - Market growth and competitive advantage (Hackett, 1990; Nastjuk et al., 2020)*
- *Operations - Performance improvement, quality and consistency of product (Cirani et al., 2010; Hyder, Siau and Nah, 2019; Meroño-Cerdán and López-Nicolás, 2017; Nastjuk et al., 2020; Weng, Lim and Phang, 2019)*
- *Financial - Economic benefit and profit improvement (Emmerich et al., 2020; Hanis, Trigunarsyah and Susilawati, 2011; Hyder, Siau and Nah, 2019; Jha, Bose and Ngai, 2016; Lee et al., 2015; Lin et al., 2019; Meroño-Cerdán, 2017; Trianni, Cagno and Worrell, 2013)*
- *Human Resources - Individual uptake and acceptance (Gimpel, Graf and Graf-Drasch, 2020; Luque-Martínez et al., 2007)*

But there are still some articles who just accept, that success is simply achieved, by adopting technology regardless how it is measured (Parris et al., 2016) as well as an aspirational view which aligns to the idea of general success (Yun, 2020). Although this is less common in the literature it does build on the ideology of what innovation is, often a creative idea to deliver enhanced value to an individual or company and would support any shared communications to engage those attempting to increase uptake.

Of the literature reviewed, the most common method to measure success is by improvement in financial gain, or market growth, with the achievement of strategic goals secondary in priority by reference (Dogruel, Joeckel and Bowman, 2015; Nwaigwe, 2022). Understanding how to measure success is important to understand the impact to technology acceptance has achieved. When considering the points made by Brown et al. (2002) around how technology acceptance priority choices change with volition versus mandatory applications, if the perceived ease of use can be prioritised early on in the process this should result in an improved uptake. This should then lead on to the company achieving its strategic targets and a better chance of achieving success which can be tested empirically.

The literature also tells us that too many determinants do not make predicting success easier, or more reliable and can be counterproductive. Considering too many determinants creates too much variability associated with predicting acceptance, the most influencing determinants become less distinct (Sepasgozar and Davis, 2018). Choosing those determinants which have a positive impact is important to prevent time and money being wasted (Kusumasari et al., 2019). Literature suggests that the most reliable method to choose suitable determinants is understanding how acceptance of comparable projects have been undertaken and to understand from them which determinants have had the most “influence” (Hong, 2019). Once

the determinants for a given technology acceptance and context are recognised, they can then be applied in similar context to offer a level of confidence enabling a successful outcome.

The risk with aspirational technology acceptance projects here is that at a corporate level, the collective view is that technology acceptance will often not result in projects being fully successful and the experiential learning is tarnished, as well as at a local level, the attitude towards use diminishes if the promised benefits do not materialise. Understanding the association between aspirational projects, the clarity of the outcome and a robust way to maintain the strategic intent is an area which needs to be focussed. If this alignment is not achieved, then the output may not be achievable or aligned to creating a benefit.

One main difference seen between the literature and the study, is those articles which reference individual uptake as a measure, are often trying to sell a product or service to the public, in some cases influence an industry to change and the individual uptake such in agriculture relates to individual farms in a geographic area (Harris et al., 2016; Rodgers, Morgan and Harri, 2017). In the context of the railway individual uptake relates to attitudes and behaviours towards use, but without a clear ability to articulate why, or what success means to those who in effect need to make the change which is fundamentally different to that presented by the literature. This means that the perception of success is context specific rather than technology specific.

Within the SLR, it has been explained that there is a direct relationship between perceived ease of use, usefulness, and success, namely the net impact and system quality. What has been identified through the empirical study is that even when TAM is being applied to the project, or the determinants are recognised by the project, the association between individual determinants which have the highest chance of positively effecting success are not consistently being focussed upon. Particularly with regards to software, there is an opportunity where both models TAM and IS Success Model enable the highest chance of a positive outcome and technology to be accepted. The synergetic opportunity between using ISSM and TAM models when considering technology acceptance is a missed opportunity.

5.2.2 Organisational preferences for normative and coercive outcomes

Commonly from the empirical study, the inward-looking approach to success appears to enable a higher level of compliance with industry or organisational goals. Already discussed, common factors of success such as those proposed by Williams (2019) could enable a better, more consolidated and consistent approach to technology acceptance outcomes.

This would not remove the need to improve against regulatory compliance as technology changes, for example digital signalling will reduce the workforce presence on a high risk activity (R38) and can only occur due to advances in technology (Smith, 2021), but would help to articulate the level of success and direct benefits. As well as being able to better articulate success, projects which have clear benefits both to regulatory compliance as well as core industry outcomes such as revenue could show the different potential outcomes which would improve engagement and act as an incentive to aid acceptance.

From the interviews undertaken, the type of success does not align to what was proposed from the SLR (figure 27). The two most prevalent factors of success are corporate strategy achievement and improvement in regulatory compliance.

Those interviewed all have a major level of influence within their respective roles, the fact that so much of the technology accepted is being done to improve the corporate risk position or achieve regulatory compliance suggests that the business has not shaken off its public company roots and should consider whether working in this way aligns with the rail reform strategy which focuses on revenue and service performance (Shapps and Williams, 2021). The measure of success is directly associated to the company performing against what it sets as its own requirements rather than typically what was seen in the SLR being a measurable quantification in improvement or an increase in market share. Measuring performance against something tangible such as industry revenue may mean that outcomes are more tangible to the individual within the organisation.

	No measure of success	Individual choice	Measurable quantification	Market share / increase uptake	Aspirational	Perceived Usefulness = Net Impact	Ease of Use = System Quality	Corporate risk model (Safety, Reputation, Finance)	Regulatory compliance
Executive Director	0	0	0	4	3	2	2	2	2
Functional Director	0	4	4	5	1	5	5	5	4
Band 1	1	0	5	6	0	2	8	10	7
Band 2	0	1	1	2	0	3	3	4	3
Band 3	0	2	1	0	0	2	1	2	2
	SLR Success Factors					IS Success Model		Empirical Success Factors	

Figure 27 - Count of respondent against factors of success

Figure 27 also shows that from an IS Success Model point of view, the Director group have the most pronounced ability to recognise the effect of the individual on the success of technology acceptance. Those closest to the deliver have the least recognition for the importance of perceived ease of use and usefulness and this is probably because they are focussed on the corporate level of success. Once more, the table shows inconsistency across the levels within the organisation when considering the strategic outcomes related to success.

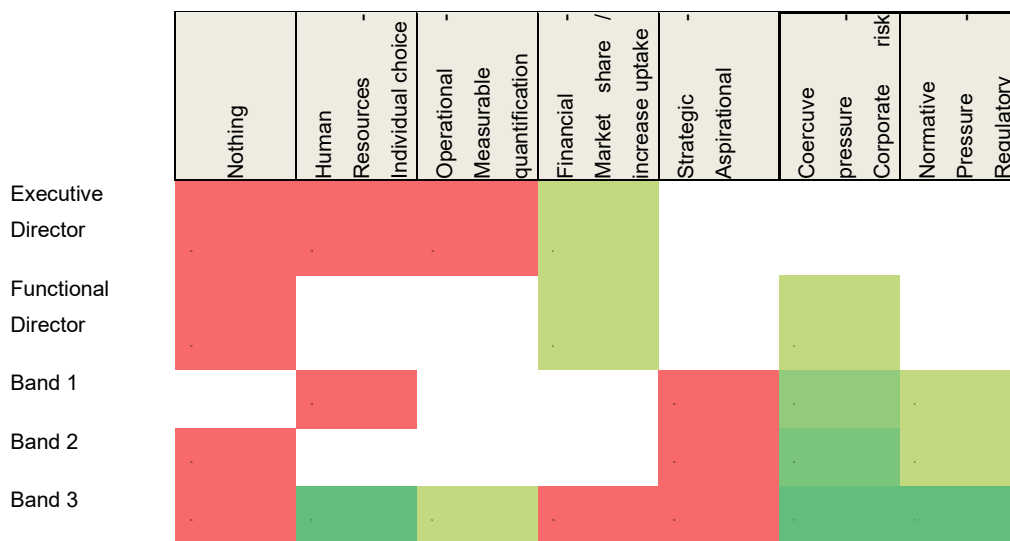


Figure 28 - Normalised responses to success based on highest and lowest influence (Green = High, Red = Low)

When the respondent scores are normalised by those who have undertaken the semi structured questionnaire (Figure 28), the more senior in the organisation the more likely the respondents discuss market share, in this case an increase in the “revenue” position which relates to industry ticket sales as discussed by R25 and R38.

“It's just a difficult normalization as no values but what changed? Things should be ours was the revenue incentive. And when the business unit given by a p&l so they actually had a revenue and a cost side and they had to make the two work together.”

R25

“ They have to meet a certain revenue target to sell them on at the value they want. But on a good day, we're just the commercial opportunity on a bad day, we're in the way.”

R38

When you then consider the functional directors down to those leading the projects the most likely success criteria relates to improving the corporate position and better meeting the regulations. Growth in revenue is a direct association with market share although different to competition, revenue requires individual choice to choose to use the railway. This is a paradox where it is difficult to quickly have a positive impact since the individual choice to buy a ticket is well, often individual. There could be political decisions which influence ticket sales but most of the fare paying passengers need to choose to travel on the railway instead of alternative means of transport as made clear by R40.

“they're not getting what they want. And we've driven people away from the railway. So, there's an impact on our revenue.”

Those who were closest to the technology referenced measurable quantification as well as individual choice as factors of successful uptake. This could suggest that those individuals who have the closest experience of technology acceptance either;

- *Have retained a level of experience and knowledge which is more aligned with the literature than the rail industry*
- *The clarity and consistency on the factors of success are not being communicated well from the leadership.*

This is a direct contrast to seniority in the organisation, but the study has not looked to understand which one is correct. The comparison shows that the measurability of technology acceptance projects varies depending on the perspective of the level of the person who is considering it. Those on the coal face are concerned with the performance for the individual whereas those at a more senior level are more interested in strategic and financial success. This could be undertaken as future research.

5.2.3 Successful outcomes associated with determinants.

The alignment to coercive and normative outcomes (Martínez-Ferrero and García-Sánchez, 2017) which are reduction of organisational risk or achieving regulatory compliance respectively were the highest regarded in the empirical study. An example given was the Class 153 project where success was measured by the choice to move to an automated recording system to measure switches and crossings [the railway equipment which allows trains to move from one track to another]. The success was described as the choice that individuals take to use the information provided from the automated recording system rather than undertake direct visual inspection. The reason which this was encouraged was because a colleague had been fatally injured. *“Carrying out some basic visual inspection of switches and crossings strayed onto a live line was hit.”* (R28). This created an imperative, which also had a direct link to those determinants within TAM more than any others. The success in this case and the determinants are closely linked because the outcome of the project can be directly associated with the individuals who need the project to be delivered. This suggests that TAM was a model which could directly help the successfulness of technology acceptance in this case.

This is in direct opposition to another example given which is collision avoidance and explained by R9. *“An incident which seriously injured a member of the team, and as an output. I had a vested interest to try and come up with the solution”*.

In this case, like the Class 153 the leader needed to change, needed to improve safety and yet, even though there was a clear imperative which directly affected the team, there was not the same level of uptake, in fact the project when being discussed had not concluded. The reason for this is outlined below by R9:

“Conflicting views as to whether it was the right thing to do when you have existing controls in place that they (approvers) deemed were sufficient. And then there was the trade unions and the users. Two things really, resistance to change and concerns around how the technology is being used.”

R9

This would suggest that although the success could be articulated and bought in to by the individuals which would be positive in regard to TAM, this was not as effective as it could be because individuals seemingly had not bought in to the technological improvement. This could mean that a strong imperative may not only be the determinants which needs to be influence and actually autonomy had a major part to play in this example (Kuciapski, 2017).

These two case studies are important because when considering the success, and association with the determinants you could oversimplify the use of determinants to think that a smaller number, which could be easier to influence could enable success. This comparison shows that is not the case and so for each project, you cannot simply rule out determinants without understanding the drivers behind the project and those involved – probably as human factors also will potentially have an effect on any outcome as explored by R24.

“that but the person that's looking at it doesn't fully understand that process and how that fits in and how it aligns to the user needs”.

R24

Something which is interesting is that the level of the role appears to have a different preference for the determinants as well as the success factors. As an example, executives tend to focus on the conditions required to enable technology acceptance as well as the organisational and structural requirements. Whereas those delivering would focus on availability of the technology, effect on the individual and the proposed technology outcomes. This data can be seen in Figure 26.

It could be argued as this would be an expected outcome as those at a more senior level would focus on the organisation conditions required to enable technology acceptance however, this perspective changes when you consider those new determinants which have been identified. The influence of trade unions, internal policy and governance, relational engagement and strategic approach to solutions are all consistently found at all organisational

levels and do not show a difference and when normalised around 50% of each organisation role level MVP, Trade Unions, Trust and Governance initiatives.

This shows that even though the interviews took part across the organisation seniority, four determinants stand out as being seen to drive influence. Previously argued, these are not unique determinants in the same way that those proposed by the models and theories but have an affect which is noticeable across all of the organisational levels within the Railway context.

Local team and individual considerations come as highly influential, but these same considerations are not really understood by those making them. Consistently the idea of individual engagement is made by “*getting local buy in*” (R2) and considered by R3 and R17.

“Much more buy in throughout the organization for significant individuals. Before we went public.”

R3

“I think it was difficult for people object or or to get in the way of doing that given what had happened previously. That's not often the case. There isn't often that buy in at a macro level in Network Rail there is not agreement across the organization, I think. Centralization didn't work because it felt like we were doing things to the front line or doing things to the regions and roots.”

R7

“so you're lacking buy in but you're creating imperative. as soon as that imperative dies off, staff go back to typically what they've always done”

R17

There is no evidence of further discussion surrounding what enables engagement particularly with the business or technological acceptance and therefore change. As well as the position of the individual, there is considerable discussion around strategic considerations such as procurement systems, financial resources, and the overall benefits of the technology but little further discussion on why these are of such influence referenced by the following directors.

“you're going to come up with a behemoth of project that's gonna be over budget. There's not going to deliver anything. And ultimately, it's gonna be unsuccessful and waste waste money. And I think we do too much of that.”

R7

“it wasn't a national scene as a national program felt as a national program and that we were only developing stuff that was required. So almost the opposite of, you know, the intelligent infrastructure program. And that's been really, really successful, so working with the end user who's got an idea and wants something and willing to invest some skin in the game is very much the approach we've taken with the IM products and then once you've once you've developed that with someone who's

really keen, wants it and demonstrated that it works and starts talking about it really quickly, you get, you get other people going well. I want a bit of that.”

R8

“what that really brings to my mind is people often talk about the change program needs. For the fundamental difference between success or not success is that it's got senior level sponsorship who are committed in the technology benefits”.

R11

What these two opposites groups of determinants suggest is that those who have been involved in the railway sector generally have an appreciation for what is important but do not really understand why or what underpins decision making of either the individual or the organisation. Although those interviewed could articulate what specifically was a challenge, they were unlikely to be able to articulate why.

This section has articulated the individual accounts of the association of success with the respective determinant. This has presented cases from all levels within the business where success is described but I cannot be aligned to specific determinants where in other cases individual determinants have been seen to drive a successful outcome. In each of the cases, the determinant is the important element rather than the model, applied in full. The suggestion from this is that the business could benefit from better recognising the association between the frameworks and the successful outcomes but also that there is no holistic learning process across those who are delivering technology acceptance-based projects. This is suggested as an important factor because successive projects are failing or succeeding and there doesn't appear to be a robust method to capture the learning and pass forward in a robust method to enable corporate learning. Knowledge is retained by those involved with the projects directly.

5.3 Researchers' notable themes

This short section responds to a theme which was presented through the empirical study which was around the personal impact that technology acceptance projects has had on those who have been involved. The following quotes from R36, R37, R23, R7 and R27 are all used in this section to show the reality of the challenge at a personal level when it comes to technology acceptance.

“So we've felt quite a little bit of pain on that on that particular

R36

“Had a lot of short-term pain for them without benefit.”

R37

"You don't have to have the argument"

R23

"It hasn't delivered anything at all. So, people get frustrated."

R7

"Stopping and reflecting some of the things that frustrated me around, we just need to get this stuff done and moving quicker"

R27

The impact of technology acceptance could have a direct impact on both the leadership attitude and knowledge (Oorschot, Halman and Hofman, 2020) and also the attitude towards use (Rogers, 1983) which are all determinants associated with leadership. The experience of going through an activity which has the potential to leave lasting memories which are uncomfortable may lead some to want to stay away from technology acceptance which would not lead to the company achieving its strategic goals. The ability to test, experiment and to fail are all prevalent and have already been referenced in this study as has the relationship between different parts of the organisation when delivering technology acceptance, and yet still there is a corporate memory to suggest there is a personal toll when engaging in technology acceptance which needs specific consideration by Network Rail.

Objective	2nd Order Themes from Data Structure	Findings from Literature	References from Literature Review
NA	Emotional impact of technology acceptance is having a lasting profound impact on those who are involved in technology acceptance.	Technology acceptance impact is discussed in the literature as positive, but it often does not consider the personal impact of the process on those involved which would have an impact on the attitude to engage in the process.	NA

Table 38 - Notable theme from the empirical study

Table 38 covers a single theme which was an undercurrent in many of the interviews that relating to the personal pain anguish and in some cases trauma which has come from delivering technology acceptance projects which are evidence by comments from R9, R3 and R20 .

"frustrating" because there's been other stuff we've used more simple technology for."

R9

“And that probably fostered. That that probably muted mutated into a a self frustration. And almost a bit of a sulking situation now, for God's sakes, we are the experts. Why won't you just let us get on with it?”

R3

“condition based monitoring is probably the one that's caused the most personal pain and frustration and should probably a good example. “

R20

These feelings are amplified by the fact that the industry is risk averse and so failure to deliver technology acceptance stays with the individuals who are enabling it. The emotional impact of delivering projects is likely to have an impact on the wider management of such technology based projects and should be a consideration for the business.

As referenced earlier in the study, *“the stronger the intention to engage in a behaviour, the more likely should be its performance”* (Ajzen 1991, p. 181) which underpins TAM and DOI means that those who have skin in the game to succeed are motivated to do so because it delivers performance, but it also means there is a personal impact when it does not.

There are three potential outcomes of these feelings;

- *A desire to learn and understand what has happened and how the business can learn and not fall in to the same traps, we have already seen that there is not robust communication around learning from technology acceptance*
- *A reluctance to lead technology-based projects due to the inherent personal commitment in favour of someone else – “Has an incredible amount of energy and is tenacious and won't let it go. That's one of the reasons I won't that I go”. B1 - 1212221300*
- *Leadership attitude and knowledge which is one which limits the ability to experiment.*

The alternative is that the experience builds knowledge for the individual who is more able to make sure that challenges are address at the right time to improve the chance of success.

almost the opposite of, you know, the intelligent infrastructure program. And that's been really, really successful, so working with working with the end user who's got an idea and wants something and willing to invest

Executive Director - 1312221530

5.4 Research Objectives summary

The chapter has presented numerous discussion points identified throughout the study in a format which follows the same flow as the findings chapter. Considered points regarding each

research objective, and more general areas of consideration have been put forward which can be summarised as follows.

5.4.1 Research Objective 1

- *The typical projects undertaken by Network Rail are similar to those from the SLR articles suggesting commonality*
- *Network Rail is not consistent in its understanding or application of determinants.*
- *Executives perspective is more focussed on organisational level models and determinants compared to those working closer to the outcomes who focus more on the impact on the individual.*
- *New proposed determinants are not unique determinants and are mostly context specific to the railway and need to be understood.*

5.4.2 Research Objective 2

Success factors are predominantly based around risk (coercive factors) and governance (normative factors) (Discussion literature was finance and market) – institutional theory (Martínez-Ferrero and García-Sánchez, 2017)

The association between the IS Success Model and TAM is not pronounced. The opportunity of a close association to enable an improved chance of success is inconsistently applied if at all.

- *Technology acceptance factors of success are not aligned to a tangible business requirement and are often disassociated to the end user – Public versus commercial*
- *Executives see success being achieved when organisational objectives are met such as increase in market share compared to those on the coal face who see success as individual uptake and local acceptance of change.*

Research objectives 1 and 2 have both been presented comparing the empirical data to the extracted literature as well as presenting the which affect the success of technology acceptance.

6 Chapter 6: Recommendations, Conclusions and Contributions

6.1 Recommendations

It is recommended that Network Rail learns from the research the implications presented which will influence the acceptance of technology within the UK Rail Sector. To do this, there are numerous different ways to consider the findings of the study and it is recommended that Network Rail looks to apply where suitable. For each of the recommendations, the risk of not implemented as an impact to the business is proposed as probability multiplied by impact and the rating shown in table 39. The scoring has been applied would be familiar to Network Rail and the level of the score would be based on the continuation of activity and its achievement of strategy outcomes for the company. The risk therefore is the opportunity impact which could be missed if the recommendations are not taken forward:

Probability		x	Impact	Loss of benefit
Low	Unlikely to happen		Low	Less than £1M
Medium	Likely		Medium	£1-£10M
High	Very likely to happen in a short timescale		High	£10M or more

Table 39 - Risk validation table to support recommendations

6.1.1 Recommendation 1

Title: Develop and undertake basic awareness training on the application of technology acceptance models within the UK rail sector.

To establish a programme of awareness of the models and their potential applications to enable increased knowledge and understanding for those within the railway. This would be web based to enable speed of engagement and should consider being made mandatory for any project which relies with technology acceptance as a function of business change.

Intention: To give immediate knowledge and information to those leading projects to enable further consideration for determinants which are likely to benefit technology acceptance in the railway.

Time Line: Medium term

Risk to success: Medium (High x Medium)

Probability: there is a high likelihood that this would be applied to projects if it is recognised as important by RCoE who could establish this in policy meaning a national benefit achievement.

Impact: The probability of impact would be unknown, this is because the empirical study was undertaken in hindsight, projects which were discussed were spoken about in the past and so understanding for the future if specific elements were missing is also known and this work would change the future reality if successful.

6.1.2 Recommendation 2

Title: Apply a single Technology Acceptance model consistently to projects

Investigation the application of TAM or DOI and UTAUT to the fullest extent on a project-by-project basis by increasing the awareness through training of the project leaders and managers. The aim of this would be to maximise the knowledge of the frameworks which focus on individual uptake within an organisation. In support of this, amend company policy to ensure that TOE and Iacovou models are consistently assured at an organisation level.

These are the most commonly referenced models through the empirical study but all have elements which were not drawn upon.

The recommendation will include the choices which can be made to help identify the most suitable model for the intended application, as given by the following;

- *Where the technological acceptance is required by a constrained group of individuals – TAM and specifically determinants which align to the IS Success Model*
- *Where the technological adoption is targeted towards a functional part of the organisation – UTAUT or TOE*
- *Where the technological impact is intended to affect various parts of the organisation beyond a specific given group of people – Diffusion of Innovation.*

(based on Figure 16 and supporting information)

Intention: To increase the knowledge and understanding of those managing projects in relation to the common models whose determinants were referenced the most.

Time Line: Long (6 months) – due to the development of the training

Risk to success: Medium (Low x Medium)

Probability: There is a medium likelihood of this taking place in the timescales purely due to prioritisation and therefore the reduced immediate benefits.

Impact: As can be seen from the SLR, the more developed industries have more experience in the application of the models and therefore increasing the skill of those leading projects will help to improve the chance of successful acceptance.

6.1.3 Recommendation 3

Title: Development of a context specific common which can be built on and developed – this may also be supported by ongoing future research

Development of a consistent model, using the information from this study and experts in the business who have already demonstrated how technology acceptance can be achieved. The model would be constructed using both a model which focus on the individual and the organisation. The model could then be built on and developed as more projects are envisage and delivered

Intention: To offer all project leads a common method to check the main determinants recognised by the organisation as having the biggest influence and to aid in the corporate knowledge and learning.

Time Period: Long

Risk to success: High (Low x High)

Probability: If there is a ready opportunity to enable projects to look with hindsight at in flight projects there is the greatest opportunity to recognise if determinants have been considered or not. This would also help with understanding the association between the determinant and the outcome enabling the best chance to respond.

Impact: Implementing this would have a minimal time and cost burden and would enable project leads to use the hindsight form the study to help understand the project progress and chance of success. It is likely to have the highest impact as it would be specifically applied to the industry and empirically tested and refined removing determinants which did not have the greatest impact.

6.1.4 Recommendation 4

Title: Amend current Investment Policy in response to the study

Include the requirement for project leads to understand technology acceptance, the models and determinants which are readily available and also the clear association between the articulation of success and the determinants which are being focussed upon.

Intention: To embed learning into the corporate memory for the future.

Time Line: Long

Risk to success: Low (Low x Low)

Probability: Scored low as a policy change requires a lot of time and also many stakeholders making it complex. If those who have experienced projects are the same who respond then it could be likely that the amendments may be watered down as they are different to what is typically applied. However it is just as likely that as Recommendation 3 is a self-representation of the organisation, it is seen as a not needed amendment.

Impact: Create an ongoing and lasting legacy for the organisation but this also would only support Rec 1-3 and provide a level of compliance rather than increasing the knowledge and awareness hence the lower score overall.

6.2 Conclusions

The thesis has considered the data presented from the Systematic Literature Review and obtained real world data to demonstrate the phenomenon in relation to a specific context within industry. The conclusion from the work is as follows for each research question.

6.2.1 Conclusion - Research Question 1

The conclusion for research question 1 is that there are 39 discrete determinants which make up 5 models that affect technology acceptance of which only 1 is not recognised in the UK Rail Sector in the UK. As well as this conclusion, there are further outcomes which follow.

This study has presented an up-to-date perspective on the determinants which impact technology acceptance. It offers a new and up to date view on the definitions related to this area of literature and suggests likely and considered areas which have been taken into an empirical project which has enabled credible outcomes which can be applied to research policy and practise.

The study concludes that the existing literature based around models and frameworks such as TAM are directly applicable to the railway sector in the UK, the evidence has suggested that many of the extent determinants are being applied, but indiscriminately without clarity or consistency. Providing some consistency by applying a single or multiple models to technology acceptance projects is likely to aid the opportunity for success. However, it has also been seen that if too many models are applied, then consideration must be given to the the prevalence and influence as the affect may be unique within the railway sector context.

What can also be identified from the empirical data is that there are 10 determinants which are the most prevalent referenced that do feature in all of the projects which have succeeded. A recommendation has been proposed to develop a context specific model for the rail sector and these 10 should be considered within that model and then tested for its suitability. This would be similar to other industries, however the study has shown that most industries typically start from a base understanding of an existing model or framework, hence, this is the primary recommendation for the rail sector to introduce a level of consistency.

The primary type of project being undertaken by Network Rail, the implementation and acceptance of software and hardware is common to the literature articles, however the associated technology acceptance models and determinants are different and come with a different level of prevalence suggesting there is an inconsistency between the literature and knowledge within Network Rail.

In an organisation where experiential learning appears to be the primary way to learn and pass on information may suggest that the way to accept technology is passed from one to another, and therefore insight from literature can help to develop and broaden the thinking. What can be seen is that overtime, Network Rail has organically developed its knowledge, and it is learning which determinants are important through experiential learning. The conclusion of the study is that the application of research theory will help to close gaps in knowledge and accelerate the understanding.

Four new determinants were proposed however determined that these are subsets of existing determinants already being used in by the models and frameworks. Specifically in the railway context they are important to give consideration to as they have the potential to drastically impact the technology acceptance process, the prevalence of response from the empirical study would suggest that although they exist with other determinants they are prominent enough to prevent technology acceptance in their own right and should be focussed upon.

Independent determinants play their part in technology acceptance within the UK Rail Sector however the new proposed determinants appear to be better positioned alongside existing determinants and models rather than to be applied in their own right. The consideration for new determinants also raised the question about how well Network Rail understands its own processes, such as Product Acceptance which was seen as a barrier.

The empirical study also identified that the determinants of organisational models were more likely to be understood by executives in the business than individual affecting models which were more prevalent when discussing with those who delivered or oversaw projects directly. But there was also a considered difference where the literature viewed leadership as an hierarchical position, compared to the empirical evidence which suggested consistently that in technology acceptance a leader is someone who is local, understood and influential and may not be senior within the business. These two differences would be important if identifying those who would lead technology acceptance and also the type of training and support they would be given prior to commencing the technology acceptance process.

The overarching view of the author is that applying a single theory regarding the individual acceptance or organisational level acceptance is likely to offer immediate business benefits and if this can be supported with a process to develop, learn and retain the experiential learning then this will make sure the business can continually improve. This would remove the inconsistencies which have been identified and will allow a firm basis to progress from and aid learning. There is a consideration however that the choice of theory could be influenced by the context of the project or application. In this case, using the requirements of the Diffusion of Innovation, namely relative advantage, trialability, observability, compatibility and complexity

could be identified to support the choice of a theory. In this case, each of the projects could identify the suitability of cascade of opportunity through natural inherent structures of their own will, accelerating diffusion. For example, if software change can enable users to pass on the opportunity and explain selfishly how they benefit personally, the likely diffusion would be accelerated and could be a strategy to employ (Rogers, 1983, p.258). This method would be different based on each project and would assume there was a level of direct understanding of the skill, capability and recognition of the benefit to the end user, influencing their desire to accept in the first place, therefore it is likely to be a more robust solution if the technology had been implemented and could be learned from in a smaller sample.

6.3 Conclusion - Research Question 2

The conclusion for research question 2 is that there are 4 main methods to measure success from the literature however these are different to the common success measurements from the empirical review which focus on normative and coercive outcomes.

The conclusion for the organisation is that it is likely that Network Rail can improve its technology acceptance and therefor improve the chance of success which benefits public finances (Shapps and Williams, 2021).

Success was presented from the literature as tangible outcomes related to performance, finance, human resources, and strategic achievements whereas the data collected from the empirical review suggested typical outcomes would normally be normative or coercive pressures such as compliance with policy or regulation. These pressures are normally organisational and not associated to the individuals but for the Network Rail business created robust and consistent imperatives to enable projects relating to technology acceptance to commence so were influential. It was also acknowledged that as the company, Network Rail, is publicly owned and in a safety critical industry, this would have an effect on the success criteria.

Regarding the individual involved in technology acceptance, in some cases specific individual determinants become the driving force between technology acceptance achieving success. In these cases the imperative to deliver the outcome means that other determinants do not feature due to the overwhelming requirement to achieve success which was also seen in the SLR outcomes. Although less common, it shows that when you have a team behind a common purpose, it will push forward and achieve success.

The standout projects which presented success are those which could articulate the benefits of success relating to both the organisation and the individual, and in a way which has a level of credibility to both parties but not oversold as to its importance. Considering how success is articulated and bought in to by the individuals (end users) and the organisation should be considered as an important outcome by the author. These projects also referenced the core dimensions which related to the IS Success Model, perceived usefulness and ease of use. It may seem common sense but making the solutions easy to use and actually having a purpose is not consistent across the evidence received. This mismatch appears to be having an effect of the success of projects and should be considered by the organisation as a priority to resolve.

6.4 Contributions

The study has identified many areas which are contributions to knowledge.

The reason for the study is to look at the public sector in the UK, specifically the rail. This context for technology acceptance was not found in the literature, and the closest application was the construction of transport systems within Singapore (Pheng, Arain and Mingdong, 2019), although under public ownership the system is privately owned which is different that the research was intending to understand hence this being an addition. Therefore, the study is extending the literature in the area of technology to include the railway context in the UK, enabling a new industrial consideration and contextual area to the established theories.

6.4.1 Extension of existing theories

The main extension of theories relates to the 4 proposed new determinants which when examined could be deemed to be part of existing determinants and models. However, they did play an important part which could over play the level of influence and render other determinants not applicable in the context of technology acceptance. From an empirical point of view, the influence of these sub-determinants are context specific as they have not been seen in other industries but have an important role and impactful role and should be considered for any future application of any of the models in industrial applications.

A further feature of the research is the demonstration of the link between the IS success model, TAM and therefore with projects accepting hardware as well as software. Although as seen with bridges, there is a limited opportunity for the IS Success Model, a consideration for the individual and their engagement with the project is paramount in enabling a successful outcome.

6.4.2 Empirical contributions

The study has identified the extent material which is available and has applied it into a new context which is the rail sector in the UK. This has shown that there are 5 models of technology acceptance which to some extent are all being applied, but inconsistently within this industrial sector.

Technology acceptance cannot be guaranteed, the models and frameworks suggest the same to this phenomenon. The current theories and models offer an insight in to the considerations which affect technology acceptance but there is no hard and fast solution, primarily due to the variability of internal, external, corporate and consumer variables (Sepasgozar and Davis, 2018) and the same has been shown in the UK Rail Sector. The application of technology has nuanced details exacerbated by actors and processes which means there is no exact way to guarantee a successful outcome. However, testing, learning and the development and application of knowledge does help to improve the chance of success.

Executives within the railway sector see success being achieved when organisational objectives are met such as increase in market share compared to those delivering projects who see success as individual uptake and local acceptance of change, this means often benefits are not aligned and can mean that there is a challenge in enabling technology uptake as the benefits are not directly understood by those accepting the technology.

A robust outcome from the empirical study which is different to the literature and also those delivering technology acceptance projects is that technology acceptance is often separated from business change meaning that the focus is on the technology and not making sure it works properly to achieve the business benefit. This discrete difference is understood to be new addition to knowledge from what has been identified in this study and brings a different and alternative perspective on what could affect technology acceptance.

It is argued by the researcher, that the evidence provided within the thesis adds to the existing knowledge, creates new knowledge in this field and also challenges some of the most recent works around leadership in terms of the role with technology acceptance.

6.4.3 Contribution to practice

Network Rail invests over £5 billion per annum in the UK on behalf of the government and the UK taxpayer. Of this investment, a proportion is direct investment in research and development and the rest is invested in process which need to be more efficient to enable an efficient public service, as outlined below:

Network Rail's total income in 2017/18 was £11.2 billion, comprising:

- *£4.5 billion of network grant*
- *£4.5 billion of borrowing (net public funding provided)*
- *£0.5 billion of commercial income from sources other than passenger train operators*
- *£1.7 billion of net income from train operators*

Network Rail's expenditure during 2017-18 was £11.2 billion, comprising: a.

- *£3.0 billion on operation and maintenance of the rail network.*
- *£2.4 billion on network renewals*
- *£3.3 billion on network enhancements*
- *£1.3 billion of (external, non-government) financing costs*
- *£1.2 billion of other expenditure.*

(Regulator, 2020)

The practical value of this thesis is in better understanding the determinants which affect technology acceptance therefore the success, there is a higher chance of improved spending on the railway which can either reduce the burden on the taxpayer, enable more spending on other public sector services or invest more in the existing infrastructure improving the service.

For the finances detailed above;

- *£1.7bn is directly targeted and referenced in the plan for rail as needing ticket reform to increase revenue (Shapps and Williams, 2021). This is directly aligned with the majority of the articles on success which associate successful technology acceptance with increasing market share (Brown et al., 2002; Waqar et al., 2023).*
- *£3.0 billion on operation and maintenance of the rail network, £2.4 billion on network renewals and £3.3 billion on network enhancements all rely on technology to enable the outcomes. For the latest instalment of the railway finances in 2023, although the regulator has awarded £44bn of funding for a 5 year period, £3.6bn in real terms has been held back. It is expected from the regulator that Network Rail will make up this difference primarily to improving its efficiency of how it delivers the activities. Therefore, the implementation of new technology makes up a proportion of the £3.6bn savings which are required (Larkin, 2023).*

An example of the opportunity which exists that has been directly influenced by thesis study is the potential opening of Meir Station in the Midlands. To enable the station to open, the current forecasted spend of £23m is not available and so the proposal is to reduce this figure by investigating the application of technology acceptance to inform new and novel approaches to deliver the station and reduce the target cost down to £13m (Price, R. Caroline, 2023). By using new and novel technologies it is estimated that 2 years can also be removed from the

opening timescales which will directly benefit the travelling passenger. An early indication of the learning from the study is that in local media, the success of the project is to deliver a station, on time and budget to benefit the local community, success is directly associated with the imperative.

The project at Meir Station is considered to be the first of a kind, this means that if successful more will be enabled across the country. The success of Meir Station is already being seen across the organisation with acceleration of technology and innovation a corner stone for CP7 where much more consideration is being taken in how technology acceptance can be undertaken effectively across the industry (Consulting, 2023).

The example above can only be a success if the information from the thesis is shared, learned and applied. The recommendations of the study will enable dissemination and the process changes which related to funding release specifically will enable improved engagement within the topic. However, exploitation can only be a success if there is an opportunity to show that working with a different view and approach is going to make success easier to achieve. Practitioners and leaders recognising the opportunity to improve by delivering the recommendations and then openly sharing the outcomes both to inform policy and practise will help the thesis to be shared wider and enable business and industry to learn from the approach. The researcher is attending board sessions, investment panels and project reviews are all enabling the thesis information to be not only shared but applied directly and for challenge to be leveraged against projects being worked on now. Having those who took part in the study engage using current, real world examples of technology acceptance projects in progress that are being challenged to develop their understanding of models such as TAM is already helping the transfer of knowledge from the thesis to practise. This “in the room” broadening of the understanding helps both leaders develop their understanding as well as those in the projects. Sharing real examples where success has been achieved and making the relational associations enables a common approach which is hoped to lead to better outcomes.

Although talking about the topic will help to change the realisation, the positive impact will help to reinforce the outcome through company adherence to process.

6.4.4 Contribution to Policy

The author of this study is working closely with the policy authority within the organisation. The intended outcome is to implement changes to the existing policies which are being developed to focus on clarity around the imperative and demand as well as a future process to better inform projects delivering technological change as part of the program of how to make this a success. This has only been possible due to the study taking place and the ability to

influence those in the business who now are able to recognise that there is more to technological acceptance than simply a procurement exercise although a considerable element.

6.5 Personal Reflections

Considering the reflection model Boud's, Triangle (Boud, D. Keogh, R. Walker, 1985, p.36) which breaks down reflective learning in to three core steps, Experiences, Reflection and Outcomes are presented below.

A common response after each interview is the discussion around reflection. 6 interviewees experienced the interview as "*cathartic*" (R7, R38) and a feeling of comfort that they have been able to "*get things off their chest*" (R3). This would suggest that there had been a positive level of engagement with the semi structured questionnaire, however more than this there is a consideration that problems and challenges associated technology acceptance had stuck with those as permanent emotive memories. These 6 examples all described projects where technology acceptance had not gone to plan, and time, money or quality had suffered as an outcome, some projects in particular signalling systems had no choice but to continue and the company is left with substandard technology which does not achieve its original purpose.

As the interviews took place, 50% of the interviewees recommended speaking to others in the company to gain their perspective, often as they shared frustration with the lack of technology acceptance. This was offered because they have a perspective that would aid the research and also share "frustration" with examples given by R12, R20 and

R29 with the lack of technology acceptance which succeeds.

Stopping and reflecting some of the things that frustrated me around, we just need to get this stuff done and moving quicker.

R12

that's caused the most frustration for me

R20

some key people believe that which the frustrated me for a long time, especially people on safety, believe or not

R29

6.6 Thesis Impact

Evidence Based Management provided an insight into how best to consider academic information in a practical context and shared a method to make organizational decisions. (Briner, Denyer and Rousseau, 2009)

In terms of this research, this translates to:

- *Determining how the Researcher understands and learns from their own experiences and therefore the impact of the research in practice,*
- *understanding how others will respond to the research as key stakeholders especially where they may have experience in the same field.*

To do this, there needs to be relevant information collected from industry and compared with available literature through original research.

Briner, Denyer and Rousseau (2009) presents a structured approach for using knowledge as part of business decisions. Evidence based management follows a structured process through exploitation, dissemination and evaluation to support practical decision making. By following this approach and attempting to deliver measurable impact to both research knowledge and practice the knowledge disseminated should help to progress academic knowledge but also accelerate the approach to technology acceptance in practice.

With technology acceptance being a very current, and applicable topic in the UK Rail Sector currently, it is likely that the research does find interested parties who can be used to both test the knowledge found, but also help with further dissemination. These individuals and agents will be key to the quality of the research by offering insight and feedback and are hoped to be key enablers in taking forward some of the ideas found from the themes. The aim of the research is to enable engagement throughout to make sure there is understanding, and those influencers are prepared to disseminate the ideas.

As well as those who are directly involved with the research project, conferences for both literature and practice have been attended which has enabled a broadening and widening of the reach of the knowledge being shared. There has also been attendance at leadership and discipline practice events to enable sharing of the findings to those who benefit from technology being accepted such as a program board looking at improving the efficiency of installing bridges over the rail. Reaching out to as many as possible across both academia and practice will mean the ideas can be evaluated, tested and trialed to make sure the knowledge found is relevant and applicable.

The study has enabled a broad group of individuals who are prepared to support the research and share it further who are committed to helping to disseminate the information and knowledge forward through a companywide policy. The group see the work is relevant and important to the business and have taken part in the data collection process to support the study and is being led by an executive director.

The research has been funded by the organisation which the research is part of, meaning that there is already an awareness of the research topic. By gaining support of those within the business who are influential to undertake interviews, an initial discussion has had to happen around the topic, even if not on the specifics of the review. This will have increased the awareness of the topic and the process to develop new knowledge in this area of research.

Whilst undertaking this study, the Researcher has shared learning from the study so far within the organisation and industry. The basis of the learning includes the findings from the systematic literature review and general understanding of what the literature is suggesting in terms of themes for the determinants which affect technology adoption.

There are two ongoing industry working groups being influenced directly by the research:

1. *Network Rail Research and Development Group – knowledge created from the study is being used to inform strategy for rail research to better enable Research to succeed. This group works with academic communities such as UK Rail Innovation Network to consider when looking for research-based activities to benefit future technological improvement. The ultimate aim will be two fold, to support the selection of projects which are more likely to be technically accepted and also to aid those projects being proposed to understand what information already exists to learn from.*
2. *Network Rail Enterprise Level risk working group – has developed controls to enable an improved level of uptake of technological improvements which benefit the railway. This group is reporting to the policy setters within Network Rail and therefore the Department for Transport on how to influence policy relating to technology and innovative application. This will influence industry level policy for the rail industry.*

Both groups have been meeting for almost a year now, with information from the study being fed in and used. Most recently the Research and Development group shared outcomes taken from a company wide information gathering exercise which shared the following areas as outcomes to support improved technology acceptance (Figure 27);



Figure 29 - Principles of innovation adoption, (NetworkRail,2024)

Within figure 29, many outcomes from the study have been directly referenced such as the definition of success equalling value and that this needs to be measured and aligned to the imperative. As well, determinants such, procurement strategy, system openness, benefits of innovation and leadership attitudes are all captured. Even more, some items such as the ability to be able to fail, to learn and to do this in a safe space have been articulated in the important areas to improve. Since this was published in April 2024, further feedback has been given around the importance between perceived usefulness and ease of use for the individual as this is a key finding, and the consideration to apply frameworks in full at least to test the suitability of them in regards to project outcomes the information has been update and consideration is being given for a basic educational awareness programme for those engaged with technology acceptance.

The intended impact on policy will be a direct change in the corporate policies in the rail industry relating to technology acceptance. This will be seen if the existing policies are amended, or if there are working documents which are publicized offering an improvement in how to address technology adoption. This should then be able to be measured in either a reduction in the lessons learnt from projects or an improvement in the time in which benefits can be realized and with the publication of information in Figure 28 being used to inform investment decisions and national policy this outcome will begin to have a positive effect.

What this will also enable at the leadership level is helping to create Leadership Capacity when it comes to technology acceptance. Creating leadership knowledge is a fundamental requirement and a core determinant of technology acceptance in organisations (Oorschot, Halman and Hofman, 2020). By working with those who set and inform the policy with the understanding from research literature and complimentary industries, leadership knowledge as a determinant of technology acceptance will be improved. To share across the railway leadership, the following events have been targeted and presented at with the majority requiring follow up sessions with individuals;

- *Presented at the UK national Engineering and Asset Management Forum where industry professionals meet to discuss important improvements and changes to the industry.*
- *Presented to members of the National Strategy Council to deliver a project applying the direct learning from this study, giving visibility at a board level.*
- *Delivered a workshop with a group of practitioners to understand how the learning can be directly taken and applied to existing and ongoing projects.*

The reason these areas have been chosen is to target both practice at both a functional level and organisational level and there are projects which are in flight currently that are being monitored to understand how they progress by testing the recommendations produced in this thesis.

To understand if there is a positive impact in practice would be that the GRIP process, which is the Governance for Railway Investment Projects would be updated to include a review and consideration for determinants at the start of the process, whereas today, there is simply reference to “determine the benefits” NR/L2/INI/P3M/001 - Governance for Railway Investment which is being reviewed currently and elements of the study have been fed into the working group.

Figure 32 presents the impact summary and its potential effect on policy and practise within the business and contextual area. The table articulates by financial, organisation, people, customer and customers impact the typical timescales and the type of impact, however in applying the findings of the study, along with the knowledge which has already been shared by virtue of the study taking place, the increase in knowledge of the business will affect its ability to accept technology.

Network Rail should consider how to better associate success with the needs of an individual in a way which can incentivise the use of technology for and at an individual level. A common proposition from the responses is that to make the best chance of success for a technology acceptance project, it needs to be delivered locally, but in a way which makes sure it carries scalability to enable a similar scale of the benefits, otherwise there is a potential for a number of varied solutions where the time and energy outweighs the level of success.

Practical Impact – Summary						
	Financial		Organisational Performance		People	Customers
<i>Description</i>	Reduction in costs of project failure and time.	Increase in the opportunity to achieve benefits on time increasing financial savings or resource effort.	Having more projects deliver what has been committed to will enable the organisation to improve the chance to meet corporate goals and therefore exceed performance expectation. Leading to more content stakeholders	Seeing success in technology acceptance will help to inform other proceeding technologies to be developed and implemented, increasing the clock speed of the industry.	Seeing projects succeed will enable further pride and motivation from those who work within the business, inspiring them to do more and in some cases, having less arduous roles due to technological support.	Those using the rail sector will see the change in approach and reputational benefit will follow. This will inform investment decisions because there is a higher chance of reliance on a trusted organisation.
<i>Strategic Impact (Long)</i>			Yes		Yes	Yes
<i>Tactical Impact (Medium)</i>		Yes		Yes		
<i>Operations Impact (Short)</i>	Yes					

<i>Internal Impact</i>	Yes	Yes			Yes	
<i>External Impact</i>			Yes	Yes		Yes
<i>Environmental Impact</i>			Yes – reduction in resource, logistics and carbon technologies	Yes – benefitting the speed of progression		
<i>Social Impact</i>	Yes – due to the potential for remuneration benefits.	Yes – Due to the reduction in reliance on subsidy funding			Yes – pride in working for the organisation	Yes – in using the organisational services

Figure 30 - Study impact outcomes on Policy and Practise

The practical impact described in table 30 is not unique to the rail industry in the UK and could be applicable to many other projects or outcomes which require technology to be accepted. This commonality means that others beyond this thesis can benefit from the work directly and should be looking to understand how to apply the work within the specific context. Figure 30 above has been further explained in the following sections.

6.6.1 Financial

As the study commenced, the improvement in efficiency for the rail has a direct impact on its ability to invest in the infrastructure and enable train journeys to complete. The investment in technology acceptance which either fails or achieves less return than is planned means funding cannot be spent on the existing railway requirements. A direct reduction in inefficient spending will enable either more local investment or more investment in technology acceptance. The governments white paper has already outline that to save money things must change and so it is unlikely that the status quo worsens as it has a governmental focus but the failure to maximise the savings relates to the successful implementation of recommendation 1 and 2.

6.6.2 Organisational Performance

The aim of technology acceptance in the railway has been seen in chapter 4 to be areas which affects coercive and normative risks. This means the technology is aiming to help the business improve in its own strategic requirements and therefore should benefit the organizational performance. In doing so, the stakeholders and users of the railway will recognise the improvement in corporate performance and its direct impact on their journeys and train movements. As each project is completed, the learning can be built in to the next speeding up and refining the approach to technology acceptance to help further.

There are some specific technologies which have been discussed such as the Class 153 project which aims to remove manual processing of data whilst the trains are running and relay it back to an office. These types of projects have an immediate impact on both performance and also safety and so being able to succeed in more of these, quicker can only have a positive outcome for the business.

Other technologies will help to increase productivity, and this will also have a direct impact on organizational performance by removing the inefficiency and waste in things such as manual processing of data, another example of the Class 153 project which has been reported to have succeeded.

6.6.3 People

The opposite to the emotions of failure and anguish from the effort to enable technology, if this was undertaken in a structured approach and more likely to succeed, those involved would be much more likely to be involved and support other technology acceptance projects. The success of projects will make people feel proud of the works they are undertaking as well as the users see that technology is there to help and make their role easier to undertaken. This has a direct impact on organisational performance just the same as attitude towards use has an impact on the behavioural intention to use technology.

If people receiving technology which works and helps them to do their job, they would be more likely to reflect positively on technological change and either want to help in the future or be a driver for change itself and therefore improving the corporate knowledge and leadership attitudes toward technology acceptance.

6.6.4 Customers

The biggest beneficiaries of the impact will be the passengers freight users. Gaining the benefits of improved processes, reduction in inefficient activities and a reduction in spend will not only build confident in the railway but increase the ability to use and access the service due the improvement in performance.

The growing confidence may mean

- *improved revenue from ticket sales as more will want to use a reliable service,*
- *increased private investment because individuals will recognise the value of the investment*
- *increased governmental support for further improvement projects*

All of which aid a national network which is public owned.

6.6.5 Impact on with industry parties

The Researcher is influential in the organisation by virtue of their position within the company. Within a public sector organisation, Director level are more influential due to the preference of a command and control style of hierarchical leadership (Hatch, 2006). This means that by virtue of the researcher undertaking the research, and sharing it openly, more are likely to take note broadening the potential impact which will directly benefit the organisation. However, technology acceptance often will need broader engagement, it has already been noted that parties such as trade union bodies have an important part to play.

There are several key stakeholders who have benefited from the research indirectly, these are not included in the research due to the reason given but can be useful in understanding if there is a broader impact to be had. Examples are as follows;

Industry research bodies – the rail industry is closely supported by numerous research bodies (Such as the UK Research and Innovation network) where the findings have been shared. These can influence other research activities offering those a higher chance of success and uptake in the industry. The coordinator who works for Network Rail has been briefing on the study, the test and commissioning site teams and also one of the UKRRIN partners. Going forward the intention is that others involved as partners will also be given the opportunity to discuss the study.

Finance teams – the study has been shared and presented to senior leaders in the finance team, also supported by the fact that the CFO was interviewed as part of the study and the results have been replayed back. The increased understanding of what may be important to projects means there is a higher chance of delivery should yield either an improved financial benefits or reduced contingency.

Technology End users – if there can be an improved level of sharing and understanding about projects and what has worked or not including the associated determinants then the understanding of models such as TAM, DOI and user autonomy will be better applied which will improve the engagement of the end users. These end users are anyone who receives the technology and as Network Rail is the infrastructure manager, the technology it implements covers the majority of the supply chain and so will affect them also. Creating a better and more robust relationship with technology changing the paradox surrounding technology acceptance and success. There is such a wide array of end users who can benefit and understand the findings however the process to do this is going to be via the policy change and associated briefing materials which will be shared across the whole business when completed. This normally has a 12 month time period to be completed.

Regulatory liaison teams – the determination for future funding is often based on the anticipated benefits and perceived likelihood of success. Demonstrating to these groups that learning is being undertaken and applied will offer a higher level of confidence to enable confirmation of ongoing or increased funding. The current regulatory liaison session was given a brief overview as the study was being complied and is due to have a further update on the outcomes in September 2024.

Other railway bodies - As this is the first study of its kind, railways in Europe are all publicly owned and the government in the respective countries are the primary funder and sponsors.

This means that there is a potential level of knowledge and understanding that this study will enable them to learn from and apply directly.

The beneficiaries and users of the of the research will predominately be those who are introducing new technologies as part of business change and technology driven projects. Diffusion of innovation discusses that often the first enablers of technology are the first to identify the value from change and to become ambassadors to its success (Rogers, 1983). Rogers suggests that by identifying those who can benefit from the uptake of new technology, can directly help to spread and lead the roll out. For this research the same method is being undertaken to help to encourage the use of the learning which will come from it. The agents who will be encouraged to support will be chosen by their engagement with the project and their choice to be involved with the study. The hope is that they will promote the research to a broader audience by virtue of their level of influence directly on projects and teams.

Everyone who took part in the semi structured interviews have become agents of the research and to different levels will take something from the study which will be taken forward. An aim of the discussion surrounding technology acceptance has been to create a network across the company of like-minded people who are in support of looking at technology acceptance in a new way, if this is the case, and help to proliferate this across the industry. This has been a partial success, as members of the Government Department have sought to find out about the study, and to be updated on its progress and how it could be used to support the establishment of a Sector Capability Strategy which is looking to include technology development and acceptance at an industry level. The initial sessions have shown promise, consideration for the outcomes of the study and the attempt to include in the discussions around capability. It is not clear on the specific outcomes, what a Sector Capability Strategy would look like but those who are taking part are being given a level of exposure directly to the study which will inform their thinking and understanding.

As it has been seen that the organizational environment plays a big part in the acceptance of technology (Baker, 2018) the study looked solely at Network Rail however sharing the learning broader than Network Rail will only help the understanding within the industry context. The study has been presented to a cohort of railway senior leaders consisting of Small (Medium) Enterprises, Train Operating Companies, Trade Bodies, key Supplier partners and Industry professionals which as part of a connected learning opportunity. This has led on to further sharing of information, from basics such as the TAM model to more specific discussions on some of the challenges between individual and organizational levels. This may inspire those companies to look further into technology acceptance themselves, or create further research opportunities in the specific context. An example which has been delivered with one of the

partners has enabled a new technology to be introduced on a pilot into the railway industry. The trial used directly some of the determinants from the study such as;

- *A clear imperative – Adner 2002*
- *Leadership attitude and Leadership Knowledge - Oorschot, 2020*
- *Procurement - DOI*
- *Facilitating conditions, Ease of Use and Usefulness – TAM*
- *But as well as these core determinants, TAM was applied in full.*

The technology being accepted cannot be shared due to the sensitive nature however the project demonstrated the successfulness of the technology in the rail industry to reduce costs, improve sustainability and engage the local team.

6.6.6 Impact on research

The research has been undertaken in the field of social sciences where there is a plethora of information surrounding technology acceptance, there is less within the public sector, especially the railway. It is hoped that the research inspires other researchers to look specifically at the rail sector in this field as it will inform the ability to improve the outcomes of technology acceptance within the sector.

The study has been shared within the University at the School Colloquia which resulted in follow up discussions relating to different applications of the learning such as the impact of technology acceptance within marketing of technology.

As further opportunity which helps both practice and research literature, the understanding of the phenomenon and how research can help to improve the outcome will have an effect on those who engage with the study. This could see further uptake of research by those in practice directly. Of those who have been interviewed, two individuals are investigating the opportunity to accept their own research in topics which are likely to align with this study. Network Rail is also looking to fund a further PhD in one of the future studies commencing from 2025.

The study outcomes have been shared with the organisations Industry Research and Development Board members to prompt further consideration of technology acceptance as funded research programs to help to better understand the phenomenon in particular social science. The distinct lack of information within this field suggests there could be an opportunity, and with the number of potential further research opportunities presented would suggest there is a breadth of opportunity to create knowledge which can benefit practice.

The most important impact on research, is the study itself and the new knowledge created by its findings as can be seen in Chapter 7.

6.6.7 Measuring impact

Although the dissemination of knowledge can be undertaken in many ways, understanding how successful this has been is not as straight forward. For example, the presentation of information in conference proceedings is difficult to determine if it is being taken forward however some of the potential methods of dissemination can be measured.

There are several methods which can be used to give factors of success of the organisation. There are three main factors which can be measured within the business. The first is an amendment of a companywide policy which reflects the outcomes from the study. This will aid the dissemination across the organisation. The updating of such policy would likely relate to how to apply good practice for projects and would affect all future workstreams.

Once policy has been amended, the application of the policy as a mandate within any project that relates to the introduction or acceptance of technology. This would be instigated as part of the investment process to consider the information produced and apply it to the particular projects. This is planned to take place however in the short term the researcher has been asked to become a member of the panel to enable direct challenge to the projects as they request funding.

Once there is a common approach, and a mandated application of policy, the learning from projects can be captured, reviewed and learned from. A specific outcome could be to measure the number of lessons learnt which are reporting from projects where technology introduction is mentioned. These are currently captured on a national central system for the whole of the company. Understand how many of these are being recorded now and how this may change over time. As this data set develops, to also understand if there are themes, or changes in those themes. To do this the system needs to be developed to enable the capturing of specific lessons learned which is intended to be completed by 2025 as the policy will drive the categorization.

There is also a potential for specific learning to be taken from the study and applied within the business. This may be the outcome of the presentations or conferences given but as an example there could be a decision to increase the leadership capacity either through recruitment or upskilling. This would be recognized as a change in the business as a direct outcome of the study.

The only irrefutable method to determine if the impact has been a success would investigate the time and cost of future projects which rely on technology acceptance to understand if they

have succeeded after they have been concluded specifically relating to the information given in section 5. If the UK Rail Sector is to be successful in achieving its overarching outcomes and funding agreement, technology acceptance will need to be improved and the Plan for Rail realised (Shapps and Williams, 2021).

The core recommendations to benefit the successfulness of the study are presented in Section 6 including initial timescales to support introduction. However, there are corporate milestones, Key Performance Indicators and reports which would be used to measure the impact of the study that will be included as part of the organisational policy changes, these are as follows;

Milestones

- *New corporate Milestone – Project commencement report confirms review of common and uncommon determinants.*
 - *Project by Project – within 6 months*

Key Performance indicators

- *National unit rate comparator – Corporate data showing the average cost of technology-based projects across the whole business should see this fall.*
 - *Organisational level – within 12 months*
- *Innovation funding – increase in the number of projects for a given size of funding*
 - *Industry level – within 5 years.*

Reports

- *Project termination reports – number pertaining to technology acceptance reduce.*
 - *Organisational level – within 12 months.*

As the project and outcomes examined within this thesis stretch over many years due to the complexities of the industry, it is difficult to measure true impact within the short term of the study. What is possible is to understand the immediate steps what can and have been taken in direct response. These immediate process changes will have an effect and will help to transform the approach of the business such as what can already be seen in Figure 29.

6.7 Research Limitations

As part of the interview process, 41 people were interviewed which is 0.16% of the whole organisation. Given that not everyone in the business would meet the criteria, it is a still a small sample of the organisation, and even smaller if you consider this is representative of the 250,000 across the industry. As a small sample, it still covers 40% of the most senior leaders within the business who supply most of the business influence and so should help to impress the need to understand what the research suggests and address any gaps in knowledge.

A further limitation is that the study is a point in time. Once the data is captured, if the anticipation is correct that those who have engaged will take away some learning and new knowledge which can be applied, this may change what is being measured. The business may start to change and by the time the thesis is concluded and published, the learning may be out of date. To prevent against this, continually business updates will be supplied back to the forums which are established and those who have taken part in the study. Restricting the time line and not allowing the study to extend will limit this to some extent, as has the sharing of knowledge throughout the study which is impacting those who have taken part or who have engaged in the study and applied its learning and outcomes.

6.8 Future Research Opportunities

In undertaking empirical research, there are a number of potential research opportunities which could be engaged with and taken forward as future research. These are proposed as either suitable to be undertaken by the business or to support the further development of knowledge within the existing literature.

6.8.1 To support Network Rail

The current research only covers Network Rail, many projects relied on government, regulator, and external parties. The scope of this research is regarding those projects within Network Rail solely and therefore the perspective of the rail sector is limited to what is a single part of it. The study has seen that supply chain has been referenced a number of times and so this expansion could aid further exploration of these areas to understand if the perspectives of technology acceptance are consistent at an industry level. This study would aid the external factors which influence network rail as well as the normative and coercive factors affecting success.

How the UK rail industry compared with other rail industries in different geographical territories in regard to the acceptance of technology. This would consider both government owned and privately owned to understand if the fundamental structure from a Stakeholder Theory perspective an effect on the ability has to deliver technological acceptance. The literature showed that the same technologies were being implemented in different continents and territories and a considered factor could be to test the UK Rail Sector against others to understand if there is a difference in approach as this was not identified from the literature review.

Investigate the role of agents and their influence on technology acceptance within the UK Rail industry. This would expand the work started and look critically about the parts which agents play and their influence on technology acceptance to understand different to determinants

what roles actors play in technology acceptance and how the levels of influence could be affected. With the number of actors involved in technology acceptance creating a clear map of the expectation of role types and value they add to the process could be beneficial to technology acceptance.

A final future opportunity could be that with time and an improved establishment of knowledge within Network Rail, the opportunity for a quantitative study regarding the frameworks and determinants of technology acceptance applicable to the railway sector in the UK to understand the specific influences which affect the success outcomes. This would be a direct continuation of the study and would also aid the validation of the impact.

6.8.2 Develop knowledge

There are a number of opportunities to build on what has been found in this study and progress forwards. Questions which have been posed that have not been answered such as what the influence of corporate incentivisation is have on the individuals involved in technology acceptance would enable corporate public entities to review their incentivisation programmes to help corporate progress with technology acceptance. Further studies such as this would be applicable beyond the rail sector in the UK.

When considering incentivisation, the study identified personal emotion and lasting grief from working with technology acceptance projects and so considering how does the success or failure of technology acceptance incentivise an individual's choice to be part of technology acceptance in the future. This would not only give a consideration for the changes in attitude but also would link back to the founding theories such as TRA and TPB from a different contextual perspective, that of the individual psychology.

Shared by each of the executives from Network Rail, business change is the major activity which from their perspective enables technology change, therefore consideration of the comparison between the determinants of technology acceptance and those which enable successful business change would be interesting to understand alignment and differences and this may further expand the respective models to give a more inclusive outcome.

The final proposal for the future research opportunities would be the relationship between leaders, employees and the trade union representatives and the direct influence on the outcome of technology acceptance. The existing models discuss elements such as the interconnectedness of the business, but not about the influences of industry bodies and parties which play a role in the technology acceptance process. These three actors were referenced many times but with different perspectives and rely on policy and influence and so this lens

would be interesting and could apply in other unionised industries, in particular if research already exists that could show differences and comparators.

6.9 Thesis Summary

The study has presented extensive research within the field of social sciences. Extracted using a proven systematic technique which then has been used to develop a set of robust questions which were asked to experts and influencers within the UK Rail Sector. From this data, themes have been compared back to the research to understand how to best benefit practise, policy and also develop the research knowledge base.

The final chapter has summarised the conclusions and described the contribution to theory including the potential further research opportunities which will continue to build on the knowledge created from the study.

The outcomes have had a profound impact on the author, are already showing improvements being made within the organisation and hopefully will have a lasting effect.

-: End :-

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Appendices

Appendix A – Search terms for SLR

<i>Determinants</i>		<i>Technology</i>		<i>Acceptance</i>
Determinant*	AND	Technolog*	AND	Acceptanc*
OR		OR		OR
First		Innovati*		Adoption*
OR		OR		OR
Prim*		Tool*		Implement*
OR		OR		OR
Precursor		Mechan*		Approv*
OR		OR		OR
Prelimin*		Equip*		Agree*
OR		OR		
Influenc*		Invent*		
OR		OR		
Driver*		Develop*		
OR		OR		
Barrier*		Creat*		
OR				
Enabl*				
OR				
Challeng*				
OR				
Anetecedent*				

Keywords and Search Terms used within the systematic review for RQ1

(Determinant OR First OR Prim* OR Precursor OR Prelimin* OR Influenc* OR Driver* OR Barrier* OR Enabl* OR Challeng* OR Anetecedent*) AND (Technolog* OR Innovati* OR Tool* OR Mechan* OR Equip* OR Invent* OR Develop* OR Creat*) WITHIN 3 WORDs (acceptanc* OR adoption* OR Implement* OR Approv* OR Agree*) NOT (Medic* OR Biolog* OR Biometric* OR Nurs* OR School OR Educat* OR Health OR Telemedi*)*

<i>Determinants</i>		<i>Technology</i>		<i>Acceptance</i>		<i>Successfulness</i>		<i>Not related terms</i>
Determinant*	AND	Technolog*	N3	acceptanc*	AND	success*	NOT	Medic*
OR		OR		OR		OR		OR
First		Innovati*		adoption*		achieve*		Biolog*
OR		OR		OR		OR		OR
Prim*		Tool*		Implement*		benefit*		Biometric*
OR		OR		OR		OR		OR
Precursor		Mechan*		Approv*		improve*		Nurs*
OR		OR		OR		OR		OR
Prelimin*		Equip*		Agree*		measure*		School
OR		OR						OR
Influenc*		Invent*						Educat*
OR		OR						OR
Driver*		Develop*						Health
OR		OR						OR
Barrier*		Creat*						Telemedi*
OR								
Enabl*								
OR								
Challeng*								
OR								
Anetecedent*								

Keywords and Search Terms used within the systematic review for RQ2

(Determinant OR First OR Prim* OR Precursor OR Prelimin* OR Influenc* OR Driver* OR Barrier* OR Enabl* OR Challeng* OR Anetecedent*) AND (Success* OR improve* OR benefi* OR achieve* OR measure*) AND (Technolog* OR Innovati* OR Tool* OR Mechan* OR Equip* OR Invent* OR Develop* OR Creat*) WITHIN 3 WORDs (acceptanc* OR adoption* OR Implement* OR Approv* OR Agree*) NOT (Medic* OR Biolog* OR Biometric* OR Nurs* OR School OR Educat* OR Health OR Telemedi*)*

Appendix A.1 – Expand search terms for success

<i>Theories</i>		<i>Successfulness</i>		<i>Technology Acceptance</i>		<i>Not related terms</i>
Theor*	AND	success*	AND	Technology Accept	NOT	Medic*
OR		OR				OR
Model*		achieve*				Biolog*
OR		OR				OR
Framework*		benefit*				Biometric*
OR		OR				OR
Method*		improve*				Nurs*
		OR				OR
		Accomplish*				School
						OR
						Educat*
						OR
						Health
						OR
						Telemedi*
						OR
						Student*

Keywords and Search Terms used within the systematic review for expanded RQ2

(Theor OR Model* OR Framework* OR Model*) within 2 words (Success* OR improve* OR benefi* OR achieve* OR Accomplish*) AND (Technology Accept*) NOT (Medic* OR Biolog* OR Biometric* OR Nurs* OR School OR Educat* OR Health OR Telemedi* OR Student*)*

Specific Database Search strings

(Theor OR Model* OR Framework* OR Model*) N2 (Success* OR Improve* OR Benefi* OR Achieve* OR Accomplish*) AND (Technology Accept*) NOT (Medic* OR Biolog* OR Biometric* OR Nurs* OR School OR Educat* OR Health OR Telemedi* OR Student*)*

Appendix B – Example data extraction form

Abstract	Title		Applicable to the SLR				
A technology acceptance model for empirically testing new and user information systems: Theory and Results The goal of this research is to develop and test a theoretical model of the effect of system characteristics on user acceptance of computer-	Yes	1	Davis, FH	Authors			
		1985	Massachusetts Institute of Technology	Year			
			Management	Journal			
				Field			
				Conceptual	Applicable		
				Mathematical	Empirical		
				Statistical			
				(Positivist) Experimental design			
				Statistical sampling			
				Case studies			
				Post-design: Theory free design - theory used to theorize empirical data	Theoretical lens		
				Pre-post-design: Theory laden design - theory used to design the study and to theorize findings			
				Developed a construct and then tested.			
				Conceptual	methods		
				Mathematical			
				Statistical			
				Regression technique			
				Experimental design	Empirical methods		
				4 data matrices broken down in to perceived usefulness and ease of use.			
				Statistical Sampling			
			Case studies				
			Mixed methods				
			Sample size	Sampling			
			120 (112 response)				
			IBM Development Laboratory (IT)				
			Industry				
			Canada				
			Country				
			Unit of analysis	analysis			
			Unit of data collection				
			Org. or dyad >>> Network	unit of analysis			
			Network >>> Org. or dyad				
			Perceived quality of output, Perceived usefulness, Ease of use, Enjoyment, Attitude towards use	Key relationships			
			What are the determinants of technology adoption?				
			Percentage of those who have readily moved to a differing position.				
			How is technology adoption measured?				
			Acceptance can be predictable, limited to 1 item of technology based around training.				
			Key findings				
			Perceived Usefulness (Davis, 1985)	Determinants			
			Perceived Ease of Use (Davis, 1985)				
			Attitudes towards technology (Rogers, 1995)				
			Behavioural Intention (Enjoyment/Motivation) (Kuciapski, 2017)				
			Energy Usage/Utilities				
			Housing / Construction				
			Self Service/ Mobile device				
			Agriculture and mining				
			Travel				
			Manufacturing				
			Education				
			Public Sector				
			Chemical production / Nanotech				
			Vehicle Automation				
			Management Innovation				
			Technology Acceptance Model (Davis, 1985)				
			Unified Theory of acceptance and use of technology 2 (Venkatesh, 2003)				
			Diffusion of Innovation (Rogers, 1985)				
			Technology Organisational Environment (Tomatsky, 1990)				
			Iacovou, Benbasat, and Dexter model (1995)				
			Government (Policy and regulation)				
			Organisational adoption				
			Consumer adoption				

Appendix C – Interview protocol V1

• Question	Type	Purpose	RQ
Name	Closed Name		NA
Consent and right to withdraw: Do you consent to the interview being used for the purposes of the research?	Closed Consent		NA
Consent to recording: Audio recording is requested to enable coding only and any audio file shall only be for the consideration of the researcher and supervisory team and not shared. Are you happy for the interview to be recorded?	Closed Recording		NA
Position within the company	Closed Role Title		NA
Time spent in current and previous roles	Closed Recent role		NA
Technology acceptance is the process by when an individual or group use technology to deliver a predetermined benefit, it can be hardware or software and is often referred to as an innovation. Have you been involved with any projects which delivered a technological change or required a technology change as part of the project?	Closed Yes/No		NA
<p>1. Describe a project which you have been associated with that have enabled technological change?</p> <p>a. Follow up question: Can you explain your role in relation to the project?</p>	Open Question		1

<p>2. <i>What were the challenges in delivering the technology?</i></p> <p>3. <i>Can you please expand on each?</i></p>	Open Question		1
<p>4. <i>Was technology accepted as planned?</i></p> <p>a. <i>Follow up: How did you overcome challenges?</i></p> <p>b. <i>Follow up: How did you maximise opportunities?</i></p>	Open Question		1
<p>5. <i>How did you measure if the project was a success?</i></p>	Open Question		2
<p>6. <i>How could the chance of success be increased if the project was run again?</i></p>	Open Question		2
<p>7. <i>What do you believe are the most important considerations when starting a project to make sure the acceptance of technology is successful?</i></p>	Open Question		2
<p>8. <i>Is there anything else you wish to add?</i></p>	Open Question		NA

Appendix D – Interview protocol V2

This interview is to support research related to the successfulness of technology acceptance within the UK Rail Industry. The purpose of the interview is to understand what determinants influence technology acceptance how to measure the level of success. In undertaking this interview, the data will be themed to present overall considerations relating to the research and apart from direct quotes, the outcome data will be anonymous to the individual.

Technology acceptance is the process by when an individual or group use technology to deliver a predetermined benefit, it can be hardware or software and is often referred to as an innovation.

• <i>Question</i>	Type	Purpose	RQ
Name	Closed Name		NA
Consent and right to withdraw: Do you consent to the interview being used for the purposes of the research?	Closed Consent		NA
Consent to recording: Audio recording is requested to enable coding only and any audio file shall only be for the consideration of the researcher and supervisory team and not shared. Are you happy for the interview to be recorded?	Closed Recording		NA

Current Position within the company	Closed Role Title		NA
Time spent in current and previous roles	Closed Recent role		NA
Have you been involved with any projects which delivered a technological change or required a technology change as part of the project?	Closed Yes/No		NA
• <i>Describe a project which you have been associated with that have enabled technological change?</i>	Open Question		1

<ul style="list-style-type: none"> Follow up question: Can you explain your role in relation to the project? 			
<ul style="list-style-type: none"> What were the challenges in delivering the technology? Can you please expand on each? 	Open Question		1
<ul style="list-style-type: none"> Was technology accepted as planned? Follow up: How did you overcome challenges? Follow up: How did you maximise opportunities as you progressed? 	Open Question		1
<ul style="list-style-type: none"> How did you measure if the project was a success? 	Open Question		2
<ul style="list-style-type: none"> How could the chance of success be increased if the project was run again? 	Open Question		2
<ul style="list-style-type: none"> What do you believe are the most important considerations when starting a project to make sure the acceptance of technology is successful? 	Open Question		2
<ul style="list-style-type: none"> Is there anything else you wish to add? 	Open Question		NA