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Reimagining Constraints and Accessibility in the Rail Sector: Late Technology Adopters in Increasingly Digitalised Travel Environments

Thesis submitted to the University of Nottingham for the degree of Doctor of Philosophy

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ABSTRACT

This thesis explores the constraints and accessibility of rail travel for late adopters of technology, focusing specifically on leisure travellers in Great Britain. As British rail undergoes structural and digital transformation, ensuring accessible services for all passengers has become increasingly vital. Late adopters of technology represent up to half of all leisure passengers, and are often stereotypically portrayed as elderly, technology-averse and resistant to change. However, this research reveals a more complex reality.

The overarching objective of identifying, analysing and understanding travel constraints for late technology adopters is addressed through four key research questions related to: the representativeness of existing literature on late adopters, the effectiveness of current constraints analysis methods, the constraints of rail travel, and potential service improvements. To comprehensively assess travel constraints for this passenger group, the research applies a multilayered approach incorporating both industry and passenger stakeholder perspectives. This qualitative investigation employs multiple methods including industry focus groups, semi-structured passenger interviews, travel-along ethnographies, and passenger focus groups. Methodologically, the research combines cognitive work analysis from human factors with constraints negotiation theory from leisure studies, developing an innovative interdisciplinary approach to investigate this diverse passenger group.

The findings demonstrate that late adopters are more diverse and technologically engaged than previously recognised in academic literature. Their technology use varies significantly between home and travel environments, challenging assumptions about universal adoption patterns. The research identifies multiple interconnected constraints affecting rail travel experiences, categorised as intrapersonal (confidence, trust), interpersonal (reliance on others), and structural (system design, accessibility). Notably, while many late adopters actively use digital technologies at home, they express hesitancy about using similar technologies in travel settings, preferring human interaction for complex or unfamiliar tasks.

This thesis makes several contributions to knowledge. First, it develops a novel constraints analysis framework that provides fresh insights into the constraints of rail travel and the nature of constraints for the late technology adopter passenger group.

Second, it challenges stereotypical representations by revealing late adopters as selective and strategic technology users, rather than universally disinterested in technology and resistant to change. Third, it demonstrates how environmental context influences technology engagement and adoption, highlighting the importance of situational factors in understanding user behaviour.

For industry stakeholders, the findings highlight two key insights: the essential role of traditional support mechanisms alongside digital innovation and the influence of trusted intermediaries in technology adoption. Recommendations include leveraging staff and volunteers to build confidence in digital travel services. This research also identifies a significant gap in the Great British rail sector's accessibility policy regarding technological engagement. Integration of digital accessibility considerations, particularly for those hesitant or unable to use technology, could help industry better evaluate how service digitalisation impacts passenger experience.

PUBLICATION DECLARATION

The following publications resulted from this thesis:

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TABLE OF CONTENTS

PAGE

DEDICATION 1

ACKNOWLEDGEMENTS 2

ABSTRACT 3

PUBLICATION DECLARATION 5

LIST OF TABLES 10

LIST OF FIGURES 11

CHAPTER 1: INTRODUCTION 14

1.1 The Rail System in Great Britain: Structure, Accessibility, and Digital Transformation 14

1.2 Research Context and Objective 15

1.3 Research Questions 16

1.4 Thesis Structure 19

CHAPTER 2: THE INFLUENCE OF TECHNOLOGY AND TECHNOLOGY ADOPTION IN TRAVEL AND TOURISM 25

2.1 Introduction 25

2.2 Connections to Travel and Tourism 25

2.3 Technology in Travel and Tourism 26

2.4 Built and Digital Travel Environments 29

2.5 Understanding Technology Adoption 31

2.5.1 Diffusion of Innovation 32

2.5.2 Representation of Late Adopters in Academic Literature 35

2.5.3 Diffusion of Innovation in Tourism and Transport Research 36

2.6 Chapter Summary 37

CHAPTER 3: CONSTRAINTS ANALYSIS 39

3.1 Introduction 39

3.2 What are Constraints? **39**
3.3 Cognitive Work Analysis **41**
3.3.1 Phase One – Work Domain Analysis **42**
3.3.2 Phase Two – Control Task Analysis **43**
3.3.3 Phase Three – Strategies Analysis **44**
3.3.4 Phase Four - Social Organisation and Cooperation Analysis **45**
3.3.5 Phase Five – Worker Competencies Analysis **46**
3.3.6 Summary of Phases **46**
3.4 Constraints Negotiation Theory **47**
3.5 Chapter Summary **49**

CHAPTER 4: METHODOLOGY **51**
4.1 Introduction **51**
4.2 Research Philosophy **52**
4.3 Research Design **54**
4.3.1 The Passenger Group **57**
4.3.2 Context of the Ethnography **58**
4.3.3 Multi-Stakeholder Approach **59**
4.4 Data Collection – Qualitative Methods **61**
4.4.1 Focus Groups for an Industry Perspective **63**
4.4.2 Passenger Perspective: Semi-Structured Interviews **66**
4.4.3 Travel Along Accompanied Journeys **69**
4.4.4 Passenger Participant Focus Groups **73**
4.5 Data Analysis **77**
4.5.1 Thematic Analysis **77**
4.5.2 Industry Focus Group Thematic Data Analysis **78**
4.5.3 Cognitive Work Analysis **79**
4.5.4 Passenger Interview and Travel Along Thematic Analysis **81**
4.5.5 Passenger Participant Focus Group Analysis **84**
4.6 Discourse Analysis **85**
4.7 The Constraints Analysis Framework **88**

4.8 Researcher Positionality **95**

4.9 Chapter Summary **98**

CHAPTER 5: UNDERSTANDING LATE ADOPTERS OF TECHNOLOGY **100**

5.1 Introduction **100**

5.2 The Late Adopter Spectrum **101**

5.3 Understanding the Late Adopter Perspective **104**

5.4 Constraints of Technology Use and Engagement **111**

5.4.1 Intrapersonal Constraints **113**

5.4.2 Interpersonal Constraints **118**

5.4.3 Structural Constraints **121**

5.5 Chapter Summary **127**

CHAPTER 6: ANALYSING TRAVEL CONSTRAINTS OF LATE ADOPTERS OF TECHNOLOGY **130**

6.1 Introduction **130**

6.2 Understanding Rail Travel Environments for Late Adopters of Technology **131**

6.2.1 Analysis of the Rail Passenger Environment **132**

6.2.1.1 Developing a Visual Understanding of Travel Constraints in the Rail Passenger Environment **133**

6.2.1.2 Section Summary **146**

6.2.2 Activity Analysis of the Rail Passenger Environment **150**

6.2.2.1 Mapping Constraints **150**

6.2.2.2 Constraint Mapping by User Group **154**

6.2.2.3 Section Summary **160**

6.3 Understanding Rail Travel Constraints for Late Adopters of Technology **163**

6.3.1 Technology Use in Rail Travel **165**

6.3.2 Passenger Support **173**

6.3.3 Section Summary **176**

6.4 Insights and Implications of Constraints Relating to Rail Travel **178**

6.5 Chapter Summary **187**

CHAPTER 7: SUPPORTING AND IMPROVING THE PASSENGER EXPERIENCE **190**

7.1 Introduction **190**

7.2 Provision of Support for Late Adopters **191**

7.3 Passenger Support Improvements: An Industry Perspective **196**

7.4 Passenger Support Improvements: The Passenger Perspective **201**

7.5 Chapter Summary **210**

CHAPTER 8: CONCLUSION **213**

8.1 Introduction **213**

8.2 Review of the Objective and Research Questions **214**

8.2.1 Contribution to Knowledge **214**

8.2.1.1 Question 1: To what extent does the diffusion of innovation literature accurately represent late adopters? **214**

8.2.1.2 Question 2: How effectively do current approaches to constraints analysis understand, examine, and represent constraints of travel? **217**

8.2.2 Managerial and Policy Implications **219**

8.2.2.1 Question 3: What are the constraints of rail travel in Great Britain for late adopters of technology as leisure passengers? **220**

8.2.2.2 Question 4: How can the built and digital environments of the rail sector be improved to better support this passenger group? **222**

8.3 Limitations **224**

8.4 Recommendations for Future Research **225**

8.5 Concluding Remarks **227**

REFERENCES **229**

APPENDICES **259**

LIST OF TABLES

		PAGE
Table 4.1:	Industry Professionals Involved in this Research	**60**
Table 4.2:	Focus Group Session Question List	**65**
Table 4.3:	Pre-Interview Screening Questionnaire: Answers Containing the 'X' Symbol Indicate Late Adopter Tendencies	**67**
Table 4.4:	Interview Details Per Participant	**69**
Table 4.5:	Travel Along Journey Details	**71**
Table 4.6:	Outline Ketso Plan	**76**
Table 5.1:	Interpretation of Themes and Sub-Themes Identified During Thematic Analysis of Passenger Participant Interviews	**105**
Table 5.2:	Application of the Constraints Negotiation Theory Approach to the Thematic Analysis of Late Adopter Interview Data	**112**
Table 6.1:	Themes and Sub-Themes Associated with the Constraints of Travel Topic Identified Through Thematic Analysis of Focus Group Data	**132**
Table 6.2:	Examples of Constraints Identified Using a Constraints Negotiation Theory Approach to the Removal of In-Person and Telephone Staff Support Scenario	**142**
Table 6.3:	Themes and Codes Identified from Passenger Interview Data	**163**
Table 7.1:	Themes and Sub-Themes Identified in Relation to Support for Late Adopters Discussion Topic at Industry Focus Groups	**192**
Table 7.2:	Themes and Sub-Themes Identified in Relation to the 'Improvements' Discussion Topic at Industry Focus Groups	**198**
Table 7.3:	Solutions and Improvements Proposed by Late Adopter Interview Participants Categorised by Associated Theme	**202**
Table 7.4:	Solutions Favoured by All Focus Groups with Comments Captured from the Discussions	**208**

LIST OF FIGURES

		PAGE
Figure 1.1:	Thesis Structure Flow Chart	**20**
Figure 2.1:	The Diffusion of Innovation Adopter Categories (Rogers, 2003)	**33**
Figure 3.1:	Example Abstraction Hierarchy Structure with How-What-Why Matrix Overlaid from Mcllroy and Stanton (2012)	**43**
Figure 3.2:	Contextual Activity Template Structure from Naikar et al. (2006)	**44**
Figure 3.3:	Information Flow Map for Strategies Available for Air Traffic Controllers During Thunderstorms from Ahlstrom (2005)	**45**
Figure 4.1:	Research Onion (Saunders et al., 2015, 164)	**55**
Figure 4.2:	Sequential Order of the Four Distinct Parts of this Ethnographic Research	**57**
Figure 4.3:	Diagram Highlighting the Contribution of Each Study to the Research Objective and Questions	**62**
Figure 4.4:	Example of Edited Photos Taken During Travel Along Fieldwork	**72**
Figure 4.5:	Feedback and Discuss: Ketso Seed Question Strategy	**74**
Figure 4.6:	Extract of Fieldnotes from Journey Four with Themes Highlighted	**83**
Figure 4.7:	Complete Ketso Workspace at the Conclusion of Focus Group Two	**84**
Figure 4.8:	Example of Ketso Spreadsheet Containing Data from all Three Focus Group Sessions Sorted by 'Felt' (Group Number)	**85**
Figure 4.9:	Example of Discourse Analysis Coding Applied to Thematic Analysis of Passenger Interview Data Categorised by Implication	**87**
Figure 4.10:	The Constraints Analysis Framework for Combining the Approaches of Cognitive Work Analysis and Constraints Negotiation Theory	**89**
Figure 4.11:	Example Contextual Activity Template Structure with Social, Organisation, and Cooperation Analysis and Constraints Negotiation Theory Applied	**92**
Figure 4.12:	Example Segment from Developed Contextual Activity Template with Social, Organisation, and Cooperation Analysis and Constraints Negotiation Theory Applied to the Activity of 'Journey Planning'	**93**

Figure 5.1:	Stacked Column Chart Showing Late Adopter Participant Scores Segmented by Age Group	**102**
Figure 5.2:	Radar Chart Showing the Cumulative Results of the Preliminary Late Adopter Questionnaire	**104**
Figure 6.1:	Abstraction Hierarchy Analysis Focusing on the Passenger Journey Aspects of Rail in Great Britain	**134**
Figure 6.2:	Example Section of the Abstraction Hierarchy Demonstrating the Links Between the Provision of Up to Date and Accurate Information with the Other Hierarchical Layers of the Work Domain	**136**
Figure 6.3:	Extract from the Abstraction Hierarchy Focusing on 'Wayfinding' as the Value and Priority Measure of Interest While Demonstrating the Links Between Each Layer	**138**
Figure 6.4:	Extract of the Abstraction Hierarchy Taking the 'Wayfinding' Value and Priority Measure as the Focus with Provision of Staff Removed at the Purpose-Related Function and Physical Object Layer	**141**
Figure 6.5:	The Constraints Analysis Framework for Combining the Approaches of Cognitive Work Analysis and Constraints Negotiation Theory with Dotted Box Outlining the First Phase Analysing the Rail Passenger System	**149**
Figure 6.6:	Example of Complete Contextual Activity Template	**151**
Figure 6.7:	Example of the Contextual Activity Template with Constraints Negotiation Theory Applied to Explore the Implications of Soft Constraints for the Activities Relating to Navigating the Station and Train	**153**
Figure 6.8:	Social, Organisation, and Cooperation Analysis Applied to the Contextual Activity Template with Colours Indicating Availability of the Different Support Mechanisms at Each Stage of the Journey	**158**
Figure 6.9:	Example Segment of the Social, Organisation, and Cooperation Analysis with Constraints Negotiation Theory Analysis Applied	**159**
Figure 6.10:	The Constraints Analysis Framework for Combining the Approaches of Cognitive Work Analysis and Constraints Negotiation Theory with Dotted Ring Outlining the Second Phase Analysing Activities in the Rail Passenger Environment	**161**
Figure 6.11:	Photos of Late Adopter Travel-Along Participants Using Smartphones and Ticket Vending Machines During Travel to Search for Platform Information and Purchase Tickets	**168**
Figure 6.12:	Photos of Participant Undertaking Multiple Information Verification Checks in the Station Entrance, on the Platform, and on the Train	**170**

Figure 6.13: Photos of Participant with Companion Supporting the use of Station-Based Ticket Collection and Car Parking Payment Machines **175**

Figure 6.14: The Constraints Analysis Framework for Combining the Approaches of Cognitive Work Analysis and Constraints Negotiation Theory with Dotted Box Outlining the Third Phase Analysing the Nature of Constraints and Evaluating Negotiation Strategies **177**

Figure 6.15: Diagram Demonstrating the Construction of the 'Dependence' Implications (Discourse) Through Identification of Insights (Codes Constructing the Discourse) Associated with the Thematic Analysis of Passenger Interviews **180**

Figure 6.16: Diagram Demonstrating the Construction of 'Physical Items Boost Passenger Confidence' Discourse **183**

Figure 6.17: Themes, Sub-Themes, and Insights Identified as Connected to the Construction of 'Technology as an Unnecessary Distraction' Implicatory Discourse **185**

Figure 7.1: Bar Chart Indicating the Distribution of Ideas and Discussion of an Ideal Rail Journey Across Different Themes **204**

Figure 7.2: Focus Group Two: Complete Ketso Workspace with Blue Circles Indicating Areas Where Solutions to Constraints with Potentially Negative Impacts have not been Identified or Agreed and Green Circles Highlighting Solutions Accepted by the Group **205**

Figure 8.1: Flow Diagram of the Constraints Analysis Framework with Each Phase Segmented **219**

CHAPTER 1: INTRODUCTION

1.1 The Rail System in Great Britain: Structure, Accessibility, and Digital Transformation

As Britain's railway system undergoes its most significant structural transformation since privatisation, with the establishment of Great British Railways (GBRTT, 2022) and proposed changes through the Passenger Railway Services (Public Ownership) Bill (2024-25), a unique opportunity has emerged to embed inclusivity at the heart of the network. These fundamental changes to rail governance and operations present a critical moment to ensure that no users or potential users are excluded from this vital public service. The shift towards greater public control has heightened focus on accessibility, reflecting growing recognition that publicly owned institutions must serve all members of society (Department for Transport, 2021a).

This latest evolution builds upon a rich heritage of railway innovation in Great Britain, home to one of the world's oldest rail networks, with the first recorded steam locomotive journey taking place in Wales in 1804. Since these pioneering days, the network has undergone a complex series of transformations, including periods of expansion, contraction, and devolution of certain aspects to regional authorities. While *The Railways Act 1993* established a franchise model under which private organisations operated rail services, the UK Government now advocates for a more unified and efficient system with greater public oversight (Department for Transport, 2021a).

Central to this vision of a unified rail system has been an increased emphasis on accessibility for all passengers. Since 2018, the UK Government has introduced several comprehensive schemes to enhance transport accessibility, particularly for disabled people, including the Inclusive Transport Strategy (Department for Transport, 2018), the Accessible Travel Policy (ORR, 2019), the National Disability Scheme (Department for Work and Pensions, 2021) and the Inclusive Mobility Guide (Department for Transport, 2021b). The digital transformation of rail services has introduced new dimensions to accessibility challenges (Durand et al., 2023a). Accelerated by the COVID-19 pandemic, the adoption of technology within the sector has affected both organisations and individual travellers (Rosa, 2022). The UK Government's 'Plan for Rail' (Department for Transport, 2021b) has sparked renewed investment in journey digitalisation,

encompassing digital ticketing systems, personalised travel experiences through smartphone applications, and open data approaches for journey planning.

The implementation of these technologies, whilst often perceived as solutions to accessibility challenges, presents both advantages and disadvantages for users (Durand et al., 2023a). Notably absent from discussions around digital transformation are those who are hesitant, unwilling, or unable to adopt these technologies. These 'late adopters' - people of any age who distance themselves from using technology, have concerns about adopting it, or are unable to adopt it—represent a significant yet understudied group (Rogers, 2003; Neves et al., 2018). Academic literature has largely overlooked these users, often portraying them through stereotypical representations as elderly or uninterested in technology (Essen and Ostlund, 2011; Harvey et al., 2019). This omission is particularly concerning given the current political motivation for increased technological travel planning and ticketing, as the accessibility and desirability of these technologies are not universal, potentially leading to 'digital inequality' in accessing transport (Durand and Zijlstra, 2020).

As the British rail system continues to evolve, the interplay between accessibility initiatives and digital transformation will be crucial in shaping an inclusive future of rail transport. This transformation presents a critical opportunity to create a railway system that serves the needs of all passengers through both technological and traditional service delivery methods.

1.2 Research Context and Objective

Whilst digital innovations in the Great British rail sector aim to enhance accessibility and convenience, they present a complex challenge: the potential alienation of travellers resistant, more sceptical, or unable to adopt new technologies (Durand et al., 2023a). This research addresses this tension, focusing on passengers who prefer traditional methods, may not be able to use digitalised services, or struggle with digital interfaces, and examining how their rail travel experience is affected throughout their journey.

Concurrently, the rail sector is witnessing a notable shift in travel patterns. Leisure travel has emerged as a significant and growing market segment, accounting for over three-quarters of the overall rail revenue increase between April and June 2023 (GBRTT, 2023a). Similarly, rail revenue generated by this segment increased by a further 7% in the first quarter of 2024 compared to the same period the year before (GBRTT, 2024a).

This trend is further evidenced by changes in journey purposes. For example, 54% of journeys being made for leisure purposes during quarter four of 2022, despite industrial action (GBRTT, 2023b). Meanwhile, commuting journeys decreased from 49% in 2021 to 38% in 2022 (Department for Transport, 2024). These shifts occur against a backdrop of broader transformations in the rail sector, both structurally through government and industry policies, and societally through altered passenger behaviour and travel purposes.

Thus, the objective of this thesis is to identify, analyse, and understand the constraints of travel for leisure rail passengers who are late adopters of technology. This timely interdisciplinary investigation, drawing on approaches from the fields of human factors, leisure, and tourism studies, contributes to the development of a more inclusive and accessible rail system, aligned with the industry's ongoing transformations and evolving passenger needs. Human factors is a multidisciplinary field of research focusing on understanding and evaluating interactions between people, places, and technologies. Predominantly used in safety critical sectors, such as nuclear power, rail, and the miliary, it addresses design challenges using structured, repeatable methods to improve system performance and ensure human safety and wellbeing (Stanton et al., 2017). By addressing the identified gaps in knowledge and employing an interdisciplinary approach, this research will provide a more comprehensive understanding of late adopters, challenge existing stereotypes, and contribute to more inclusive design and policy decisions in the rail sector.

1.3 Research Questions

Four questions were developed to fulfil the objective of this research and are briefly discussed below. These questions were crafted to guide the investigation, ensuring a comprehensive exploration of late technology adopters' experiences within the British rail system. Each question addresses a specific aspect of the research, collectively contributing to a thorough understanding of the challenges and opportunities in enhancing rail travel accessibility for this user group. The questions are designed to build upon one another, providing a holistic view of the subject matter.

1.3.1 Research question 1: To what extent does the diffusion of innovation literature accurately represent late adopters?

Existing studies exploring technology adoption tend to focus on early adopter user groups or stereotype late adopters as purely older adults disinterested in technology. For instance, Essen and Ostlund (2011) mobilise older adults as representatives of the laggard market to design and produce new ideas and innovations. Whilst their study focuses on late adopters as potential designers and developers of new systems, it also contributes to the stereotypical assumption that this user group is primarily composed of older adults. Prior research has also typically been limited to single contexts or activities, such as the adoption of mobile banking or smartphone applications (Mattila et al., 2003; Min et al., 2019). This narrow focus fails to capture how late adopters approach and interact with technology across different settings.

This initial research question confronts the omission and stereotypical categorisation of late adopters by critically examining our understanding of this user group. The objective is to explore the characteristics, technological perspectives, and preferences of late adopters, developing a better understanding of this user group. The research begins with a comprehensive literature review, synthesising current knowledge about late adopters across various disciplines. This review establishes the existing theoretical framework and identifies potential gaps in how late adopters are characterised within the literature using the diffusion of innovation model. Following this theoretical foundation, the study progresses to direct engagement with late adopters of technology to develop insights into the characteristics, preferences, and behaviours of the user group.

Addressing this research question contributes to the academic discourse on technology adoption and provides a solid foundation for the subsequent research questions in this thesis. By challenging and refining existing stereotypes about late adopters, this investigation informs more inclusive strategies in both theoretical conceptualisations and practical applications in the rail sector and beyond.

1.3.2 Research question 2: How effectively do current approaches to constraints analysis understand, examine, and represent constraints of travel?

The second research question considers the efficacy of existing constraints analysis frameworks within the context of rail travel for late adopters of technology. A review of constraints analysis literature across the fields of human factors, leisure, and tourism

studies establishes a comprehensive understanding of existing approaches highlighting the similarities, differences, and potential limitations in how travel constraints are currently conceptualised and examined.

The research then progresses to an empirical phase, combining the analytical approaches of cognitive work analysis with constraints negotiation theory to explore the constraints of travel for late adopters as rail passengers. The findings contribute to the academic discourse on constraints analysis and may lead to refinements or new approaches that more accurately capture the complexities of travel constraints. Ultimately, this research question sets the stage for developing more comprehensive and nuanced methodologies for understanding travel constraints, informing both theoretical advancements and practical applications for improving travel experiences across various modes and contexts.

1.3.3 Research question 3: What are the constraints of rail travel in Great Britain for late adopters of technology as leisure passengers?

This research question shifts the focus from general characteristics and preferences of late adopters to their specific experiences within the context of rail travel in Great Britain. The research examines the impact of increased digitalisation through identifying and analysing the broader constraints of rail travel for this user group. By framing these impacts as behaviour-shaping constraints, the findings provide valuable insights for industry to better understand the consequences of service digitalisation for this diverse user group. This understanding creates a foundation for developing practical solutions to enhance the rail travel experience for these often-overlooked passengers.

1.3.4 Research question 4: How can the built and digital environments of the rail sector be improved to better support this passenger group?

Whilst the thesis aims to make significant theoretical contributions to the existing literature, it also has a strong practical focus. This fourth and final question addresses these more practical aspects of this thesis. It develops tangible ideas and solutions to improve the passenger experience of late adopters as leisure travellers. This question is crucial as it bridges the gap between academic research and real-world application. By leveraging the insights gained from the previous questions, this research identifies specific areas within both the built and digital rail environments that present challenges to late adopters of technology. It then proposes innovative yet practical solutions

cocreated by late adopters that cater to the needs of this user group without compromising the experience of other passengers.

The study evaluates the feasibility and potential impact of these solutions, as well as considering how emerging technologies could be harnessed in user-friendly ways to enhance the travel experience for those less comfortable with digital interfaces or reluctant to engage with technology. By addressing this question, the thesis provides actionable recommendations to rail operators, policymakers, and designers. These insights could inform future infrastructure projects, digital service development, and customer service strategies, ultimately contributing to a more accessible and inclusive rail system for all passengers.

1.4 Thesis Structure

This thesis is set out across eight chapters. A summary of this is presented in Figure 1.1.

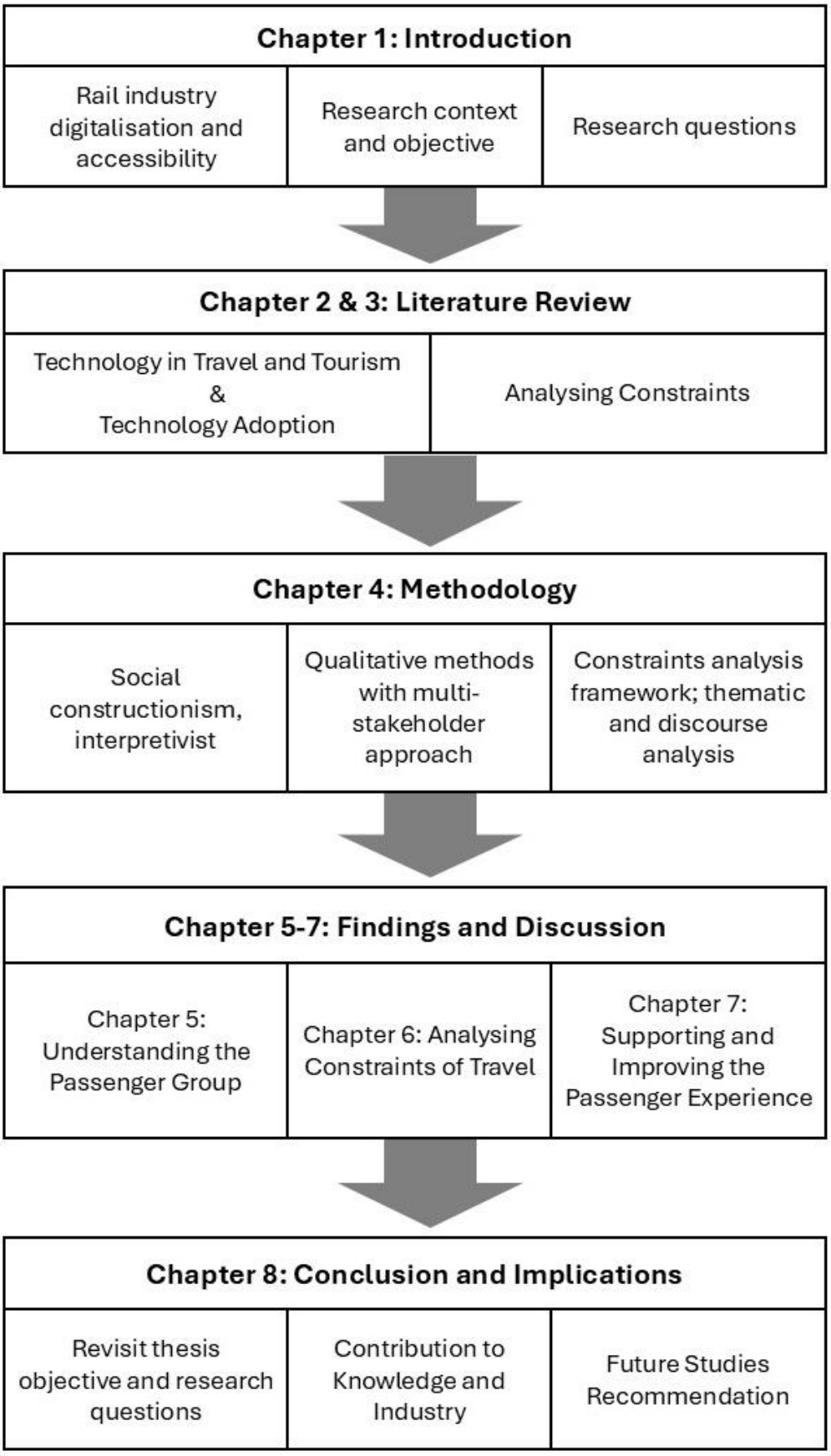


Figure 1.1 – Thesis Structure Flow Chart

Chapter 1 sets the stage for this research by introducing the Great British rail network as its primary context. The chapter establishes the rationale for the study, highlighting two key areas of focus. Firstly, it emphasises the need for a more nuanced understanding of late adopters of technology as a distinct and often overlooked user group. Secondly, it underscores the importance of conducting a thorough analysis of the constraints present within the rail travel sector. By addressing these aspects, this chapter lays the foundation for an exploration that aims to bridge gaps in current knowledge and contribute to more inclusive rail travel experiences.

Chapter 2 is the first of two literature review chapters. It lays the groundwork for this research by exploring the connections between rail transport, tourism, and technological innovation. The discussion opens with an examination of how public transport systems, particularly rail, intersect with tourism, highlighting the importance of leisure travellers in this research context. Building on this foundation, the chapter scrutinises the transformative role of technology in reshaping both industry practices and traveller experiences within the tourism sector with special attention paid to digital exclusion and its implications for travel accessibility. The latter part of the chapter introduces Rogers' (2003) diffusion of innovation theory as a pivotal framework for comprehending technology adoption patterns. By tracing this concept's evolution and its applications in tourism and transport studies, the chapter sheds light on current academic discourse surrounding late adopters and non-users of technology in various contexts including travel, healthcare, and urban planning. This theoretical exploration provides a robust foundation for a multifaceted investigation into the experiences of these users within the British rail system, paving the way for the empirical research that follows.

Chapter 3 is the second literature review chapter. The focus of this chapter is constraints analysis. The chapter begins by explaining the definition of constraints, drawing from both human factors and leisure studies literature, before presenting the specific interpretation adopted for this research. This foundational understanding paves the way for an exploration of two principal approaches to constraints analysis: Firstly, the chapter examines cognitive work analysis, a formative framework originating from human factors research (Rasmussen et al., 1994; Vicente, 1999). This approach offers valuable insights into identifying and analysing constraints within complex sociotechnical systems. Subsequently, the discussion shifts to constraints negotiation theory, a conceptual hierarchical framework rooted in leisure studies (Crawford et al., 1993;

Jackson and Rucks, 1995). This perspective provides a method for categorising constraints and investigating constraint negotiation strategies. This multidisciplinary lens highlights the significance of constraints analysis in enhancing accessibility, bolstering safety measures, and elevating overall traveller experiences in the transport sector.

Chapter 4 is the methodology explaining the philosophical assumptions guiding this thesis and the rationale for using qualitative approaches for data collection. Reflecting the interdisciplinary nature of this investigation, the chapter draws upon a research from human factors, tourism, and leisure research. This multifaceted approach provides a comprehensive foundation for the chosen methodology, ensuring its relevance and efficacy across various academic domains. It is in this chapter that the constraints analysis framework, combining approaches from human factors and leisure studies, is presented as a novel methodological framework for identifying and analysing constraints.

Chapter 5, the first of three findings chapters, explores the distinct characteristics, preferences and behaviours of late technology adopters as a unique user group. It addresses whether academic literature accurately represents this demographic, defined here as the last 50% to adopt innovations, including non-users, as per Rogers' (2003) diffusion of innovation theory. The chapter examines late adopters' engagement with and disengagement from technology in daily life, challenging stereotypes of resistance to change and disinterest in technology. It explores the diversity within this group, analysing their preferences, concerns and attitudes towards digital technologies more broadly. This foundation is crucial for understanding how late adopters' everyday technology use—or non-use—influences their rail travel experiences, given the increasing integration of digital technologies in both spheres (MacKay and Vogt, 2012; Lamsfus et al., 2015). Subsequent chapters will build on these insights to explore late adopters specifically in the context of rail travel.

Chapter 6 delves into the multifaceted constraints of rail travel in Great Britain for late technology adopters. Employing a novel constraints analysis framework that combines cognitive work analysis and constraints negotiation theory, this chapter offers a comprehensive exploration of the rail passenger environment from both industry and passenger perspectives. The chapter begins with the rail industry's viewpoint, using data

from focus groups with industry representatives to construct an understanding of rail passenger environments and associated support. It then shifts to the passenger perspective, drawing on thematic analysis of interviews with late adopters and insights from travel-along ethnographies. This multi-contextual approach compares late adopters' technology use across different environments, particularly contrasting home-based engagement with that in rail travel settings. Discourse analysis further uncovers how late adopters construct narratives around technology use in rail travel. Through the synthesis of these diverse analytical approaches, the chapter not only provides a comprehensive understanding of how constraints shape late adopters' behaviour and rail travel experiences, but also introduces a novel framework for examining such factors.

Chapter 7 is fundamental exploring potential improvements to enhance rail accessibility and passenger experience for late technology adopters in Great Britain's increasingly digitalised rail environment. The chapter is structured around three key areas of investigation: Firstly, it examines the provision of support for late adopters, analysing industry debates on the extent and nature of assistance. This section highlights tensions between digital advancement and maintaining traditional support mechanisms, reflecting broader challenges of digitalisation in the travel sector (Durand and Zijlstra, 2020; Durand et al., 2022). Whilst industry stakeholders broadly acknowledge the importance of considering all users' needs, including those who are late to adopt technology, current frameworks such as the Accessible Travel Policy (ORR, 2019) do not explicitly address this group—creating a potential risk that these passengers could be overlooked in the industry's digital transformation.

Secondly, Chapter 7 explores improvement strategies from an industry perspective. Through thematic analysis of focus group data, key themes such as process simplification, enhanced support initiatives, and the role of organisational culture in shaping passenger experiences are identified. Lastly, the chapter presents solutions proposed by late adopters themselves during the one-to-one interviews, offering insights into their needs and preferences. This section highlights potential misalignments between industry perceptions and user realities. This comprehensive analysis serves to bridge industry initiatives with passenger needs and ideas, paving the way for more accessible and user-centric rail services. The insights offer a foundation for policy makers and rail operators to craft strategies that embrace technological progress while ensuring no passenger is excluded.

Chapter 8 concludes the thesis by revisiting its primary objective and research questions. It distils key findings from the study's multifaceted approach, highlighting their theoretical and practical implications for the rail industry. The chapter emphasises the innovative constraints analysis framework's contribution to interdisciplinary research, showcasing its effectiveness in analysing complex constraints across diverse domains. Additionally, it outlines the study's limitations and proposes avenues for future research, ensuring the work's ongoing relevance in the evolving landscape of rail travel and technology adoption.

CHAPTER 2: THE INFLUENCE OF TECHNOLOGY AND TECHNOLOGY ADOPTION IN TRAVEL AND TOURISM

2.1 Introduction

This chapter focuses on the context of this PhD research, namely the relevance of tourism literature for rail passenger transport, as well as technology and digitisation in the travel and tourism sectors. The first section introduces the relationship between public transport systems and tourism as well as explaining why leisure passengers and tourists are relevant for this research. The next section discusses the impact of technological advancement in the travel and tourism sectors for both the industry and travellers, before examining digital exclusion in a travel context.

The chapter then moves to focusing on one of the key theories associated with understanding technology adoption, specifically diffusion of innovation (Rogers, 2003). This section explains the development of the concept, its use in tourism and transport research, and current understandings of late adopter users and non-users in academic literature.

2.2 Connections to Travel and Tourism

Exploring constraints to travel for late adopters of technology within the context of leisure and tourist rail travel in Great Britain is the focus of this research. Passenger transportation modes, including rail and aviation, are integral to the tourism industry as without transportation people cannot travel (Sorupia, 2005; Khadaroo and Seetanah, 2008). Transportation infrastructure influences travel demand to certain geographical areas and destination development (Rebollo and Baidal, 2009; Costa and Almeida, 2018). For example, the distribution of low-cost airlines across Europe has introduced new routes and increased traveller numbers to different regions. In some cases, such as Malta, low-cost airlines increased traffic and passenger numbers but did not change the seasonality or cultural development of the destination (Graham and Dennis, 2010). More recently, Zhang and Zhang (2022) confirm the relationship between transport infrastructure and tourism noting that the railway in China enhances tourism accessibility. From a policy perspective, several countries in Europe are taking steps towards reducing short-haul flights which could be substituted by more sustainable rail

journeys (Luman and Gouveia, 2022). This could also influence travel demand to different regions if they become less accessible through increased travel time or cost.

The roles of transport in tourist experience and destination development are also highlighted by Mendes et al., (2022). Building on the concept of Mobility as a Service (Giesecke et al., 2016), they propose a 'Tourism as a Service' model involving a similar smartphone application to Mobility as a Service. The aim of this new destination mobility model is to better integrate public transport, mobile ticketing for touristic attractions, and route planning to improve tourist experiences of getting to and travelling around the destination. Puhe (2014) suggest tourists in urban areas immerse themselves in the destination through using public transport which is also influenced by the availability of offers and discounted travel and attraction tickets. Yet, the majority of mobile ticketing services, particularly for public transport, are developed with only local people in mind (Mendes et al., 2022). It is also noted that the needs of visitors to new places are often quite different to the needs of local residents. The Tourism as a Service model addresses this gap through extending the Mobility as a Service and mobile ticketing concepts to focus on the needs of leisure travellers and tourists.

Tourists and leisure travellers also add an interesting dynamic for exploring constraints to rail travellers. Unlike commuters using the railway to regularly make the same journey from home to work, leisure passengers and tourists are likely to be less familiar with the route, stations, processes, and destination. These passenger environments are also increasingly digitised (Rebernik et al., 2021). This adds further complexity to the travel environments navigated by leisure passengers. For example, infrequent travellers only using rail for leisure travel may also be unfamiliar with the numerous online and mobile applications that may be available to support their journeys. This is particularly relevant to this research and will be discussed later in this chapter.

2.3 Technology in Travel and Tourism

The rise of the internet in the early 2000s, and more recently smart mobile devices, the Internet of Things (IoT), and artificial intelligence (AI), are arguably the most disruptive technologies to penetrate the travel and tourism sectors over the past thirty years. At the turn of the century, Buhalis (2000), and Buhalis and O'Connor (2005), argue the internet and information communication technology (ICT) will fundamentally change the way businesses in the sector interact with stakeholders and customers. Travel organisations

who do not engage with technology or offer their customers access to enhanced information, planning, and personalised services are likely to be less competitive in an increasingly digitised sector (Buhalis, 2000). More recently, the incorporation of Big Data, IoTs, and other advanced technologies has seen the travel and tourism industry evolve into a smart sector (Pencarelli, 2020). The focus of a smart tourism is the role of innovations and technologies as infrastructure to improve efficiencies, sustainability, connectedness, and traveller experiences (Buhalis, 2015; Gretzel et al., 2015).

Connecting consumers and travellers to smart technologies during travel and tourism activities relies on consumer-facing technology such as the internet, websites, and smartphones. The development of the internet from a browsing platform to a participative and interactive platform (also known as Web 2.0) has influenced the way many travellers find information, plan, and book their trip (Xiang et al., 2015). Likewise, the proliferation of smartphones and mobile devices has allowed people to access this information on-the-move while also connecting them back to their home lives (Pearce and Gretzel, 2012). Wang et al. (2016) advocate for travel and everyday activities to be considered as complementary of one another rather than being treated as separate cases. This is because habits and routines related to everyday living tend to spill over into the travel context, particularly the way we use technology to navigate travel experiences (MacKay and Vogt, 2012; Lamsfus et al., 2015).

In the United Kingdom in an everyday context the use of smartphones has increased across every age group since 2012 with the most notable usage increase of over 70% observed in the 55–65-year age group (Ofcom, 2025). Whilst the over 65's remain the age group least likely to own or use a smartphone, Ofcom (2017) suggest that usage of smartphones and other smart devices such as tablets has increased with around 39% of 65–74-year-olds using smartphones, and 27% of over 75's using tablet devices. In terms of access to the internet, the number of internet users over the age of 75 in the United Kingdom almost doubled from 29% in 2013, to 54% in 2020 (ONS, 2021).

Prior to the evolution of the internet and mobile devices, some scholars suggest that tourism activities comprised of a three-stage linear process involving a pre-travel anticipation stage, the during trip consumption or experience stage, and a post-travel reflective stage (Craig-Smith and French, 1994; Decrop, 2014). Traditionally, activities undertaken by tourists such as planning, experiencing different cultures, and sharing

experiences with family and friends at home, each took place in one of the three separate phases. The increasing prevalence of the internet and smart devices, however, has blurred the boundaries between both the aforementioned three-stage travel process and the separation of home versus away (White and White, 2007; Munar and Jacobsen, 2014). Wang et al. (2014) support this notion of boundaries between processes becoming blurred and interchangeable as they suggest that the smartphone and other internet-enabled devices have led to the unlocking of the linear three-stage travel process. Through digital connections it is argued that the decision-making environment in a travel context is becoming increasingly flexible and dynamic with travellers' planning less prior to departure, changing their plans more often whilst travelling, and sharing experiences in real-time (Wang et al., 2014; Lamsfus et al., 2015). Thus, in this context smartphones and similar devices can be said to provide three-dimensional support for travellers' during all phases of the travel process by enabling them to solve, share and store information on a portable device (Wang et al., 2012).

The different ways in which smart devices can assist travellers with problem solving, sharing experiences, and storing information throughout the travel process has been studied by various scholars since smartphone functionality improved and use increased across the general population. For example, in separate studies Wang et al. (2012; 2014), Lamsfus et al. (2015), and Linton and Kwortnik (2019) each suggested the smartphone empowered tourists to better solve problems they encounter whilst travelling by using navigation or information applications leading to increased flexibility and spontaneity with their choices. Similarly, White and White (2007), and Munar and Jacobsen (2014) explored how connections to home life facilitated by the internet and smartphones offered travellers' a sense of security and connectedness with friends and family. This sense of connection also extended to travellers' work lives being accessible to them whilst they are away travelling. Whilst Kirilova and Wang (2016) reported that some travellers may experience reduced anxiety relating to returning to work post-trip by being able to access work-related content whilst on holiday; other scholars including Derks and Bakker (2014) suggest that these positive outcomes of internet connection whilst away from home are not felt by all travellers as they argue that a lack of detachment can be bad for some people's mental health and wellbeing. Thus, whilst the positive impacts of smartphones enhancing experiences and increasing access to information is an important line of inquiry, it is also important to consider the potential

negative outcomes that connectedness via smartphones and the internet can have on tourists' overall experiences of travelling or a destination. None of these studies considered how the non-use of smart devices in an increasingly digital landscape of tourism activities affected the way people accessed services and information whilst travelling.

All the aforementioned studies explored, in some capacity, how the rise and prevalence of the internet and internet enabled devices have shaped consumers' behaviour both in and out of the travel and tourism sector. A large majority of these have gathered data from a broad range of participants, for example, Wang et al. (2016) selected their sample using a criteria relating to smartphone ownership/use and frequency of travel within a strict period of time. Similarly, Munar and Jacobsen (2014) gathered data from a wide variety of passengers returning from Mallorca to Denmark on scheduled and chartered flights. More recently, Linton and Kwortnik (2019) gathered their data as part of a larger industry-based research initiative. While their participants were of varied backgrounds, employment types, and levels of household income, most of their respondents were under the age of 55 years old with only 4% of participants representing older consumers. Thus, even though reports suggest that older consumers' spending on travel and tourism activities accounts for more than half of the UK's total spend on these leisure activities (Jones, 2015), academic studies in the field of tourism tend not to focus on this important market segment. Similarly, there are no studies exploring the consequences of not using technology, such as smartphones, in the field of travel and tourism for accessing information and service support.

2.4 Built and Digital Travel Environments

Rebernik et al. (2021) suggest that in an increasingly digitised world, technology and digital spaces should now also be considered by academics and industry professionals as areas in which disadvantage can occur. Most research into accessibility of digital travel and tourism spaces tend to focus on pre- and post- tourism experiences occurring in terms of website and mobile application accessibility (Mills et al., 2008; Silva and Borges, 2019; Vila et al., 2020). Other studies tend to explore the impacts and potential for technology to enhance physical accessibility of built environments through access to additional information and support. For example, Lavieri et al. (2018) explore how travel behaviour is influenced by accessibility of virtual and physical spaces and tools. They

suggest that enhancement of physical accessibility for adults over the age of 50 is of urgent concern for a demographic generally less engaged with technology. Astroza et al. (2017) also found that ownership and use of smartphone devices influenced travellers choices in terms of taking multimodal and more complex journeys. Likewise, Mouratidis et al. (2021) suggest that development and expansion of smartphone travel applications will influence traveller behaviour and lead to changes in how built travel environments are used.

In a study promoting inclusive city design, Rebernik et al. (2020) look more specifically at the relationship between the digital and built environment for people with disabilities. They found that while none of their participants were overly reliant upon or exceptionally skilled with using digital devices, when using the devices and smartphone applications as part of the study the ways they interacted with the physical spaces altered. Examples of changed users' interactions with physical spaces as a result of their engagement with digital devices include altering their route due to more accessible suggestion. Although digital services increased information availability and potentially improved navigation confidence for people with disabilities, they couldn't eliminate physical barriers in the built environment (Rebernik et al. 2021). While a smartphone application might suggest an alternative, more accessible route, it couldn't remove obstacles like uneven paths or stairways. This highlights the ongoing need for improvements in physical infrastructure alongside digital advancements to truly enhance accessibility in urban spaces.

Technology is often perceived as a tool to solve issues of accessibility in travel environments. However, the technology itself is not always accessible or desirable for all users, be it as a result of poor design, personal choice, or socio-economic reasons. This leads to some potential users of digital tools being excluded and disadvantaged (Groth, 2019). This gap between users and access to information and communication technologies (ICTs) is commonly referred to as the "digital divide" (OECD, 2001). Some studies have sought to explore the impact of digital inequality in the transport and tourism sectors. Durand et al. (2023a) argue that digitalisation in the transport sector presents a complex network of advantage and disadvantage for many users. For example, on the one hand digitalisation in travel environments provides efficient access to real-time information, however some passengers do not feel comfortable using their device on-the-go. Similarly, providing access to a smartphone or similar device does not

completely remove digital inequalities as some users lack confidence and skills to use it in an efficient way (Zhang et al., 2020; Durand et al., 2022).

It is suggested that older adults, women, minority groups, and people with lower income and education levels are most vulnerable to digital inequality (Durant et al., 2022; Shin and Baek, 2023). Where a lack of access, knowledge, skills and willingness to use digital technologies for travel exist users may be disadvantaged. This is particularly relevant in increasingly digitised travel environments where there are no alternative offline options. For example, Groth (2019) suggests that transport poverty is exacerbated by smart mobility trends where marginalised groups, who were already inhibited to access multimodal mobility, are further disadvantaged by a lack of alternative options to accessing smart mobility other than using smart devices. Similarly, Zhang et al. (2020) found that marginalised and vulnerable groups in China were less likely to have the skills and knowledge to access transport information with location-based services. These are both examples of how digital inequality in increasingly digitised travel environments directly impact the accessibility of the built environment.

The first part of this chapter has explored the connections between tourism and public transportation systems, the differing needs of leisure travellers and commuters, and the impact of technological advancements for the sector. It has been established that digital environments cannot be completely separated from built environments, especially as travel environments become increasingly dependent on digital technologies (Rebernik et al., 2021). While this can be beneficial for certain aspects of accessibility in the travel sector, it can also disadvantage some (non)users of technology (Durant et al., 2023). The following section will examine one of the key theories for understanding technology adoption and how innovations are disseminated, namely Rogers' (1962) theory for the diffusion of innovation.

2.5 Understanding Technology Adoption

Several models have been developed to understand technology adoption, including the Theory of Diffusion of Innovation (DOI) (Rogers, 1962), the Technology Acceptance Model (TAM) (Davis, 1985, 1989), and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003).

Rogers' (2003) DOI theory focuses on explaining how innovations spread through society by categorising individuals into adopter groups and examining the varying rates

at which people accept new products or ideas (Marsden, 2011). The DOI approach proposes five characteristics influencing innovation adoption: relative advantage, complexity, observability, compatibility, and trialability. It also considers factors related to the innovation itself, its marketing and communication, the timeline of adoption, and the social system. The social system is defined as the structures, norms, and values shared among individuals, groups, and organisations that influence innovation diffusion and adoption (Rogers, 2003). However, some studies suggest that certain change agents and organisations may not be as influential in this process as initially thought (Bell and Ruhanen, 2016).

In contrast, TAM and UTAUT focus on factors specific to the product or technology, such as usability and perceived usefulness (Davis, 1989). UTAUT expands on TAM by incorporating approaches from other acceptance models and considering additional factors like age, gender, experience, and voluntariness of use (Rejali et al., 2023). The choice between these models depends on the research focus. TAM or UTAUT is most appropriate for studies exploring factors influencing the adoption of specific products or technologies. On the other hand, DOI is better suited for studies seeking to understand the preferences, characteristics, and adoption tendencies of different adopter groups (Rogers, 2003). The latter is most aligned with the objective of this thesis, namely the identification of constraints to rail travel for later adopters of technology. The following section will discuss the development and use of the DOI theory as well as defining the adopter categories set out by Rogers (2003).

2.5.1 Diffusion of Innovation

Innovations according to Rogers' (2003) are new ideas, practices, or objects as perceived by the individual considering adoption. While these innovations may not necessarily be new, if they are new to the individual this is still considered an innovation (Dabphet et al., 2012). These new technologies, innovations, and ideas are dispersed throughout society through knowledge and individual experiences of the innovation. These experiences are passed from person to person starting with the earliest adopters to more sceptical users. This is represented as a bell-shaped curve of normal distribution (see Figure 2.1). The left-hand side of the bell curve represents the innovators, early adopters, and the early majority. Once half of the potential users have adopted the technology the curve reduces toward the right-hand side as the number of people that have not yet

adopted the technology becomes fewer. This is where the late adopters and laggards are represented.

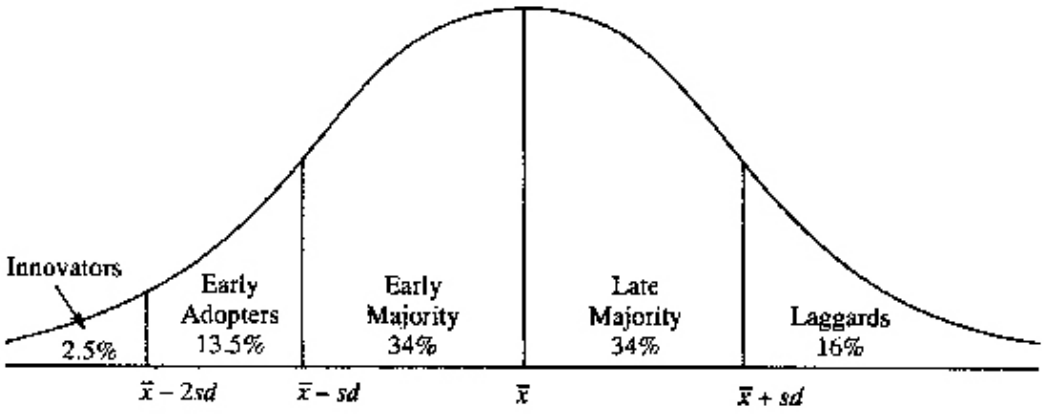


Figure 2.1 – The Diffusion of Innovation Adopter Categories (Rogers, 2003)

The innovativeness of individuals, organisations, and even governments can be explored using this approach as the main principles remain the same. Individuals or organisations are categorised by their level of innovativeness and how likely they are to adopt new technologies in comparison to others within their social or comparable networks (Rogers, 2003). Those that are most likely to seek out and adopt new innovations are grouped under one of the first three categories; 2.5% of adopters are grouped as innovators, the following 13.5% are known as early adopters, and the next 34% of people are the early majority. The latter half of the DOI curve is where 34% are categorised as late adopters and the final 16% of users are thought to be laggards. These two groups are most sceptical of new products, ideas, and innovations. They will only adopt a new technology once most others in their social circles and networks have adopted it or they are forced to transition (Rogers, 2003). For example, organisations may be influenced by the "bandwagon effect" where it becomes a necessity to adopt a technology or risk being left behind competitors (Mikl-Horke, 2004).

While Rogers' (2003) developed five adopter categories, several studies have adapted and modified these categories to suit their agenda. For example, Marsden (2011) proposes four adopter categories: innovators, early adopters, imitators, and laggards. Similarly, Brooker and Joppe (2014) develop three adopter categories, namely the artist, the artisan, and the painter. Others simplify the model further to a binary format of early (innovators, early adopters, and early majority) and late adopters (late majority and laggards), or even non-adopters (Guttentage and Smith, 2022), as two distinct groups

(Jahanmir and Lages, 2016). While highlighting the unhelpfulness of other binary standpoints in tourism literature, such as host-visitor, work-play, and self-other, Brooker and Joppe (2014) suggest such a binary and radical view of innovation diffusion is not representative of actual diffusion of innovation in the sector which is usually more incremental.

A systematic review of literature between 1996 and 2011 found that the majority of research using DOI uses questionnaires to collect quantitative data about a single innovation (Kapoor et al., 2014). It also found the majority of research using DOI explores organisational adoption of innovations rather than innovations adopted by individuals. Exploration of factors influencing early adopter behaviour and willingness to adopt new products is more prevalent than late adopters (see Schegg et al., 2008; Escobar-Rodriguez and Romero-Alonso, 2014; Wolf and Seebauer, 2014; Zijlstra et al., 2020; Strebinger and Treiblmaier, 2022). This could be because early adopters are often easier to recruit, receptive to trying new things, and more willing to give feedback on new products. For example, Rogers (2003) suggests the targeting of this user group by designers, developers, and researchers is a strategic move to use the path of least resistance to accelerate the research process, product development, and dissemination of the product. Some studies which appear to be exploring adopter categories across the spectrum inadvertently focus on the early adopter categories. For instance, Guttentag and Smith (2022) developed hypotheses which all relate to the attributes of early adopters even though their study explores differences of early and late adopter categories in the context of Airbnb guests. Similarly, Escobar-Rodriguez and Romero-Alonso (2014) focus heavily on early adopters and how they can be identified pre-innovation diffusion in their exploration of differences between early and late adopter groups in the context of technology acceptance in hospitals.

Fewer studies explicitly focus on the behaviours, preferences, or needs of late adopters (exceptions include Essen and Ostlund, 2011; Matzler et al., 2014; Jahanmir and Lages, 2016; Jahanmir and Cavadas, 2018; Harvey et al., 2019). Researchers that have focused on later adopters have argued that this demographic of user has historically, and arguably unjustly, been observed as uninterested in technology or innovation. It is suggested that this narrative means these often-marginalised user groups have only been utilised by researchers and industry for their opinions and experiences relating to existing products rather than as contributors for developing emerging technologies (Vines and Thompson,

2007; Essen and Ostlund, 2011). This is particularly problematic as Jahanmir and Lages (2016) and Harvey et al. (2019) suggest this user group prefer simple technological solutions without lots of additional features. Thus, if designers are not utilising late adopters at this stage in the technology development process, they are not catering products to the needs and desires of this important user group.

Rogers (2003) draws attention to the paradoxical relationship between innovation creation and adoption, and the laggard user groups who usually have the most to gain from adopting the new ideas or products. Essen and Ostlund (2011) suggest that older users, as a group typically perceived as likely to be late adopters of technologies, are ignored by designers of innovative products and services in favour of lead adopter groups. It is for this reason that scholars including Harvey et al. (2019) call for designers to take a more user-centric inclusive design approach which involves older people during the early stages of developing new technologies.

2.5.2 Representation of Late Adopters in Academic Literature

The ageing population has tended to be the demographic profile of late adopters and laggards in research taking a more explicit approach to experiencing this user group. There is evidence in the literature which suggests that older people, generally considered to be those over the age of 60 (Mattila et al., 2003; Essen and Ostlund, 2011; Hwang and Nam, 2017), are more likely to be late adopters as they experience deterioration in their ability to learn quickly, their memory function, and reaction speeds as well as their openness to change (Barnard et al., 2013; Damant and Knapp, 2015). Additionally, the discourse surrounding older people and technology in research tends to support the notion of ageing being an issue of medical problems and social isolation (Tobbin and Joseph, 2012). Technology in these discourses is perceived to be a tool, created by younger people, that can reduce or solve the problems associated with ageing. These approaches to the identification and categorisation of late adopters as older adults risks oversimplifying the DOI theory as well as presenting ageist research. It is problematic to frame the ageing population as an inherent problem or burden on the younger population that needs resolving through the use and production of new technologies (Vines et al., 2015; Neves et al., 2018). Rogers (2003) and Kim et al. (2010) highlight the inconsistency of research which suggests a relationship between age and technology

adoption, noting that early and late adopters have been identified in all age groups of users.

The assumption that older people are a homogenous group who are the only or primary (non)users to be categorised as late adopters would be a severe over-simplification of ageing populations. Harvey et al. (2019) highlights the heterogeneity of older people as users/non-users of digital technologies in their investigation of how this user group engage with new technologies in a transport context. They suggest that the digital divide between those with high and low levels of digital literacy does not purely exist between younger and older adults but is present throughout all age groups. Neves et al. (2018) argue that an intersectional approach considering multiple aspects of people's lives and technology usage, such as gender, social class, education, and ability, as well as the ageing process will lead to a better understanding of the digital divide and ultimately assist with closing this gap for all users. For example, Kim et al. (2017) suggest technological innovations can disadvantage senior women more than the older men due to individual, cultural, and structural barriers.

Current research using DOI theory is lacking an intersectional approach to examining the digital divide and adoption of technology amongst later adopters as a diverse group of (non)users. A lack of investigation into the effects of lower digital literacy and adoption of new technologies for people across a range of demographic backgrounds has been led by a misguided discourse stereotyping late adopters as troublesome older adults who are of less importance than younger digitally literate people (Rogers, 2003; Vines et al., 2015). This research seeks to address this gap by focusing on how later adopters of technology, as a diverse group of users, perceive and experience digital technologies in a travel context.

2.5.3 Diffusion of Innovation in Tourism and Transport Research

As an interdisciplinary approach, DOI has been used in a range of disciplines to explore innovation adoption, including travel, tourism, and transport research. In line with the findings of Kapoor et al. (2014), research using DOI in these fields also have a strong focus on organisational adoption of innovations (Aldebert et al., 2011; Bell and Ruhanen, 2016; Lesar and Weaver, 2022). Dabphet et al. (2012) use the theory to explore sustainable tourism development at a destination level involving both government and local resident stakeholders. They suggest that connection to other organisations, leaders,

and business owners positioned government agencies as early adopters of sustainable tourism development innovations at the destination level, whereas local residents with reduced access to distribution channels and less awareness of the concept are considered laggards. Other studies use DOI to explore the adoption of innovations by travellers, including adoption of alternative accommodation booking (Guttentag and Smith, 2022), use of travel applications and smartphones (Lu et al., 2015; Shin and Baek, 2023), and transport innovations such as Uber, bicycle sharing, and electric bicycles (Bernatchez et al., 2015; Seebauer, 2015; Min et al., 2019).

All of the aforementioned studies are product focused. Using Rogers' (2003) five innovation characteristics, these studies explore how innovations are diffused across society and their impact on the travel sector. Rather than focusing on a particular innovation, this research uses DOI and the late adopter categories as the lens through which to explore constraints to rail travel.

2.6 Chapter summary

Based on this discussion of the literature, it is proposed that Rogers' (2003) theory of diffusion of innovation should be used as the lens to explore the constraints to rail travel for passengers considered late adopters of technology. As an under examined passenger group this thesis challenges stereotypical representations taking a more inclusive approach to building an understanding of who these passengers are and why they are considered late adopters. This will help to develop a better understanding of the passenger group and the challenges they encounter with rail travel in Great Britain. For the context of rail, it has been established that leisure passengers and tourists are also an under researched group, particularly in transport literature where mobility development tends to focus on local residents. Yet, literature suggests that tourists in urban areas are keen to use public transport and have differing needs to locals when using these mobility systems (Puhe, 2014; Mendes et al., 2022).

Technological advancements have fundamentally changed tourist behaviour and the operations of tourism organisations (Buhalis, 2015; Xiang et al., 2015; Pencarelli, 2020). For tourists and leisure travellers, the boundaries between pre-travel, during-trip, and post-travel stages have become blurred, allowing for more flexible and dynamic decision-making (White and White, 2007; Munar and Jacobsen, 2014). People are able to use their personal smart devices to access information and make further travel

arrangements while on-the-go reducing the need for pre-trip planning and delivering more efficient during-trip experiences (Linton and Kwortnik, 2019). While this is beneficial for many travellers, it can also be an area of disadvantage for people who cannot or do not wish to use these digital services. Most studies exploring the impact of digital accessibility in the tourism sector tend to focus on product design and web accessibility (exceptions include Rebernik et al., 2021; Durand et al., 2022; Durand et al., 2023a). There is a need for further exploration into the accessibility of travel for people who cannot or do not wish to engage with digital technology and the impact this has on their travel experience. More specifically, the research in this thesis will address the need for understanding constraints experienced by passengers in this user group in a rail context and how these are negotiated. The following chapter focuses on constraints analysis providing an interdisciplinary discussion of how to identify, analyse and understand constraints.

CHAPTER 3: CONSTRAINTS ANALYSIS

3.1 Introduction

Identifying, analysing, and understanding constraints of travel for people who could be considered late adopters of technology is a core element of this thesis. The rationale for exploring late adopters of technology as a passenger group is explained in the previous chapter. This chapter focuses on constraints and negotiation of constraints. In the context of transport, travel, and tourism identifying and understanding constraints is important for improving accessibility, upgrading safety, and enhancing traveller experiences (Eichhorn and Buhalis, 2010; Salmon et al., 2016; Kim et al., 2022).

The first section discusses the definition of constraints as detailed in human factors and leisure studies literature before setting out the definition adopted in this thesis. The following two sections of the chapter discuss two core approaches to exploring constraints. The first from human factors, cognitive work analysis, is a formative framework for identifying and analysing constraints within complex sociotechnical systems. The second from leisure studies, constraints negotiation theory, is a conceptual hierarchical framework for categorising constraints and exploring how these can be negotiated.

3.2 What are Constraints?

According to the Cambridge English Dictionary (2024) a constraint is “something that controls what you do by keeping you within particular limits”. While this definition is straightforward, the term “constraint” has vastly different interpretations and uses across and even within academic fields. Some literature perceives constraints to be neutral, whereas others view constraints more negatively. The definition of constraints within the field of human factors - where the focus is predominately on system design, safety, and efficiency - is not too dissimilar from the definition above. For example, Naikar and Elix (2016) and Naikar (2017) refer to constraints as boundaries which limit, but do not completely restrict, the possibilities of available action for different actors within a system. The focus is on the behaviour of and interaction between people and the environment of the sociotechnical system which is shaped by the presence of constraints (Rasmussen, 1983).

In leisure and tourism studies, the focus is still on how constraints influence and limit behaviour, but the language used to describe constraints often implies more negative outcomes. Terms such as impeding (Jackson et al., 1993), inhibiting (Kim and Trail, 2010; Kim et al., 2019), and hinder (Aziz and Long, 2022) are commonly used to define and describe constraints in this body of literature. The term "barrier" is also often used interchangeably with "constraint" (Tao at el., 2024). The outcomes of constraints for people in this context are usually reduced or non-participation or non-attendance in leisure and travel activities (Chen, 2019). By contrast, Mei and Lantai (2018) suggest constraints influence traveller behaviour and choice rather than completely inhibiting travel. This is similar to the definition used in human factors as outlined by Naikar (2017) where the behaviour and choices of people are limited by constraints, but not entirely curtailed.

The approaches taken to constraints analysis in the fields of human factors and leisure studies will be discussed in further detail later in this chapter. While there are benefits for considering constraints in a more neutral way, particularly in safety-critical environments, it is also understandable that constraints may be considered more negatively when the context is exploring accessibility and participation. It is most common to see research focusing on safety-critical domains in human factors (for example, see Braaten, 2015; Salmon et al., 2016; Kim et al., 2022), while leisure and tourism studies tend to focus more on constraints as prohibiting participation (for example, see Crawford et al., 1991; Jackson et al., 1993; Lee et al., 2012; McKercher and Darcy, 2018).

As thesis is for an interdisciplinary PhD, it adopts a definition of constraints which uses elements of the definition from both human factors and leisure studies. Therefore, the definition of constraints used in this thesis is:

> Behaviour-influencing factors that shape individuals' choices and actions within the boundaries of the activity they are pursuing which could have positive and/or negative outcomes for people and/or the environment they are in.

The next two sections of this chapter will introduce two distinct approaches to the identification and analysis of constraints: cognitive work analysis (human factors) and constraints negotiation theory (leisure studies).

3.3 Cognitive Work Analysis

Cognitive work analysis is used to analyse and understand behaviour-shaping constraints within complex sociotechnical systems. Developed by Rasmussen et al. (1994), this framework has been further developed and adopted by many human factors researchers to investigate how people are influenced by and make decisions based on constraints encountered (Rasmussen et al., 1994). The approach has been particularly successful in safety critical and high-risk domains such as the rail sector (Jansson et al., 2006; Stanton et al., 2013; Salmon et al., 2016), hospitals (Braaten, 2015), the military (Jenkins et al., 2008; Houghton et al., 2015), and more recently understanding human-AI systems (Naikar et al., 2023). For example, Salmon et al. (2016) explore how pedestrians at rail level crossings are influenced by audio and visual constraints such as the siren, physical barrier, and red flashing lights aiming to alert them to the presence of an oncoming train. The sociotechnical system in this example is the rail level crossing. Studies using cognitive work analysis can apply the framework to a range of sociotechnical systems ranging from a single office or workspace through to a network of organisations where people work or undertake activities in conjunction with technological systems (Walker et al., 2008).

Constraints analysed using cognitive work analysis are considered neutral factors producing desirable or undesirable outcomes for people and/or the system (Braaten, 2015). In the rail level crossing scenario (Salmon et al., 2016), non-participation in the activity of crossing the tracks at the time of a train approaching as a result of the visual and audio indicators creating a constrained environment is a desirable outcome keeping pedestrians safe. This perspective contrasts with those developed in leisure studies, where constraints are generally framed as negative influencing factors of non-participation (exceptions include Samdahl, 2005; Godbey et al., 2010). Similarly, cognitive work analysis encourages researchers to be open to a range of possibilities through taking a more neutral perspective. The premise of the approach is to explore how things can be done in the system, rather than how the analyst, industry, and stakeholders think they should be done (McIlroy and Stanton, 2015). This approach is also less concerned with how activities are done in practice. The objective of the cognitive work analysis approach is to explore the possibilities of how support could be provided to assist behaviour modification and/or altering system components to enhance efficiencies.

Five phases form the cognitive work analysis framework: Work domain analysis; control task analysis; strategies analysis; social organisation and cooperation analysis; and worker competencies analysis. Each phase is independent from the others exploring different aspects of the sociotechnical system. As such, this formative framework allows the researcher to decide which phases are relevant to their study using as many or as few as appropriate (Stanton et al., 2013). Three of these phases are independent of considering specific users or groups of users within the sociotechnical system to identify the possibilities of what can occur in certain environments (Naikar and Elix, 2021). While the approach is flexible, the process of conducting analysis for each phase is structured, often involving completion of a template or worksheet. These processes have been developed to help researchers visualise vast amounts of information about complex systems in a concise single-page format (Naikar et al., 2006; Jenkins et al., 2008a). The following is an outline of the five phases of analysis.

3.3.1 Phase One – Work Domain Analysis

This phase aims to visualise the sociotechnical system as segmented into a hierarchical format whereby each level represents different functions, values, and aspects of the system (Jenkins et al., 2008b). Each level of the hierarchy is interconnected with the level above and/or below it through a means-ends relationship (Vicente, 1999). This helps the researcher to understand what the different aspects of the system do, why they exist, and how they are achieved. Physical objects, such as ticket machines, leaflets, and signage in the rail context, appear at the bottom of the hierarchy. Working upwards, the hierarchy contains object-related processes, purpose-related functions, value and priority measures, and finally the functional purpose of the sociotechnical system. While some of these categories have been altered by different analysts over time, the process of analysis remains the same. The concepts and functions become more abstract the further up the hierarchy they are. For example, using the abstraction hierarchy to explore modal shift from a passenger perspective, Stanton et al. (2013) identify safety, efficiency, and comfort as three of the functional purposes of the rail sector. Figure 3.1 from Mcllroy and Stanton (2012) demonstrates how each layer of the hierarchy can be linked to the other layers through the how-what-why means-ends relationship matrix.

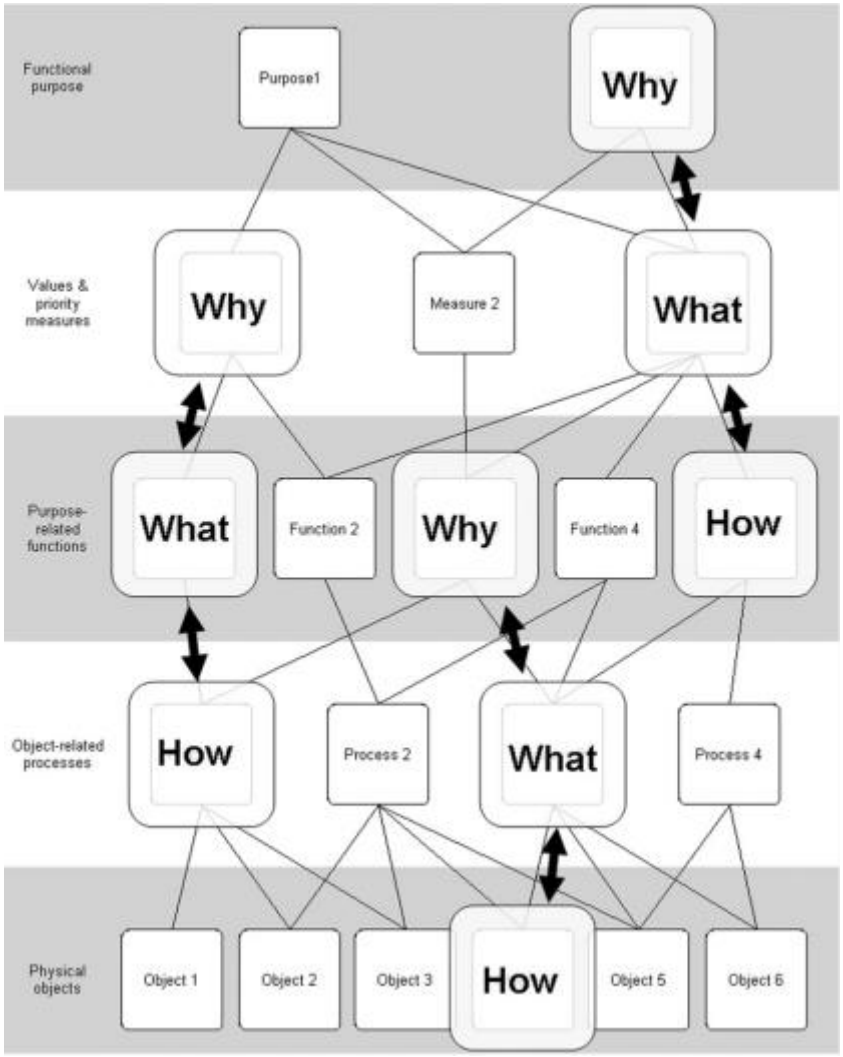


Figure 3.1 – Example Abstraction Hierarchy Structure with How-What-Why Matrix Overlaid from Mcllroy and Stanton (2012)

3.3.2 Phase Two – Control Task Analysis

The aim of this phase is to explore how different functions and activities enable the broader system to operate. Either the contextual activity template (Naikar et al., 2006) or decision ladders (Rasmussen, 1976; Vicente, 1999) tools can be used to complete this phase of analysis. Importantly, the functions and activities are explored without consideration of the people or skills required which are considered in later phases of the cognitive work analysis framework (St-Maurice and Burns, 2018). Exploring the possibilities of what can happen within the system, this phase looks at the ways in which activities can occur, rather than how they do so in practice. Naikar et al. (2006) propose the contextual activity template as a visual representation of behavioural activity within the system as segmented by functions (things that can happen) and situations (when or

where they can happen). Visually, this is presented as a table whereby the rows represent the functions or activities (see Figure 3.2). Functions, depicted as rows in the table, could include journey planning, finding a seat, and engaging with staff; and the columns of the table represent the situations in which these can happen, such as at home, on the way to the station, or on the train.

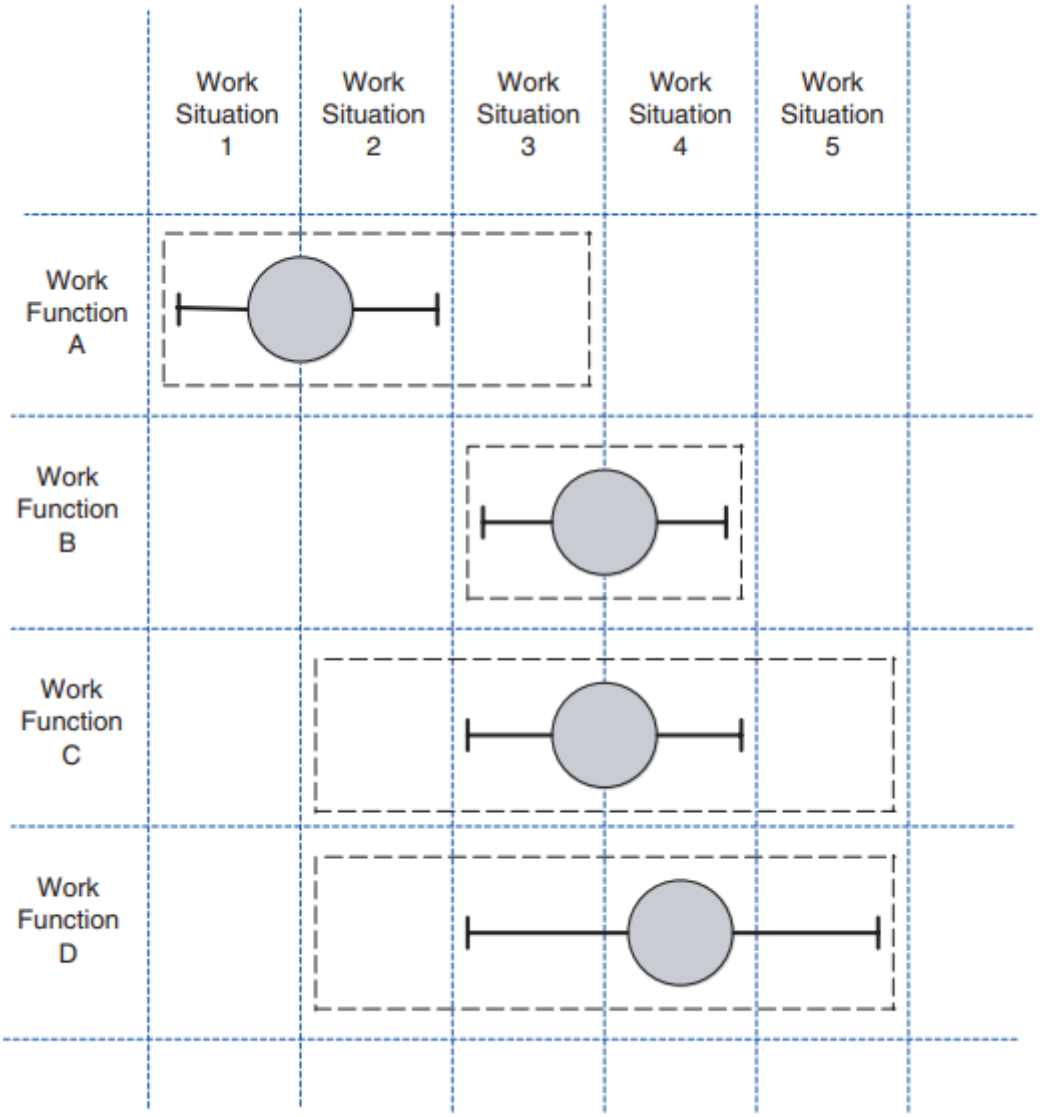


Figure 3.2 – Contextual Activity Template Structure from Naikar et al. (2006)

3.3.3 Phase Three – Strategies Analysis

Extending analysis completed in the preceding phase, strategies analysis explores how some of the activities identified as possible to occur could be done in practice (Vicente, 1999). The key difference between these two phases is that control task analysis reveals what can be done, whereas strategies analysis unpacks how these can be done. There are

usually several strategies available for a task to be completed. These can be presented as information flow maps showing the task, the potential strategies, and the outcome (Rasmussen, 1976) (see Figure 3.3). This helps to develop an understanding of the strategies available and required to complete activities within the constraints of the sociotechnical system (St-Maurice and Burns, 2018).

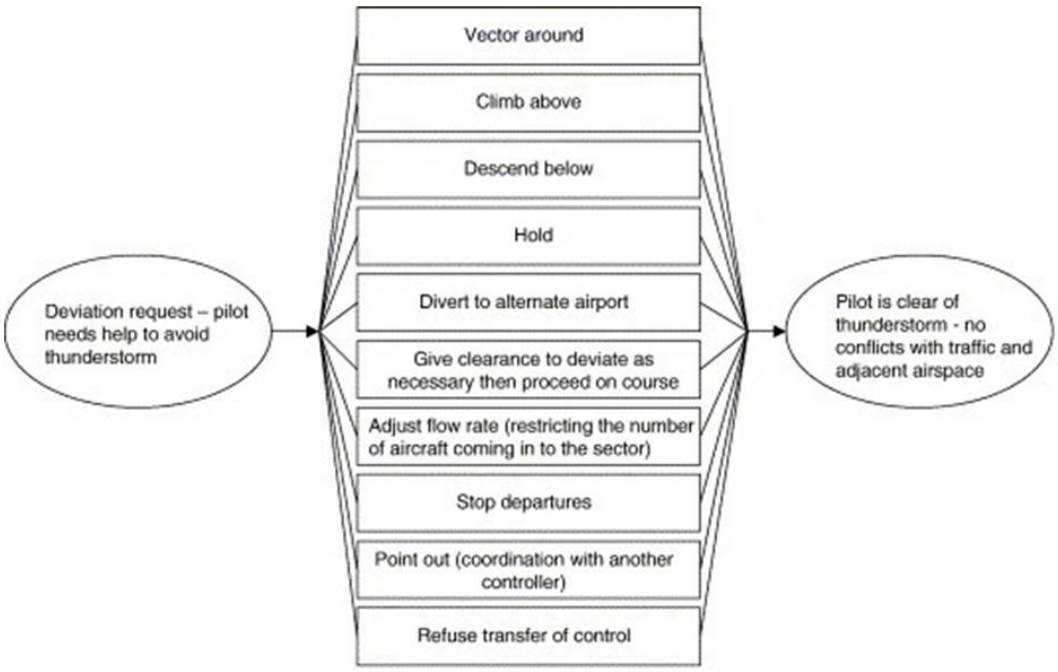


Figure 3.3 – Information Flow Map for Strategies Available for Air Traffic Controllers During Thunderstorms from Ahlstrom (2005)

3.3.4 Phase Four – Social Organisation and Cooperation Analysis

Unlike the previous phases, this phase explicitly considers the different actors in a system (who can do what) as well as the organisational and social factors influencing their ability to undertake activities (Rasmussen et al., 1994). If the researcher has completed the contextual activity template during phase two of the analysis, this can be used and further developed in this phase. Colour-coded shading can be applied to the template to demonstrate which user groups are able to undertake activities in a variety of scenarios. For example, Stanton et al. (2013) apply coloured shading representing different passenger types such as older adults, families, and disabled people. This helps to identify which groups of people are able to undertake certain tasks or activities in specified situations as a result of the social and organisational constraints in the system (Jenkins et al., 2008; Kim et al., 2022).

3.3.5 Phase Five – Worker Competencies Analysis

The final phase of cognitive work analysis explores cognitive constraints and sources of human error within the system (Vicente, 1999) through establishing the conditions and competencies required for system functions to be achieved. Division of the decision-making process into three levels using the skill, rules, knowledge framework (Rasmussen, 1983) helps to identify how cognitive constraints influence behaviour in the sociotechnical system.

3.3.6 Summary of Phases

Each of the phases of cognitive work analysis discussed here can be undertaken independently of one another and selected or deselected by the researcher depending on their study requirements (Vicente, 1999). This means that the researcher could complete a cognitive work analysis study utilising just one analysis phase. However, most phases within the framework complement or lead on from one another meaning the analysis is likely to be more detailed when two or more phases are completed in conjunction. For example, the abstraction hierarchy in phase one seeks to understand the complexities of the system which is complemented by the control task analysis completed in phase two seeking to further explore the functions and activities taking place (St-Maurice and Burns, 2018). Similarly, the contextual activity template developed for the control task analysis provides a useful base for the researcher to apply coloured shading for identification of constraints influencing certain users or groups of users.

While the order of these phases is not prescriptive, Naikar (2013) explains the framework starts with the focus on the physical environment through work domain analysis moving through to cognitive constraint analysis associated with social and cultural factors. Jenkins et al. (2008b) suggest work domain analysis is the most frequently used phase of cognitive work analysis. As has been explained, this phase is most concerned with understanding the relationship between different aspects of the sociotechnical system with no regard given to the users or actors. Likewise, control task analysis is another phase popular with researchers for examining activities in certain situations. Fewer examples of literature using the latter two phases of cognitive work analysis exist; namely social organisation and cooperation analysis and worker competencies analysis (exceptions include Jenkins et al., 2008a; Jenkins et al., 2008b; Houghton et al., 2015).

3.4 Constraints Negotiation Theory

In the fields of leisure, tourism, and disability studies constraints were traditionally considered static, insurmountable, and non-negotiable. It was believed that constrained individuals passively accepted this situation through non-participation in leisure activities (Jackson and Rucks, 1995). First appearing in the 1980s and developed throughout the 1990s, various studies sought to disprove this belief by exploring how constraints are negotiated in leisure studies (see Crawford and Godbey, 1987; Crawford et al., 1991; Jackson et al., 1993; Jackson and Rucks, 1995; Samdahl and Jekubovich, 1997). Since then, the theory has also been developed and used in related fields to leisure studies including disability studies (see Loucks-Atkinson and Mannell, 2007; Lee et al., 2012; McKercher and Darcy, 2018; Halpern et al., 2021) and tourism studies (see Chen et al., 2013; Gao and Kerstetter, 2016; Chung et al., 2017; Chen et al., 2020; Ying et al., 2021; Karl et al., 2022). The framework identifies and explores constraints of leisure participation by dividing constraints into one of three categories: intrapersonal, interpersonal, and structural. These categories are also structured in a hierarchical order with intrapersonal being most proximal to any individual or group of people through to structural constraints being most distant and to an extent out of the control of the constrained persons. Some scholars argue that a hierarchical framework for constraints misses the complexity of individual experiences of constraints and their negotiation. For example, Garrod and Fennell (2023) argue that constraints affect people differently which is not currently reflected in the constraints negotiation theory approach. This is particularly so for disabled people who experience constraints differently to non-disabled people.

Intrapersonal constraints relate to the individual and psychological factors. These could include attitude, personality, motivation, and perceptions of ability to undertake an activity. Interpersonal constraints consider the diverse nature of relationships between people, the presence of others, and communication between different actors in a situation. The relationship between people is complex and diverse which can lead to constraints with undertaking or participating in an activity. Structural constraints are different to intrapersonal and interpersonal constraints as they are largely out of the control of individuals and their interactions with others. Structural constraints include time, cost, and place-related factors, such as the accessibility of travel environments (Nyaypane and Andereck, 2008). Lee et al. (2023) suggest these structural constraints

have the greatest impact on learned helplessness of individuals in terms of constraint negotiation.

Identifying and categorising constraints is the first part in applying this theory. Exploring the negotiation of constraints is the second, and equally important, part of the process. Jackson and Rucks (1995) propose a categorisation system for constraints negotiation strategies: cognitive and behavioural. Cognitive negotiation strategies include inner voice, altering travel expectations, and self-motivation, whereas behavioural strategies include time management, budgeting, and rerouting a journey (Karl et al., 2021). It is suggested that behavioural strategies are employed more frequently than cognitive attempts to negotiate constraints (Jackson and Rucks, 1995). Jun and Kyle (2011) and Stodolska et al. (2020) suggest cognitive strategies are most commonly used to negotiate intrapersonal constraints, whereas interpersonal and structural constraints are negotiated with behavioural adaptations. For example, if a passenger is unsure how to purchase tickets for a rail journey online due to the complexity of the fares system, they may visit the local ticket office or phone the helpline for additional advice and support. In this example the passenger has modified their behaviour to negotiate the structural constraint of an overly complicated online ticket booking system. Kennelly et al. (2013) and Karl et al. (2022) suggest that cognitive and behavioural negotiations are interconnected with cognitive negotiation contributing to behavioural modification. For example, the perception of rail travel being more accessible influencing the decision (cognitive strategy) to travel by train instead of flying to a destination (behavioural adjustment).

Personality traits such as self-efficacy and extraversion have been found to lead to greater effort and persistence being asserted to constraint negotiation (Loucks-Atkinson and Mannell, 2007; Lyu et al., 2013). Similarly, negative perceptions, repeated constraints, and learned helplessness also impact the amount of effort someone exerts into constraint negotiation (Wen et al., 2020). Lee et al. (2012) suggests that travellers with disabilities may lose confidence in their ability to negotiate constraints if encounters are repeated which may also lead to capitulation. While constraints negotiation theory defines participation as the outcome of successful constraint negotiation (Jackson et al., 1993), Kono and Ito (2021) suggest that negotiating constraints is positively associated with enjoyment. This means that where constraints do not fully inhibit participation but reduce the enjoyment of an activity, people may engage in constraint negotiation to make the activity more enjoyable.

Discussion of literature in this section has largely, if not explicitly, considered constraints to be factors negatively influencing participation, engagement, and behaviour in leisure, travel, and tourism (Godbey et al., 2010). Given the context of these studies which generally seek to improve experience, enhance participation, and increase accessibility this standpoint is understandable. However, it is not without criticism. Samdahl (2005), Godbey et al. (2010) and Halpern et al. (2021) reflect on the negative positioning of constraints suggesting a more neutral position should be adopted. This is similar to the approach taken by researchers using cognitive work analysis. Constraints should be considered neutral factors influencing behaviour which can have positive or negative outcomes for individuals, organisation, or sociotechnical systems (Samdahl, 2005). For example, while some travellers may feel uncomfortable and stressed when engaging in mandatory security checks when travelling this constraint is integral to the security and safety of air travellers. This example highlights the negative outcome of the constraint for anxious travellers but also the positive outcome of keeping people safe which is the intention of the constraint. Adding further confusion to the understanding of constraints as neutral, Huber et al. (2018) and Devile and Kastenholz (2020) define factors with positive outcomes as *facilitators* and negative outcomes as *constraints* when discussing travel access for senior tourists and people with visual disabilities.

3.5 Chapter Summary

Constraints analysis is complex. The approaches from human factors and leisure studies presented in this chapter seek to simplify and add clarity to the process of identifying, analysing, and understanding constraints. Yet, across and within the fields of literature there remains confusion and debate around what constraints are and how these should be perceived. This thesis draws upon both approaches discussed in this chapter to provide a more holistic and neutral assessment of constraints in the rail travel context. The definition of constraints adopted here encourages a neutral approach to the evaluation of constraints as behaviour-shaping factors influencing the actions available within the bounded environment of the passenger rail journey.

Analysis of constraints has developed over several decades with cognitive work analysis and constraints negotiation theory dominating literature in the fields of human factors and leisure studies. The literature reviewed in this chapter suggests these approaches to constraints analysis have been designed and used for different purposes. For example,

enhancing efficiency and improving safety are key priorities within the human factors literature adopting cognitive work analysis to understand system constraints (Jenkins et al., 2008; Braaten, 2015; Salmon et al., 2016; Kim et al., 2022). Meanwhile, leisure studies literature focuses on constraints in the context of the accessibility, enjoyment, and participation of leisure and tourism activities (McKercher and Darcy, 2018; Ying et al., 2021). Arguably, this has led to leisure studies literature focusing on the negative impact of constraints. To date, there are no studies combining the approaches of cognitive work analysis and constraints negotiation theory to examine travel constraints. Likewise, there are no studies using either of these approaches to explore travel constraints for late adopters of technology in the rail sector. To provide a more holistic assessment of the constraints of travel the research in this thesis will use both approaches in conjunction with one another during the analysis of the research data. A more detailed explanation of how this is achieved will be provided in the methodology and findings chapters of this thesis.

CHAPTER 4: METHODOLOGY

4.1 Introduction

This thesis adopts a qualitative approach in order to explore and identify constraints of travel while proposing enhancements for accessibility of rail travel for passengers who are late adopters of technology in Great Britain. This chapter explains and justifies the rationale for using a qualitative approach for this specific passenger group within the context of rail travel in Great Britain as a case study. The justification for using this approach aligns with the research objective to identify the constraints of rail travel for leisure passengers that are late adopters of technology in Great Britain. As an interdisciplinary thesis, this chapter will draw on studies from the fields of human factors (engineering), tourism and transport, and leisure studies in the justification of the approaches detailed. Drawing on the research areas of travel constraints and the diffusion of innovation, this thesis will answer the following questions:

Research question 1*: To what extent does the diffusion of innovation literature accurately represent late adopters?*

Research question 2: *How effectively do current approaches to constraints analysis understand, examine, and represent constraints of travel?*

Research question 3*: What are the constraints of rail travel in Great Britain for late adopters of technology as leisure passengers?*

Research question 4: *How can the built and digital environments of the rail sector be improved to better support this passenger group?*

To explain the methodological approaches and decisions made during this research, this chapter will first explain the research philosophy adopted in this thesis (section 4.2). The research design and qualitative approach to data collection including interviews, travel along journeys, and focus groups will then be discussed (section 4.3 and 4.4). This will be followed by an explanation and justification of how the data are analysed, including the development of the novel constraints analysis framework (section 4.5, 4.6, and 4.7). Finally, the chapter will end with some reflections particularly highlighting the positionality of the researcher during the data collection and analysis phases of the research.

4.2 Research Philosophy

There are three dimensions to a philosophical stance to research: ontological, epistemological, and methodological. These correspond to the research objectives, specifically, what the object of research is, how to identify it, and how to approach it (Saunders et al., 2015). This section will explain which approaches have guided this thesis.

Firstly, the ontological approach to research is the foundation of how the researcher understands the world in terms of what reality is and whether this exists externally to the perceptions of people or if reality and the nature of being are socially constructed (Sorokina and Wang, 2018). This will guide the focus of the research and formulation of the research questions depending on which ontological stance the researcher takes. Bryman (2016) identifies two main ontological positions guiding research, objectivism and constructivism. The first starts from a position of viewing the world and social interactions as independent of people and consequences of factors that are outside the control of humans (Walliman, 2006). From a business management perspective, Saunders et al. (2015) liken this to the exploration of organisations where management are constrained by their job descriptions and make decisions in line with formal procedure set out by their company. Objectivity is dominant in the discipline of engineering research which generally uses quantitative approaches to analyse data and understand the world.

As a field within the discipline of engineering, human factors researchers are more flexible than other fields taking differing approaches on a spectrum between objectivism and constructivism (Vicente, 2000). The constructivist ontological approach taken in this research is guided by the belief that socially constructed interactions between people are the force guiding social change and phenomena (Walliman, 2006). Unlike objectivism, constructivism believes that reality is fluid, ever-changing, and conveyed in many different ways depending on the language and symbols used (Ayikoru, 2009). Therefore, approaching research from a constructivist perspective influences the researcher to consider how people are involved in the (re)construction of reality.

In addition to the ontological position the researcher takes, the research will also have an epistemological approach which guides the choice of methods and tools used to conduct research. Generally, this concerns the validity of knowledge, how knowledge is

generated, and how it is communicated. Broadly speaking, there are two epistemological approaches in research, positivist and interpretivist. The first is akin to scientific research of the natural sciences in which the 'truth' can be discovered through statistical analysis of experiments or surveys developed from hypotheses about a subject (Prayag, 2018). This is usually preceded by an objectivist ontology which guides the researcher to take a positivist epistemological approach. There are several examples of research exploring the adoption of new technologies within travel and transport contexts that are conducted from a positivist epistemological position using statistical data analysis and modelling to predict user behaviour and adoption (examples include, Kaushik et al., 2015; Zijlstra et al., 2020; Blumenberg et al., 2021). Some early research exploring constraints to leisure participation also adopted a positivist approach (see Hubbard and Mannell, 2001; Jackson, 2005; White, 2008). This type of research, often employing methods such as confirmatory factor analysis and structural equation modelling, is considered to be legitimate as a scientific inquiry, objective in nature, and generalisable (Saunders et al., 2015, 127).

Although positivism is largely associated with quantitative research techniques, it is also possible for studies using qualitative data to take a positivist epistemological approach (Su, 2018). The development and testing of a set of hypotheses on qualitative interview data, for example, applies a priori knowledge to the research subject. For example, a mixed methods study by Karl et al. (2022) develops hypotheses to be tested using both quantitative and qualitative methods to explore the relationship between constraints and negotiation strategies in the context of constraints negotiation theory. Another example of a qualitative study aligning with positivist epistemology by Samdahl and Jekubovich (1997) is criticised by Henderson (1997) for their approach to applying a pre-determined set of constraints to their qualitative research data. It is suggested by Henderson (1997) that the application of these pre-determined constraints is reflective of a positivist approach which restricts the ability to yield greater insights into the constraints to leisure impacting the people they studied.

By contrast, an interpretivist epistemological approach emphasises the involvement and influence of humans within the context of their research as well as the interpretation of these realities which the researcher is also a part of (Hemingway, 2006; Hollinshead, 2006). As can be expected from the explanation above, this epistemological approach is most often used in line with a constructivist ontology. Much of the criticisms of

interpretivist approaches to research are related to the trustworthiness and validity of the data and analysis. Unlike positivist research, which is heavily influenced by quantitative data, an interpretivist approach predominantly uses qualitative data which is analysed and interpreted by the researcher. The ambiguity around the interpretation of qualitative research data can lead to uncertainty around the validity of the research.

Techniques to enhance validity and trustworthiness in qualitative research using constructivist and interpretative approaches are proposed by Rose and Johnson (2020). These include member checking, critical reflexivity, and highlighting rich detailed fieldwork data. In interpretivist fundraising research, Alborough and Hansen (2022) note challenges like researcher over-familiarity, storytelling bias, and ungeneralisable findings. However, they also recognise the benefits of using this approach for the exploration of social processes and meaning making which are transferable to different contexts.

This thesis employs a constructivist ontology and interpretivist epistemology. While early leisure constraint studies used positivist approaches with quantitative data to produce generalisable findings (Jackson and Rucks, 1995), a deeper exploration of travel constraints is necessary. Interpretivism has been successfully applied to study leisure constraints in greater depth, including lived experiences and impacts on marginalised groups (Fendt and Wilson, 2012; Stodolska et al., 2020). Late adopters of technology, being under-represented in research, require similar attention. Interpretivism aims to uncover concepts and factors important to study participants (Saunders et al., 2015). To comprehend the complex experiences of this passenger group in a Great British rail context, a constructivist, interpretivist perspective is essential. This approach allows for a comprehensive analysis of the unique encounters of late technology adopters in navigating rail travel.

4.3 Research Design

The ‘research onion’ developed by Saunders et al. (2015) is helpful for understanding the process that a researcher undertakes when designing their study (see Figure 4.1). Focusing on the section highlighted in blue and working from the outside of the ‘onion’ towards the centre, the first design decision the researcher will take regarding the methodology is deciding if the research will be qualitative or quantitative, or whether it will incorporate a combination of the two. Research design aligning with interpretivism

as a philosophical approach usually adopts a qualitative methodology. Qualitative research strategies include, but are not limited to, ethnography, narrative inquiry, and case study (Walliman, 2006). This thesis adopts an ethnographic research strategy to achieve an in-depth analysis and understanding of late adopters of technology as leisure passengers of the Great British railway.

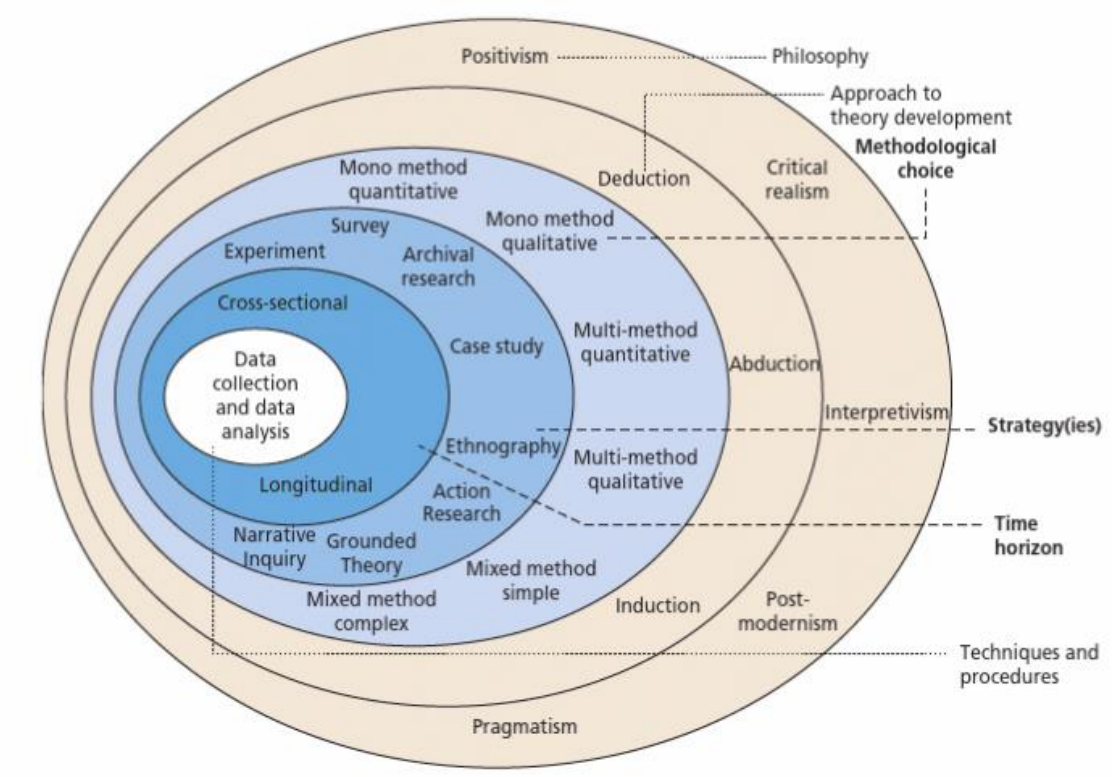


Figure 4.1 – Research Onion (Saunders et al., 2015, 164)

Ethnography is a qualitative approach to exploring social interactions in real-world settings. This usually involves the researcher conducting fieldwork and entering into the environment of the research participants to obtain first-hand experiences of social phenomena they are studying (Hammersley and Atkinson, 2019). As a research strategy, ethnography has been used for over one hundred years with early ethnographers, such as Malinowski, studying people from unfamiliar communities in a detached manner (Saunders et al., 2015). It is suggested that early ethnographers made extensive efforts to distance themselves from their communities of interest whilst maintaining adequate distance to observe behaviours and lacked the desire to improve conditions for their participants (Behar, 1999). Certain approaches, such as realist ethnography, still take a more objective and distanced approach to research through observations of what would

be considered facts through identification of formal processes, written documents, and symbols (Saunders et al., 2015, 188).

This thesis departs from the ‘armchair mode of cultural investigation’ (Van Maanen, 1988) that was common in the early 20th century. Instead, it embraces a more engaged approach, with the researcher being more closely embedded in the ‘action’ and interacting directly with research participants. This also brings some challenges such as researcher positionality. For example, the researcher as an outsider to the world of the participants can influence how participants behave during the study. This will be discussed further in the reflections section of this chapter. Methodologically, this thesis takes a similar ethnographic approach to that of Rebernick et al. (2020) and contains four distinct parts (see Figure 4.2). The initial stages of the research involve consultation with industry representatives to gather information and insights about rail passenger environments, support services, and perspectives of the late adopter user group. Like Rebernick et al. (2020) the research then turns attention to the social group of interest, in this case late adopters of technology, starting with exploratory interviews which are followed by travel along journeys with participants on the Great British rail network. Finally, late adopter participants are consulted once more in a series of focus groups to explore their perceptions of potential solutions to the negative consequences of some constraints identified earlier in the research programme.

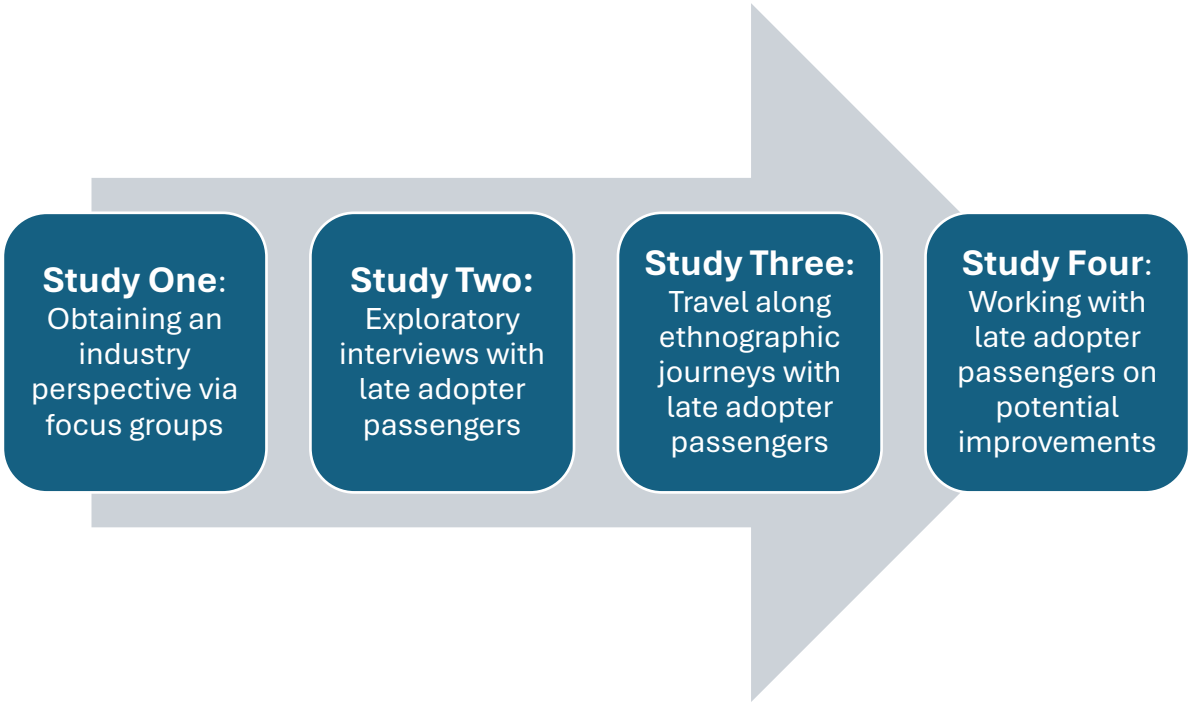


Figure 4.2 – Sequential Order of the Four Distinct Parts of this Ethnographic Research

The next section of this chapter will give details about the passenger group studied in this ethnographic research, followed by the context of the research, and detail of the rationale for involving both industry and passenger participants.

4.3.1 The Passenger Group

The theory of the diffusion of innovation, developed by Rogers (1962, 2003), states that new technologies, innovations, and ideas are disseminated through a social network as sets of knowledge and experiences. Rogers (2003) segments potential users into five categories: innovators, early adopters, early majority, late majority, and laggards. The experiences and knowledge gained by the initial users pass from one group to another until the innovation, technology, or idea has reached saturation point with the late majority or laggard groups. This model for understanding the dissemination of innovations is widely accepted and used by academics and industry to plan for implementing innovation and change (see Wolf and Seebauer, 2014; Min et al., 2019; Zijlstra et al., 2020; Chen and Tham, 2023).

This thesis rejects the stereotypical understanding of late adopters being old people who are disinterested in technology. Rather, a more holistic approach to studying and analysing the experiences, behaviours, and constraints for this diverse (non)user group is taken. This thesis considers late adopters to be people who are reluctant to use or later

to adopt technology than the early majority (Rogers, 2003). This could be for a number of reasons including, but not limited to, accessibility issues, privacy concerns, and lack of perceived need. It is also necessary to note that rail travel for leisure purposes is the focus of this ethnographic research. Passengers primarily using the railway for commuting purposes were excluded from this research as it is likely they will be more familiar with the rail network and passenger environments.

4.3.2 Context of the Ethnography

As much as ethnographic research contributes to theoretical understandings of the social world, it is also relevant for industry as it allows for an in-depth exploration of a specific segment of their market and analysis of customer experiences (Saunders et al., 2015). The research objectives for this thesis have been developed in collaboration with an industry partner: The Rail Safety and Standards Board (RSSB). In this regard, the research is also seeking to contribute to challenges the rail industry is experiencing. One of the priorities for the Great British rail sector, as set out in the Williams-Shapps Plan for Rail White Paper (Department for Transport, 2021), is to improve rail passenger experiences including the accessibility of rail services for all users. An extensive amount of research has been undertaken in academia and industry with the aim to understand and improve the accessibility of rail passenger environments (see RSSB, 2011; Blainey et al., 2012; Kurup et al., 2017; RSSB, 2017; RSSB, 2019; Swift et al., 2021). Much of this valuable work has been focused on exploring, understanding, and improving physical aspects of accessibility within the built environment. Less attention has been paid to accessibility issues concerning the digital environment with even fewer studies focusing on the relationship between the built and digital rail passenger environments and the impact of these on passenger experiences, usability, and accessibility (exceptions include Rebernik et al., 2020 [inclusive city design]; Blumenberg et al., 2021 [vehicle ownership]; Joshi et al., 2021 [urban mobility infrastructure]).

There has been renewed incentive and investment in the expedition of implementation of enhanced digital infrastructure in the rail sector including passenger-facing technologies (Department for Transport, 2022). In 2023 an industry consultation proposing to close all train station ticket offices in Great Britain in favour of supporting passengers to use digital ticking and information mechanisms was heavily criticised and since withdrawn (Transport for All, 2023). As rail passenger environments, both built

and digital, become more complex and increasingly reliant upon digital technologies it is important to consider how these environments are navigated by actual and potential rail passengers. Specifically, it is important to consider how passengers, and potential passengers, who are identified as being late adopters of technology navigate these rail environments. Late adoption or non-use of technology is not currently considered an accessibility issue per se; however, given the move to increase the digitalisation of travel environments, this thesis centralises this as an issue in the context of the built and digital travel environments of the Great British rail service. There are no studies currently exploring constraints of travel and the negotiation of constraints by people identified as late adopters of technology in the rail sector. Through ethnography this thesis aims to deliver an in-depth exploration, analysis and understanding of the experiences of late adopters in the rail sector while identifying constraints of travel and proposing further improvements.

4.3.3 Multi-Stakeholder Approach

To identify rail travel factors affecting this group, involving diverse stakeholders in research is crucial. This thesis adopts a multi-perspective approach, consulting industry and passengers to understand these elements. The process and rationale for including both stakeholder groups in data collection are briefly explained. This method ensures a comprehensive understanding of the conditions influencing the late adopter passenger group.

Since privatisation of the railways in the 1990s the British rail sector has become increasingly complex involving more than 100 independent companies who either manage, own, or lease some aspect of the rail network, albeit stations, rolling stock, or the track (Pickett and Tyers, 2022). The researcher had little involvement and experience with using and working with the rail sector in Great Britian prior to embarking on this research journey despite a background in tourism and leisure studies. To this end it was important to begin the research with building an understanding of this inherently complicated industry. The first step to achieving this began with consulting representatives from across the Great British rail industry. This was made possible by the Rail Safety and Standards Board who are directly involved with industry professionals as a cross-industry membership-based advisory body. The researcher accessed potential participants through direct introductions and widely distributed calls

for participation among industry working group networks. The breadth of job roles and types of organisations worked for by industry professionals involved in this research is detailed in Table 4.1.

Table 4.1: Industry Professionals Involved in this Research.

Participant	Job Role	Organisation Type
1	Safety and Risk Specialist	Train Operator
2	Senior Accessibility Mentor	Train Operator
3	Senior Engineer	Rolling Stock
4	Casework Manager	Industry Watchdog
5	Accessibility Mentor	Train Operator
6	Customer Assistant	Train Operator
7	Accessibility Improvement Manager	Train Operator
8	Risk Manager	Train Operator
9	Accessibility and Inclusion Manager	Cross-Industry Membership Organisation
10	Customer Experience Manager	Network and Infrastructure Management

Involving industry professionals in the first stage of the research helped to piece together a picture of how the rail network is organised as well as understanding the mechanisms available to support passengers throughout the journey. Seeking expert knowledge from industry practitioners to formulate an analysis of the behaviour shaping constraints of a complex sociotechnical system is a common approach taken by researchers using the cognitive work analysis framework (examples include Jenkins et al., 2008; Euerby and Burns, 2012; St-Maurice and Burns, 2018). This initial stage of the research was also crucial in guiding the subsequent sections involving passengers identified as late adopters of technology.

The second, and arguably most important, stakeholder group to be involved in this research are the passenger group of interest: late adopters of technology as leisure passengers of the Great British railway. Having formulated an understanding of the mechanics of the rail network guided by the input of industry professionals, the research turns attention to the passenger perspective. To build an understanding of the passenger

group and constraints of travel the researcher spent extended periods with the passenger participants during the ethnographic study. This involved conducting semi-structured interviews, travelling along with participants, and facilitating focus group sessions (further details discussed in sections 4.4.2 to 4.4.4). This approach allows for an in-depth exploration of this specific aspect of the passenger group's experiences of rail travel.

4.4 Data Collection – Qualitative methods

This thesis involves four distinct parts using several qualitative data collection methods. Together these data collection methods comprise the ethnographic research strategy. Figure 4.3 outlines how each part of the research design contributes to the research objective and answering the four research questions highlighted at the beginning of this chapter. In this section, details will be provided about the data collection methods used and the order they were deployed in the fieldwork. Before data collection began, the researcher obtained ethical approval from the University of Nottingham's Faculty of Engineering Ethics Committee. This rigorous process involved submitting detailed research plans, participant information sheets, consent forms and an ethics checklist for committee review (see Appendix 1 for examples of the participant information sheets and consent forms). The four studies detailed in this section received approval to proceed on the 23 July 2021, 21 September 2022, and 23 October 2023 respectively.



Figure 4.3 – Diagram Highlighting the Contribution of Each Study to the Research Objective and Questions

4.4.1 Focus Groups for an Industry Perspective

The British railway network involves a complex mix of organisations managing tracks, stations, trains and ticketing (ORR, 2023). Industry experts participated in focus groups to explain system operations, passenger support sources and their views on support for late adopters. Focus groups involve multiple participants discussing a specific topic in a safe environment (Hollander, 2004). Successful sessions encourage free expression, collaboration and idea evaluation (Saunders et al., 2015). Here, focus groups were used to rapidly gather data on rail system composition and observe how groups create shared understanding of late technology adopters as an overlooked passenger group.

Focus groups were conducted online via Microsoft Teams due to COVID-19 restrictions and participant time constraints (Halliday et al., 2021). The Rail Safety and Standards Board (RSSB) assisted with recruitment, advertising through industry working group meetings and email lists. Representatives from various rail organisations were recruited using snowball sampling (Adams, 2014), including customer assistants, accessibility mentors, and engineers (detailed in section 4.3 and Table 4.1). Due to last-minute cancellations from work pressures and emergencies, group sizes varied: two groups had three participants, one group had two attendees, and one session became two independent interviews when the second participant arrived significantly late.

Prior to attendance at the group sessions, participants were asked to complete a pre-session task involving listing as many support mechanisms that are currently available to help passengers at different stages of their journey. The task sheet divides the passenger journey into five phases: Information and planning, booking, pre-journey, in-journey, and post-journey. This is based on the decomposition of the passenger journey as developed by Zalar et al. (2018) for assessing the convenience of transport ticketing systems. The task also requires participants to consider whether the support mechanisms they identify are provided in an offline, online, or through industry-based infrastructure. For example, staff support at the station is considered offline support, websites or applications the passenger accesses through a computer or smartphone are online support mechanisms, and station ticketing machines are considered industry-based infrastructure. Some examples were provided on the task sheets prior to distribution to assist participants with completing them. An example of a completed pre-session task sheet can be found in Appendix 2. The task aimed to gather preliminary information

about passenger support services at each stage of their journey. This information is then compiled into one task sheet by the researcher ready to be shared and discussed by participants at the group sessions.

The focus groups were designed around a set of semi-structured questions which can be seen in Table 4.2 alongside the objective of the question. At the beginning of each group session an explanation was given to participants about the research topic and what type of passengers are being referred to when we talk about late adopters of technology. For ease of understanding, this explanation described late adopters of technology as people who are less able or willing to use digital technologies to support their rail journeys. The sessions were hosted in a semi-structured format to enable participants to explore ideas in more depth and with greater flexibility than a structured interview approach would allow (Horton et al., 2004). The researcher would intervene if the conversation was straying too far away from the research topic by introducing another idea or concept for discussion. For example, when there had been a lengthy discussion about the online support mechanisms available for passengers during the fourth focus group the researcher prompted participants to think about the other types of support available:

> "Apart from the online support mechanisms you've discussed and the ideas for new online support mechanisms you've proposed just now, do you think there's any way rail passenger support could be improved in terms of offline or industry-based infrastructure mechanisms?" - Researcher (Focus Group Four Transcript)

Each session lasted between 40 and 55 minutes with the exception of the group session which turned into two individual interview taking approximately 30 to 35 minutes per person. The researcher was also joined by two members of staff from the industry partner: Senior Grants and Partnerships Manager joined for the first five minutes of each session to introduce the project from the perspective of RSSB as well as to thank participants for their engagement. The second member of staff was a newly appointed research assistant in the Research and Development team at the company who took notes of the conversation, which were displayed on the screen live during the meeting. This allowed participants to observe the notetaking as well as to add or amend the notes to better reflect their discussion. Additionally, each session was recorded and transcribed with the permission of the participants. The recordings were automatically transcribed

using the University of Nottingham online transcription service with each document being checked and anonymised by the researcher prior to analysis.

Following completion of the focus group sessions, the researcher compiled a complete list of all the support mechanisms and services identified by participants in the pre-session task and during the discussions. A summary of the findings and list of support mechanisms was presented at a virtual industry working group meeting with over thirty representatives in attendance for further feedback, discussion, and additions. Whilst the presentation was well received by the group and some discussion ensued, there were no further additions to the data. It was at this stage that the researcher decided that the study had reached saturation point as no new information was collected from this large group of industry professionals (Saunders et al., 2015).

Table 4.2 – Focus Group Session Question List.

Focus Group Question	**Question Objective**
1. Having reviewed the support mechanisms list compiled before the session, are there any further mechanisms you can add?	Gathering general information and composing comprehensive list of support services
2. Which journey phase(s) do you think late adopters of technology would find most challenging given the support mechanisms identified?	Identification of constraints
3. How could this journey phase be improved or made easier for people who are late adopters?	Proposal of suggestions for improvements
4. How could the online support mechanisms be made more accessible for people who are late adopters?	Proposal of suggestions for improvements
5. How does or can the rail sector support late adopters to access services or information that had been digitised?	Gathering general information and composing comprehensive list of support services

6. Do you think the rail sector should continue to invest in increasing the digitisation of passenger-facing services? *If so, why?*	Industry perspective on digital futures
7. Do you think there will become a time in the not-so distant future that passengers will be required to use the internet or personal smart device (e.g. smartphone, tablet, laptop, etc) to access rail services in Great Britain? *If so, should this be prevented?* *If not, why?*	Industry perspective on digital futures

4.4.2 Passenger Perspective: Semi-Structured Interviews

The focus of this thesis is to understand the constraints of rail travel and the impact this has on rail travel experiences for passengers who are identified as late adopters of technology. Direct engagement with participants is an appropriate technique to use to build an understanding of the lived experience of a group of individuals and the impact of these constraints on their everyday experience of using trains as a mode of transport (Seidman, 2013). Following the focus groups with industry stakeholders, the data collection turns to identifying, approaching, and speaking with participants who fit the criteria of late adopter of technology and infrequent leisure passenger using the Great British rail network. The purpose of speaking directly with this passenger group is threefold: To obtain the passenger perspective of constraints of rail travel, to confirm, reject and expand upon the data collected and analysed from the industry perspective, and to begin thinking about how the negative consequences of certain constraints can be reduced to improve accessibility and the experience of late adopter passengers.

Recruitment advertisements were posted by the researcher on social media and direct contact was made with potential participants the researcher felt would be appropriate late adopters for the study. All potential participants who expressed an interest in taking part in this study were required to complete a pre-study screening questionnaire to verify their suitability for the study. The criteria used to identify participants that have late adopter tendencies is adapted from Kim et al. (2010) user classification model for mobile

payment usage. There are a total of five questions to determine whether a potential participant has late adopter tendencies and would therefore be a suitable candidate to participate in the study (see Table 4.3). Where candidates chose two or more answers relating to late adopter tendencies and confirmed they were infrequent rail users they were considered for participation in the study. A late adopter score of three or more was preferred as it demonstrates stronger late adopter tendencies, however two participants who selected just two late adopter answers were also accepted to participate (see further explanation in section 5.2).

Table 4.3 – Pre-Interview Screening Questionnaire: Answers Containing the 'X' Symbol Indicate Late Adopter Tendencies.

Please put an 'X' in one box per row next to the statement that best describes you or how you feel about technology:

I like to stick with what I know	**X**		I like to try new things
I am not generally interested in new technology	**X**		I am interested in new technology
I am usually first to buy new products		**X**	I wait until other people have bought and tried new products before buying them myself
My friends would describe me as innovative		**X**	My friends would describe me as traditional
I usually feel uncertain about using new technology	**X**		I usually feel confident when using new technology for the first time

Following the screening process, selected participants were invited to participate in the study and asked to complete consent forms. A semi-structured interview schedule was prepared by the researcher as, for the same reason as with the industry focus groups, the semi-structured format is more flexible allowing the participant to cover issues and related topics that may be important to them but not yet considered by the researcher (Wilson, 2014). The interview plan was divided into two sections. The first half of the interview was focused around understanding the everyday life of the participant in terms of how they (dis)engage with technology, their technology usage, and their preferences

when thinking about what they like or dislike about new technologies. The second part of the interview turned attention directly to thinking about a recent train journey or a hypothetical train journey if the participant could not specifically remember the details of a recent trip. During this section the researcher guides the participant through the five journey phases as detailed in section 4.4.1. The participant is asked to consider how they would complete tasks associated with the journey, what sorts of things they would do on the day to prepare, and how they would find information. Whilst the specific order in which the journey was discussed remained flexible, the researcher ensured that all journey phases were covered during the interview (see Appendix 3). Additionally, a set of prompting questions were used to encourage the participant to think more deeply about the scenario or approach it from an alternative angle. For example, if a participant is struggling to think about exactly what they might do when they first arrive at the train station the researcher might ask *if you're collecting tickets at the station, how might you do this*? Or, *if you need help whilst you're at the station what would you do*?

A total of 22 semi-structured interviews were conducted between October 2022 and January 2023. The majority of these took place in-person however, due to logistical issues 5 interviews were completed online using Microsoft Teams to connect with each participant. The shortest interview was 25 minutes in length and the longest interview was over 1 hour in total. All interviews were audio recorded using either a digital recording device or using the recording feature of the Microsoft Teams programme. The audio recordings captured using the digital recording device were uploaded to the university system and automatically transcribed. Recordings captured by Microsoft Teams were automatically transcribed at the point of recording. All transcripts were anonymised, checked, amended, and verified by the researcher for accuracy. Where participants mention themselves or others by name these names were redacted or changed in the transcript. For example, where a participant named their son or daughter, the researcher redacted the name from the transcript and inserted *[my son/daughter]* in square brackets to ensure anonymity of the participant. Details of the interviews including participant number, interview location, date, and length can be seen in Table 4.4.

Table 4.4 – Interview Details Per Participant.

Participant ID Number	Interview Location	Interview Date	Interview Duration (Minutes)
1	In-person	October 2022	25
2	In-person	October 2022	25
3	In-person	November 2022	28
4	In-person	November 2022	25
5	In-person	November 2022	34
6	In-person	November 2022	35
7	In-person	November 2022	30
8	Virtual	November 2022	49
9	Virtual	November 2022	45
10	In-person	November 2022	39
11	In-person	November 2022	57
12	In-person	November 2022	36
13	Virtual	November 2022	39
14	Virtual	November 2022	42
15	In-person	November 2022	31
16	In-person	December 2022	33
17	In-person	December 2022	36
18	Virtual	January 2023	66
19	In-person	January 2023	36
20	In-person	February 2023	34
21	In-person	February 2023	37
22	In-person	February 2023	36

In addition to taking part in the semi-structured interview, several participants accepted invitations to take part in an accompanied train journey. Further details on the ethnographic methods used during the accompanied journeys are explained next.

4.4.3 Travel Along Accompanied Journeys

To gather first-hand experience and an in-depth understanding of the constraints of rail travel as experienced by late adopter passengers, this research has been designed to go beyond interviews and focus groups to spend time with passengers using rail services in Great Britain. Travel along accompanied journeys are necessary to observe in real-time the experiences of the participants as well as being able to ask questions in the moment. There are several recent studies in the areas of human factors, transportation, and tourism studies which adopt ethnographic techniques to closely observe and document social phenomena. For example, Chiscano and Darcy (2022) conducted in-depth interviews with participants in the environment of the Barcelona Metro to explore the experiences

of people with disabilities using public transport during the COVID-19 pandemic. Similarly, Kurup et al. (2017) use ethnographic interviews taking place within the travel environment to explore rail passenger experiences and identify informational priorities for different passenger groups. Other approaches to conducting ethnographic research in a travel context include travelling along with participants whilst observing and documenting the experience (see Lofgren, 2008; Torres, 2016; Jiron et al., 2020). The travel along observational approach is more flexible and less formal than conducting interviews within the setting of the research as participants are free to perform their usual activities whilst being accompanied by the researcher.

Several participants from the previous interview study accepted invitations to take part in a travel along journey accompanied by the researcher. The destination and route were not dictated by the researcher; however, suggestions were made of routes that the researcher would find interesting to observe. For example, longer journeys involving at least one change of train were recommended to provide a level of complexity. To simulate a more natural experience for the participant, if they would usually travel with a companion, attempts were made to recruit a companion of their choice to travel with them. Kusenbach (2003) also found that having a travel companion present made key informants more comfortable. It is important to note, however, that whilst any travel companions and their interactions with the key informant were observed they remained a secondary participant and were not the main focus of the researcher during the fieldwork. Travel companions were also required to read the study information sheet and sign a consent form allowing the researcher to make notes about their interactions with the primary participant. In total seven travel along journeys were made by the researcher. Details of these journeys along with the participant number, booking method, and journey length can be seen in Table 4.5. Participants retained their unique ID number from the interview study which were allocated in the chronological order of their participation at that time. Seven participants from this sample were accompanied on rail journeys.

Table 4.5 - Travel Along Journey Details

ID	Travel Date	Booking Method	Start Station	End Destination	Travel Companion (Yes/No)	Journey Duration (Minutes)
1	November 2022	Online	Boston	York	No	315
2	January 2023	Train Guard	Boston	Skegness	No	70
3	November 2022	Ticket Machine	Lincoln	Newark	Yes	60
5	January 2023	Online	Boston	York	No	320
6	February 2023	Online	Peterborough	London	Yes	165
10	January 2023	Ticket Office	Sleaford	Nottingham	No	65
12	February 2023	Train Guard	Boston	Nottingham	Yes	190

With the exception of one journey, the researcher was present with the participant during all five phases of the journey based on the adaptation of passenger journey phases by Zalar et al. (2018). The exception to this was the booking phase with participant 5 as it was not possible for the researcher to be with the participant at the time of booking the tickets online. However, messages exchanged between the researcher and the participant during the booking phase were saved for analysis. Throughout the fieldwork the researcher observed and actively engaged (without helping or assisting) with the participants. The researcher was also present during the return journey back to the start station for each travel along journey. In between the outbound and inbound journeys, the researcher remained with the participants whilst at the destination. This also allowed the researcher to capture information about how the impending return journey influenced their behaviours whilst at the destination. For example, whilst visiting a Pizza Express for lunch in Newark with participant 3 and their travel companion, the researcher observed the companion searching for the return train journey information on their smartphone after eating.

A combination of fieldnotes written on OneNote on the researchers iPhone, in-journey photos, and post-journey reflections were collected as the primary data. The decision to take notes using the smartphone was made for two reasons. Firstly, notes typed into the

phone by the researcher would be much more legible than handwritten ones taken in a physical notepad. Secondly, and more importantly, it was felt that taken notes using the smartphone would be less obvious to participants that their actions were being recorded. Gorman (2017) comments that the notepad and pen are an overt visual reminder to the participants that they are being observed and recorded whereas the smartphone sometimes signified to the participant that the researcher was preoccupied. In this regard, the researcher underestimated the participants as comments were made by participants on several occasions that they could tell the researcher was taking notes about certain events.

In addition to notetaking, with consent of the participants, the researcher also took in-the-moment photographs of the journey as it unfolded. All photos were shared with participants at the end of the journey. Any photos that the participants were unhappy with were immediately deleted. All remaining photos including identifiable features such as the participant's face, were edited and blurred to ensure anonymity. See Figure 4.4 for example post-edit in-action photos taken during the fieldwork.

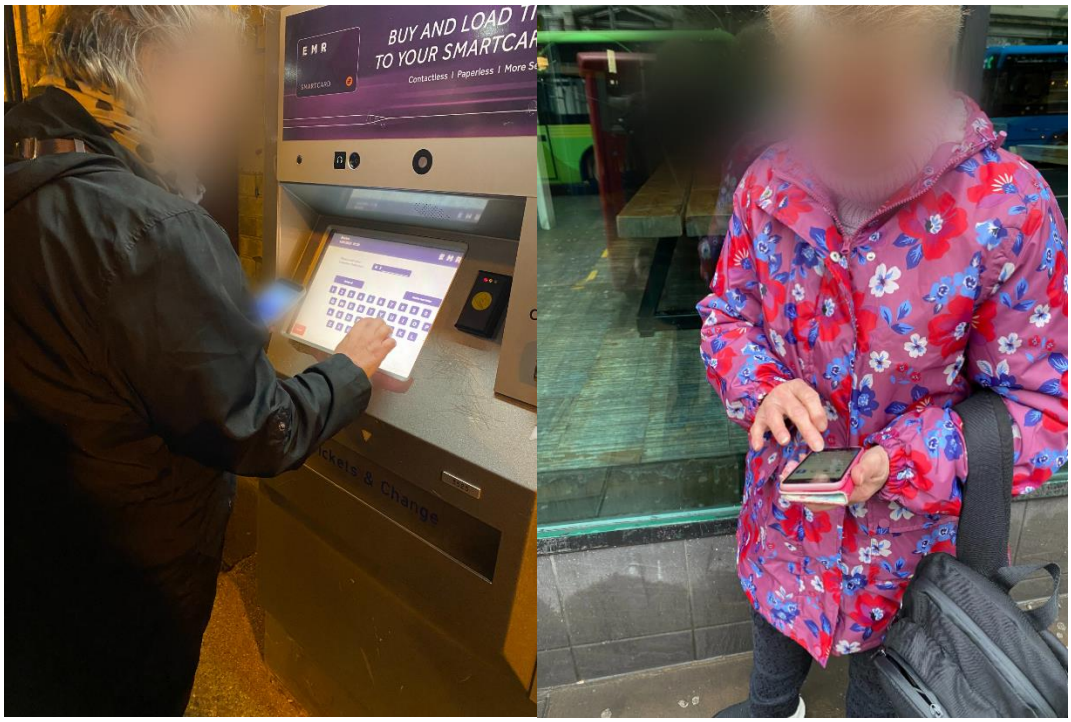


Figure 4.4 – Example of Edited Photos Taken During Travel Along Fieldwork

Other digital tools such as EthnoAlly were also considered by the researcher for use during the travel along fieldwork. EthnoAlly has been successfully used to record geographical location data and as a deposit storage facility for photographs taken during

ethnographic fieldwork by Rebernik et al. (2020). It was decided that location tracking was not necessary for this study as the relevant data could be captured by the researcher taking notes and photos. Additional software was also not needed for photo storage as these were uploaded directly to the researcher's secure OneDrive account in a password protected folder. Following the completion of each travel along accompanied journey, the researcher took time to review the fieldnotes collected on the day and also wrote post-journey reflections. The shorthand notes taken during the fieldwork were edited into longhand ordinary sentences so that each journey log could be read as one long narrative. The final field notes and post-journey reflections were copied from OneNote and added to a Word document which was stored alongside the photos from each journey in the researcher's secure OneDrive folder.

4.4.4 Passenger Participant Focus Groups

The previous two studies involved late adopter passenger participants on an individual basis through semi-structured interviews and travel along journeys. It was decided that a creative group activity with a number of late adopter participants discussing their preferences, needs, and ideas for improving rail services in Great Britain was necessary to conclude the data collection for this research. It was anticipated that collaboration between late adopter participants during this final study would develop co-created ideas and solutions for improving rail services and the accessibility of rail travel environments for this user group (McIntosh and Cockburn-Wootten, 2016). This would be achieved through idea generation in the focus group sessions as well as discussion by the participants about solutions and improvement ideas previously suggested by late adopter participants during other phases of this research. In this sense, the research turns towards an approach of co-creation with participants contributing directly to devising, developing, and appraising improvements and solutions. Academics in the field of tourism have been calling for more inclusive, transformational, and disruptive approaches to be used in the field for many years (Wengel et al., 2019). For example, Rydzik et al. (2013) explain how participants benefited from being more engaged, empowered and transformed by their approach to participatory co-productive research.

While still a relatively unknown approach, the Ketso method was developed by Dr Joanne Tippett to tackle social challenges in small villages in the southern African country of Lesotho in 1995. The Ketso toolkit provides researchers with a creative blank

canvas to use with their research participants to work together to address issues in a collaborative and equitable way (McIntosh and Cockburn-Wootten, 2016). Since the kit became available to purchase following the launch of Ketso as a social enterprise it has been successfully used as in qualitative social research across several academic fields including education research, tourism, and healthcare (AlAbbasi and Stelma, 2018; McMillan et al., 2018; McIntosh and Cockburn-Wootten, 2021). The design of the toolkit is based on a tree to grow and nurture the ideas of participants during the session. There is a central idea or topic for the session in the centre of the workspace which is symbolised as the trunk of the tree with a sub-set of ideas or themes branching off from this central point. Participants use coloured leaves as directed by the focus group facilitator to add ideas in written or drawn format to the workspace. There are several pre-defined strategies for facilitating a Ketso focus group which are also known as seeds. The seed used in this study is the feedback and discuss question strategy (see Figure 4.5).

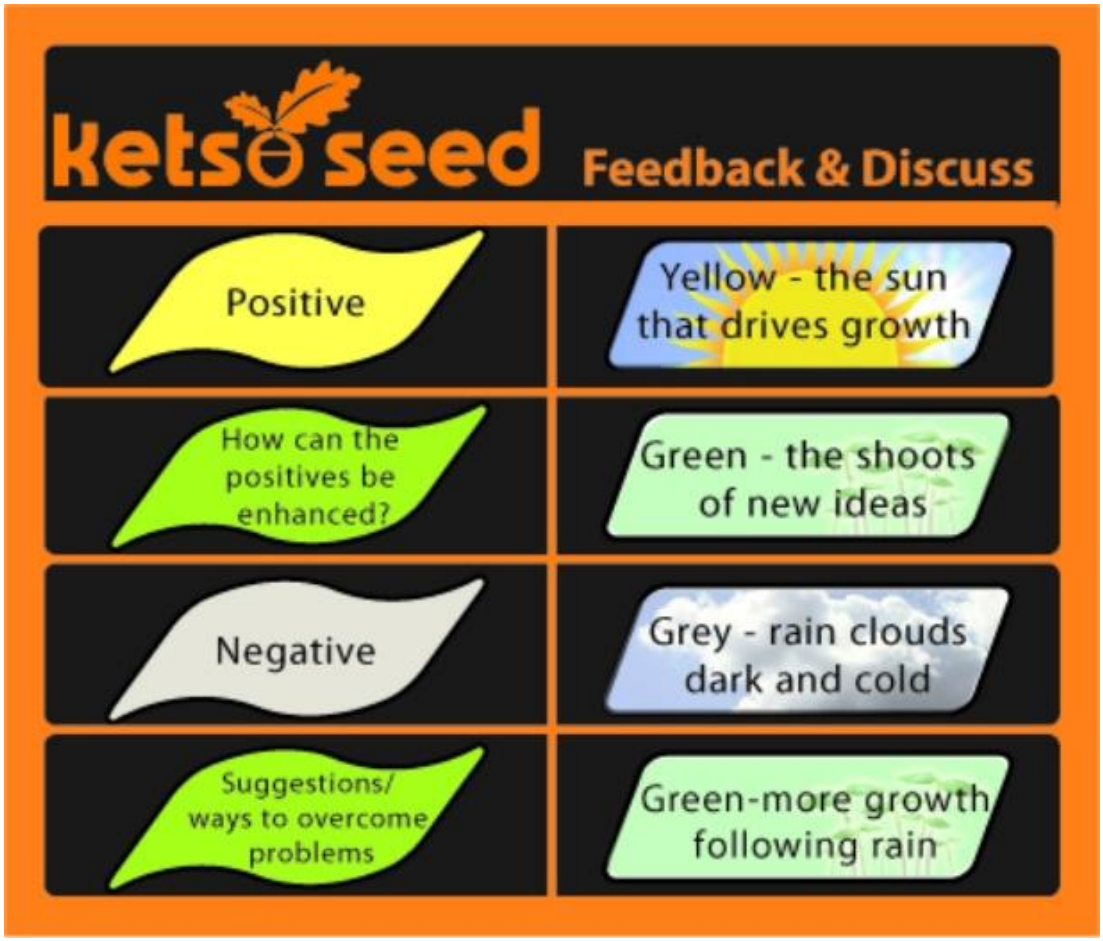
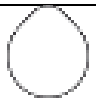


Figure 4.5 – Feedback and Discuss: Ketso Seed Question Strategy.

Whilst the Ketso focus group allows participants a degree of freedom to add ideas and discuss issues that are important to them, the session follows a structured approach and requires a detailed plan to be prepared prior to the sessions. The researcher decided to include a warm-up question to show participants how the toolkit works, make them feel more comfortable with each other prior to the main part of the session, and encourage them to be thinking about technology from the beginning. This line of questioning for the warm-up activity was chosen as the ideas generated could also potentially be used at a later stage in the main focus group session if participants are struggling to think of ideas. Following the warm-up mini exercise, the participants were asked to think about what makes a rail journey a good experience for them and to write their ideas on yellow leaves. In turns, the participants then add their leaves to the workspace explaining their point as they do this. As more ideas are added to the workspace, participants are encouraged to arrange the ideas into themes by placing common ideas near to one another (McIntosh and Cockburn-Wootten, 2021). Regardless of the chosen Ketso seed question strategy, it is important to start with a question that encourages participants to think in a positive way to avoid becoming stuck in a negative mindset (Ketso, 2023).

In addition to the main line of questioning where the participants write their ideas on different coloured leaves, the toolkit also contains icons and circular cards which can help with identifying important points or ideas. For example, participants were given up to six exclamation mark icon cards and asked to use them to indicate the aspects of the journey that are most important for making the journey enjoyable. Additionally, participants were also given a circular white blank card with their participant number on. These were used to identify which of the potential proposed solutions to reduce the negative consequences of certain constraints would be most attractive and which one they would most like to see implemented. An outline version of the focus group plan using the feedback and discuss Ketso seed strategy is detailed in Table 4.6.

Table 4.6 – Outline Ketso plan.

Outline Focus Group Plan – Exploring a Typical Railway Journey (1hr 15mins)		
Session stage	**Duration**	**Toolkit Card**
1 - Warm up exercise: What do you think is good about modern digital technology?	**5-10mins**	
2 - Introduction	**5mins**	**N/A**
3 – What makes a rail journey a good experience for you?	**15mins**	
4 – What is needed to make these things happen?	**10mins**	
5 – Identifying important aspects of the journey	**10mins**	
6 – What might prevent these things from happening?	**10mins**	
7 – Solutions to problems	**10mins**	
8 – Which solutions are most attractive to you?	**5mins**	
9 – Closure of the session	**5mins**	**N/A**

There are a number of benefits, both practically and epistemological, for using the Ketso method for facilitating focus group sessions. For example, the toolkit is designed to allow participants equal opportunity to contribute their ideas to the session through the use of the toolkit cards. This means that no individual voice is able to dominate the session (Dashper et al., 2022). Additionally, participants capture the main discussion points and organise these into themes on the workspace themselves. This means the researcher does not need to take as many notes during the session to keep a record of the discussion. When facilitating a focus group alone, this is particularly useful as it allows the researcher to give more attention to the activity and is less distracting for participants

(McIntosh and Cockburn-Wootten, 2021). From an epistemological perspective the Ketso method is beneficial for interpretivist research as the researcher is able to observe how the participants make sense of each other's ideas and contributions such as the organisation of the Ketso leaves into clusters and themes (AlAbbasi and Stelma, 2018). There are several occasions during the session where participants must work together and discuss ideas. For example, during the fifth stage of the session (see Table 4.6) participants discuss and decide which aspects of the journey they feel are the most important for an enjoyable train journey experience. The researcher is able to observe the social interactions that take place during this process and see how the group comes to a collective decision, or not as the case may be if there are disagreements and compromises made within the group.

A total of three focus groups were conducted using the Ketso toolkit involving 16 participants. With the exception of two new participants, all participants had taken part in at least one of the two previous passenger participant studies. All sessions took place in-person in November 2023 and ranged between 120 minutes and 210 minutes in duration. Participants were rewarded with a £15 shopping voucher and pizza in exchange for their time and effort.

4.5 Data Analysis

The research in this thesis uses four distinct approaches to analysing the data collected: Thematic analysis, cognitive work analysis, constraints negotiation theory, and discourse analysis. Thematic analysis is the primary approach taken. However, to explore the data in more depth this is paired with cognitive work analysis and constraints negotiation theory when analysing the industry focus group data, and discourse analysis is employed for analysing the passenger participant interview and travel along journey data. This section of the chapter will detail the processes undertaken during data analysis in this thesis including the development of a novel interdisciplinary conceptual framework.

4.5.1 Thematic Analysis

Thematic analysis is one of many qualitative techniques to analysing research data. It is suggested by Fugard and Potts (2019) that thematic analysis is part of our everyday lives as we organise things by type or category. In academic research this type of analysis is most commonly conducted on qualitative data such as interview or focus group

transcripts with the purpose of looking for patterns within the dataset (Braun and Clarke, 2006). This type of analysis also goes beyond quantitative and positivist approaches of merely counting the frequency of particular words or phrases. The researcher can find themes through a deeper exploration of a text to identify more complex connections between the things people say or do without necessarily using specific words to generate meaning (Fugard and Potts, 2019). This approach is the primary type of analysis used throughout this thesis as it is used to analyse all of the data collected in all four parts of the research design.

4.5.2 Industry Focus Group Thematic Data Analysis

According to Braun and Clarke (2006) there are six steps to completing a thematic analysis: becoming familiar with the data, coding of the data, identifying themes, review of the themes, theme definition, and report production. The researcher was present at all sessions conducted and also read through the transcripts alongside the recording to correct, amend, and verify the records. This meant they were already familiar with the data prior to the first analytical reading of the transcripts (Fugard and Potts, 2019). The steps involving coding data and identifying themes happened concurrently as the researcher worked through the data. For example, codes relating to technology complexity were identified during analysis of the fourth transcript which led the researcher to re-examine the previously analysed data to look for these codes which were not initially identified. Throughout the analysis, the codes, themes, and sub-themes were subject to changes as the researcher worked through and reflected upon the data. This is an important part of the process of conducting a thematic analysis which enables a deeper exploration of the data and uncovering hidden meanings in the texts being examined (Braun and Clarke, 2019).

The thematic analysis was largely guided by the constraints negotiation theory framework however, the researcher remained open to other interpretations beyond this model when examining the data (Braun and Clarke, 2006). The constraints negotiation theory categorises constraints into three groups—intrapersonal, interpersonal and structural—and classifies negotiation strategies as either cognitive or behavioural (Jackson et al., 1993) (see Chapter 3 for a more detailed discussion of this approach). This framework proves valuable for identifying themes and potential constraints during thematic analysis. However, maintaining flexibility is crucial, allowing for the

exploration of additional topics that may not neatly align with these predefined categories.

4.5.3 Cognitive Work Analysis

Cognitive work analysis is a well-developed approach to identifying and analysing constraints. The approach has primarily been used in safety critical domains, such as the military, nuclear power, and healthcare, to analyse factors influencing behaviour in the context of efficiency and safety (Braaten, 2015). Cognitive work analysis has also been used in the rail domain to explore modal shift to rail (Stanton et al., 2013) and pedestrian behaviour at level crossings (Read et al., 2016). This approach was adopted in this research to support the development of a thorough understanding of the passenger support mechanisms and potential constraints of travel for late adopter passengers in the Great British rail network.

The themes and sub-themes developed through a thematic analysis of the focus group data were used to undertake selected phases from the cognitive work analysis framework. As a formative framework, researcher discretion can be used to identify which of the five analytical phases are suitable for the research (Stanton et al., 2013). For this study, phases one (work domain analysis), two (control task analysis), and four (social, organisation, and cooperation analysis) were used to analyse the focus group data. As the focus of the thesis is to identify and deepen understanding of the constraints of travel for late adopters of technology it was decided that it would not be appropriate to conduct phases three or five as these explore the different ways things can be done within a certain context and the competencies required to do this, respectively (Vicente, 1999). Further details about all five phases of cognitive work analysis are given in Chapter 3 of this thesis.

The first stage of the analysis involves the development of an abstraction hierarchy to segment the sociotechnical system, in this case the passenger-facing elements of the railway network, into different levels of abstraction. This can be documented and represented on a single page where the researcher can examine the purpose of the system, the functions, and the means-ends relationships that form connections between the different levels of the hierarchy (Jenkins et al., 2008). A review of the Easy-to-Use priority documentation from the Rail Technical Strategy (2021), the pre-session task, and thematic analysis of the focus group data were used to develop an abstraction

hierarchy to represent the passenger rail network. As a visual and interactive depiction of the passenger-facing rail system the hierarchy can be filtered by matters of interest relating to the specific research questions. For example, gaining authorisation to travel – buying and collecting tickets - is an area of concern raised during the focus group sessions. The abstraction hierarchy can be segmented to explore only the means-ends relationship between this function with other elements of the rail network, such as the process of journey planning and the delivery of information (see section 3.3.1 for detailed explanation and diagram of this analytical phase). This could highlight any potential constraints of travel associated with the function of gaining authorisation to travel for the user group. While the abstraction hierarchy provides a comprehensive overview of the system's structure, the next stage of analysis delves deeper into specific passenger activities and their spatial contexts.

Building on the understanding of the relationships between different elements of the rail network in the support of passenger journeys, the second phase comprises a control task analysis. The abstraction hierarchy and thematically analysed focus group data are used to create a contextual activity template that identifies and maps available activities to their locations (Naikar et al., 2006). This approach suits the research by illustrating passengers' potential activities at various journey stages and their corresponding physical settings. For instance, the analysis visually demonstrates whether journey planning can occur at home, en-route to the station, at the station itself, aboard the train, or post-journey. Moreover, it highlights the distinction between where activities are possible and commonly undertaken, versus where they are feasible but typically neglected by passengers.

The abstraction hierarchy and control task analysis provide a solid foundation for understanding the structure of the rail network and the activities passengers can undertake at various locations. However, to gain a more comprehensive view of the activity within the sociotechnical system, it's crucial to examine how different actors interact and collaborate. This leads us to the final phase of the cognitive work analysis employed in this research: social, organisation, and cooperation analysis. This phase expands upon the contextual activity template developed in the second phase by including additional details about which actors within the sociotechnical system can undertake various activities (Rasmussen et al., 1994). To complete this phase, the physical objects identified through the abstraction hierarchy are colour-coded and

applied to the contextual activity template. This process helps identify the availability of support mechanisms for activities throughout the passenger journey, as well as the locations where these are accessed. For instance, the analysis might reveal that ticket purchasing is supported in the home environment through multiple means: telephone access to staff, assistance from friends or family, and self-service mechanisms such as online ticketing via websites and smartphone applications.

4.5.4 Passenger Interviews and Travel Along Thematic Analysis

The data collected during the passenger interviews (transcripts) and travel along journeys (fieldnotes) were both coded and analysed using thematic analysis. As with the industry focus group data, the researcher was guided by existing literature and the constraints negotiation theory approach, but the analysis was not limited to searching for constraints as per the framework. Rather, the approach to thematic analysis taken here was inductive. The researcher did not have a predetermined set of codes to work with to analyse the data. Instead, the codes used in the analysis were generated, developed, and reworked during the analysis of the data (Fereday and Muir-Cochrane, 2006). The researcher also conducted some of the thematic analysis of the interview data in conjunction with continuing to conduct further interviews. This approach is useful for identifying when the study is likely to reach saturation with further interviews being unnecessary as the generation of new codes and themes is unlikely to occur (Saunders et al, 2015).

Analysis of the passenger interviews is divided into two distinct sections. The researcher first analysed the part of the data which was relevant to exploring participants' experiences and perceptions of using the railway. As there were no predefined codes, the researcher explored the transcripts initially looking for explicit mentions of constraints or challenges related to rail travel, albeit actual or perceived. As codes were identified and the researcher re-read the transcripts, further codes relating to technology (non)use, support, and passenger behaviours were found. This process was repeated until no further codes were identified, and no additional data could be added to the identified codes (Fereday and Muir-Cochrane, 2006). At completion of the coding process 24 codes were identified which were divided into four main themes.

The same process of coding and analysis was undertaken for the first section of the interview transcripts. The focus of this part of the interview was the (non)use,

engagement, and adoption of technology in the everyday lives of late adopters. A thematic analysis identified seven overarching themes and a further 36 sub-themes. To explore the themes in greater depth the constraints negotiation theory approach was then applied. Each of the sub-themes were allocated into one of the three categories of constraint: intrapersonal, interpersonal, and structural (Crawford et al., 1991).

A similar approach involving reading, coding, re-reading, and further coding was taken in the analysis of the fieldnotes from the seven travel along journeys. Short-hand fieldnotes were converted into narrative-style fieldnotes telling the story of the journey as it unfolded (Lederman, 1990). A total of 13 themes and 12 sub-themes were identified on completion of the thematic analysis. An extract of the coding applied to the fieldnotes of the fourth travel along journey are demonstrated in Figure 4.6.

Journey 4 – Fieldnotes

Theme	Sub-Theme
Preparation	Technology for preparation (1) Negative anticipation (2) Time factors (3) Research for cost saving (4)
Insider information	Understandable if you know (1) Uncertainty of not knowing (2)
Avoidance of staff support	N/A
Searching for information	Visual cues (1) Audio cues (2) Something looking or feeling 'right' (3) Observing and copying others (4)
Permission to do or use something	N/A
Sense of un-entitlement to do or use something	
Factors influencing enjoyment	
Device type matters	
Being patient	
Making mistakes	
Staff support	
Help from other people	
Familiarity	Systems (1) Places (2)

Booking Tickets

The participant researched the train times and prices on her phone (1) whilst messaging me and sending me screenshots of potential trains and prices.

She seemed a bit confused about what SplitSave meant (1) so I questioned if she knew what it meant and she sent screenshots of the terms and conditions for the tickets. This still didn't seem to answer the question about what SplitSave (1) meant though so she was still confused by this.

For ease, as we were unable to meet up to do the booking process, I then when on the Trainline to book the tickets on the laptop. This message popped up explaining what SplitSave is. I asked the participant if this information had been displayed to her at any point when she was looking at the times and prices on the Trainline app but she said it didn't.

I then booked the tickets directly via the LNER website as it came up cheaper. The participant informed me that they wouldn't have thought to look directly on the train operator website as they thought tickets could only be bought through the Trainline or at the station desk (1).

I selected to collect the tickets at the train station so that the participant would need to use the machine to collect the tickets. When I informed her of this via Facebook Messenger she reacted to the message with a sad face and then replied "ok mate, that could be fun lol [laughing face]" (2).

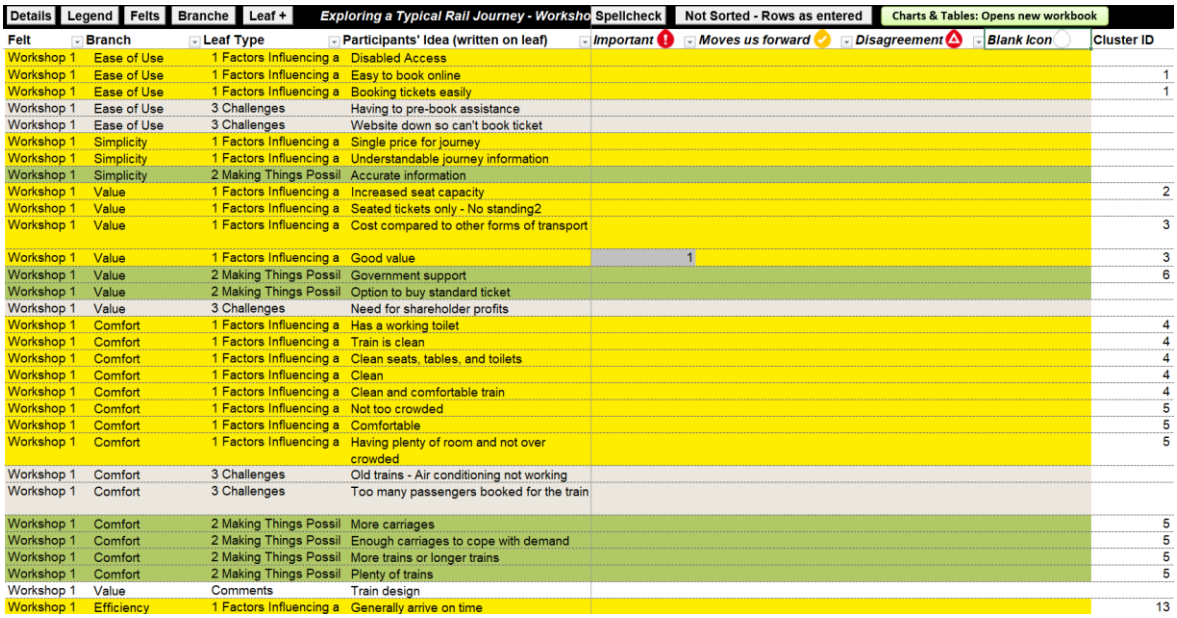
Figure 4.6 – Extract of Fieldnotes from Journey Four with Themes Highlighted

4.5.5 Passenger Participant Focus Group Analysis

The Ketso toolkit lends itself to being analysed thematically. Participants enter contributions onto coloured leaves placing them on the workspace nearby to similar or connected topics (McIntosh and Cockburn-Wootten, 2021). There are some pre-determined themes labelled on the branches leading from the main session topic, but participants are also encouraged to add new themes to the workspace. In this sense, the participants are contributing to the analysis of the focus group data as they are self-organising the data into themes and categories. Participants were also asked to indicate which themes and/or ideas were most important and which potential solutions were most attractive to them. An example of the completed workspace at the end of focus group session two is shown in Figure 4.7. Ketso (2023) provide a pre-configured downloadable spreadsheet on its website for adding the information from the completed workspaces which were photographed at the end of each session. The data is separated by branch (theme), leaf type (discussion points), individual participant ideas (the content of each leaf), and indication of important points (see Figure 4.8).



Figure 4.7 – Complete Ketso Workspace at the Conclusion of Focus Group Two



Details	Legend	Felts	Branche	Leaf +	Exploring a Typical Rail Journey - Worksho	Spellcheck	Not Sorted - Rows as entered	Charts & Tables: Opens new workbook		
Felt	Branch	Leaf Type	Participants' Idea (written on leaf)	Important	Moves us forward	Disagreement	Blank Icon	Cluster ID		
Workshop 1	Ease of Use	1 Factors Influencing a	Disabled Access							
Workshop 1	Ease of Use	1 Factors Influencing a	Easy to book online					1		
Workshop 1	Ease of Use	1 Factors Influencing a	Booking tickets easily					1		
Workshop 1	Ease of Use	3 Challenges	Having to pre-book assistance							
Workshop 1	Ease of Use	3 Challenges	Website down so can't book ticket							
Workshop 1	Simplicity	1 Factors Influencing a	Single price for journey							
Workshop 1	Simplicity	1 Factors Influencing a	Understandable journey information							
Workshop 1	Simplicity	2 Making Things Possil	Accurate information							
Workshop 1	Value	1 Factors Influencing a	Increased seat capacity					2		
Workshop 1	Value	1 Factors Influencing a	Seated tickets only - No standing2							
Workshop 1	Value	1 Factors Influencing a	Cost compared to other forms of transport					3		
Workshop 1	Value	1 Factors Influencing a	Good value	1				3		
Workshop 1	Value	2 Making Things Possil	Government support					6		
Workshop 1	Value	2 Making Things Possil	Option to buy standard ticket							
Workshop 1	Value	3 Challenges	Need for shareholder profits							
Workshop 1	Comfort	1 Factors Influencing a	Has a working toilet					4		
Workshop 1	Comfort	1 Factors Influencing a	Train is clean					4		
Workshop 1	Comfort	1 Factors Influencing a	Clean seats, tables, and toilets					4		
Workshop 1	Comfort	1 Factors Influencing a	Clean					4		
Workshop 1	Comfort	1 Factors Influencing a	Clean and comfortable train					4		
Workshop 1	Comfort	1 Factors Influencing a	Not too crowded					5		
Workshop 1	Comfort	1 Factors Influencing a	Comfortable					5		
Workshop 1	Comfort	1 Factors Influencing a	Having plenty of room and not over crowded					5		
Workshop 1	Comfort	3 Challenges	Old trains - Air conditioning not working							
Workshop 1	Comfort	3 Challenges	Too many passengers booked for the train							
Workshop 1	Comfort	2 Making Things Possil	More carriages					5		
Workshop 1	Comfort	2 Making Things Possil	Enough carriages to cope with demand					5		
Workshop 1	Comfort	2 Making Things Possil	More trains or longer trains					5		
Workshop 1	Comfort	2 Making Things Possil	Plenty of trains					5		
Workshop 1	Value	Comments	Train design							
Workshop 1	Efficiency	1 Factors Influencing a	Generally arrive on time					13		

Figure 4.8 – Example of Ketso Spreadsheet Containing Data from all Three Focus Group Sessions Sorted by Felt (Group Number)

There was a total of 286 entries to the spreadsheet taken from the data collected at the three focus group sessions. This includes 194 unique entries taken from the leaves applied to the Ketso workspaces relating to three discussion points: factors influencing a positive journey, things that make this possible, and challenges. The other 92 spreadsheet entries were relating to the 'solutions' discussion point. These were predominately pre-determined proposals identified during analysis of the individual passenger interviews and industry focus group sessions. As shown in Figure 4.7 all leaves and comment cards are connected to a branch (also known as themes). Therefore, all entries to the spreadsheet were also connected to branches/themes.

4.6 Discourse Analysis

One of the key questions this thesis addresses is exploring the constraints and their implications for the late adopter passenger group in their travel experiences. Whilst thematic analysis, the constraints negotiation theory, and cognitive work analysis provide valuable insights, it is appropriate to apply discourse analysis to provide a deeper and more critical perspective to these challenges. As a multidisciplinary technique, discourse analysis goes beyond examining the language and words used in communications. It also considers the context within which the language is used, how it is communicated, and the broader social and cultural aspects of the communication (Juez, 2009). In this respect, discourse is not neutral (Bryman, 2016). Action is also

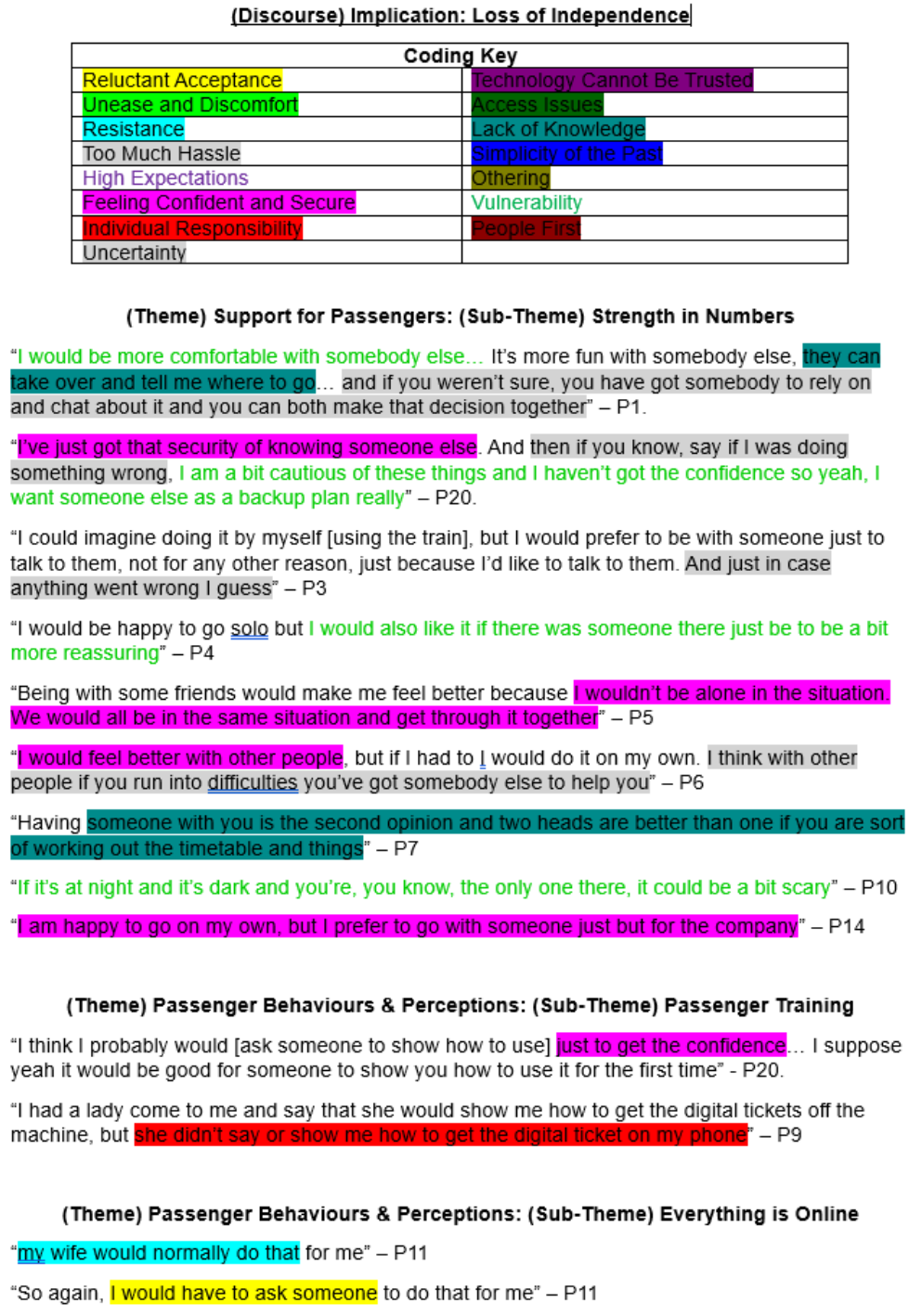
connected to discourse as the language used is constructed in a certain way to achieve something (Gill, 2000). For example, passengers wishing to apportion blame onto the complexity of technology for a bad rail travel experience may construct their argument with reference to how simple things were before using technology for travel.

Whilst less common in the field of human factors, this analysis technique has been used in the fields of tourism and leisure studies, particularly in studies analysing written documents and data such as newspapers, brochures, and websites (see Stamou and Paraskevopoulos, 2006; Hallet and Kaplan-Weinger, 2010; Estol et al., 2018; De Bernadi, 2021). Similar to the data analysed in this research, Dickinson et al. (2010) analyse in-depth interviews with discourse analysis to explore the justification to use different transport modes by travellers in the context of climate change.

Following the thematic analysis of the passenger participant interview data, discourse analysis was applied to further explore the constraints identified, their implications for late adopter travel experiences, and constraint negotiation strategies. Fifteen codes were identified in this analysis, described as 'insights' because they reveal further detail about the themes and sub-themes identified in the thematic analysis of the same data. These insights range from ‘reluctant acceptance’ to ‘vulnerability’ and ‘othering’. The ‘insights’ are connected to nine categories of discourse, known as ‘implications’ (see Figure 4.9 for example discourse analysis coding categorised by discourse/implication). These implications represent broader patterns or consequences that emerge from the way late adopters construct narratives about travel experiences. For example, an insight such as ‘reluctant acceptance’ might be connected to an implication of ‘dependence’ on others in travel decisions. Similarly, the insight of ‘vulnerability’ could be linked to an implication of ‘passengers unsupported’ in navigating rail travel environments.

Applying discourse analysis to this research allows for a more comprehensive understanding of constraints and their implications for late adopter passengers, going beyond surface-level observations to explore the underlying discourses that shape travel experience. The analysis reveals intricate details of late adopters’ experiences, such as feelings of vulnerability when navigating new travel environments, or a reluctant acceptance of technological changes despite personal reservations. These insights provide a deeper understanding of the constraints of travel for late adopters in modern travel environments, potentially informing more tailored solutions to enhance travel

experiences. Moreover, the findings from this discourse analysis complement and enrich the results from the thematic analysis, providing a deeper assessment of late adopters' constraints in the context of evolving travel technologies and systems.



(Discourse) Implication: Loss of Independence

Coding Key	
Reluctant Acceptance	Technology Cannot Be Trusted
Unease and Discomfort	Access Issues
Resistance	Lack of Knowledge
Too Much Hassle	Simplicity of the Past
High Expectations	Othering
Feeling Confident and Secure	Vulnerability
Individual Responsibility	People First
Uncertainty	

(Theme) Support for Passengers: (Sub-Theme) Strength in Numbers

"I would be more comfortable with somebody else… It's more fun with somebody else, they can take over and tell me where to go… and if you weren't sure, you have got somebody to rely on and chat about it and you can both make that decision together" – P1.

"I've just got that security of knowing someone else. And then if you know, say if I was doing something wrong, I am a bit cautious of these things and I haven't got the confidence so yeah, I want someone else as a backup plan really" – P20.

"I could imagine doing it by myself [using the train], but I would prefer to be with someone just to talk to them, not for any other reason, just because I'd like to talk to them. And just in case anything went wrong I guess" – P3

"I would be happy to go solo but I would also like it if there was someone there just be to be a bit more reassuring" – P4

"Being with some friends would make me feel better because I wouldn't be alone in the situation. We would all be in the same situation and get through it together" – P5

"I would feel better with other people, but if I had to I would do it on my own. I think with other people if you run into difficulties you've got somebody else to help you" – P6

"Having someone with you is the second opinion and two heads are better than one if you are sort of working out the timetable and things" – P7

"If it's at night and it's dark and you're, you know, the only one there, it could be a bit scary" – P10

"I am happy to go on my own, but I prefer to go with someone just but for the company" – P14

(Theme) Passenger Behaviours & Perceptions: (Sub-Theme) Passenger Training

"I think I probably would [ask someone to show how to use] just to get the confidence… I suppose yeah it would be good for someone to show you how to use it for the first time" - P20.

"I had a lady come to me and say that she would show me how to get the digital tickets off the machine, but she didn't say or show me how to get the digital ticket on my phone" – P9

(Theme) Passenger Behaviours & Perceptions: (Sub-Theme) Everything is Online

"my wife would normally do that for me" – P11

"So again, I would have to ask someone to do that for me" – P11

Figure 4.9 – Example of Discourse Analysis Coding Applied to Thematic Analysis of Passenger Interview Data Categorised by Implication

4.7 The Constraints Analysis Framework

The analysis in this thesis is guided by two key theoretical frameworks: constraints negotiation theory and cognitive work analysis, both highlighted in the literature review. Previous qualitative studies examining constraints negotiation have typically employed thematic analysis or grounded theory (Fendt and Wilson, 2012; Gao and Kersetter, 2016; Stodolska et al., 2020). This research takes a different approach, integrating multiple analytical methods beginning with focus groups that provide an industry perspective. The data is examined through both thematic analysis, informed by constraints negotiation theory, and cognitive work analysis. Passenger interviews are then analysed using thematic and discourse analysis to understand constraint negotiation strategies used by late adopters. This integrated approach, termed the constraints analysis framework, was specifically designed to identify and examine potential travel constraints for the specified passenger group.

Whilst both frameworks offer valuable insights, each has limitations when used alone. Cognitive work analysis excels at examining system efficiency and safety but may overlook personal and social factors that influence travel decisions. Its technical focus could miss the subjective experiences and perceptions that shape passenger behaviour. Conversely, constraints negotiation theory, developed for leisure and tourism contexts, may not fully capture the complexities of rail travel. While it provides structure for identifying constraints, existing literature often treats constraints and barriers as synonymous, typically framing them negatively. Additionally, it lacks tools for analysing the hierarchical relationships within rail systems that influence passenger experiences. By combining these approaches, the research develops a comprehensive understanding of systemic, social, and personal factors affecting late adopters' travel experiences.

The constraints analysis framework emerged iteratively through the application of both approaches to focus group data and passenger interviews. The complementary insights gained from each method revealed the potential for integration, leading to systematic mapping of how elements from both approaches could be combined. This process resulted in the framework illustrated in Figure 4.10, enabling comprehensive analysis of potential constraints, environmental factors, consequences, and negotiation strategies. The development of this framework will now be explained.

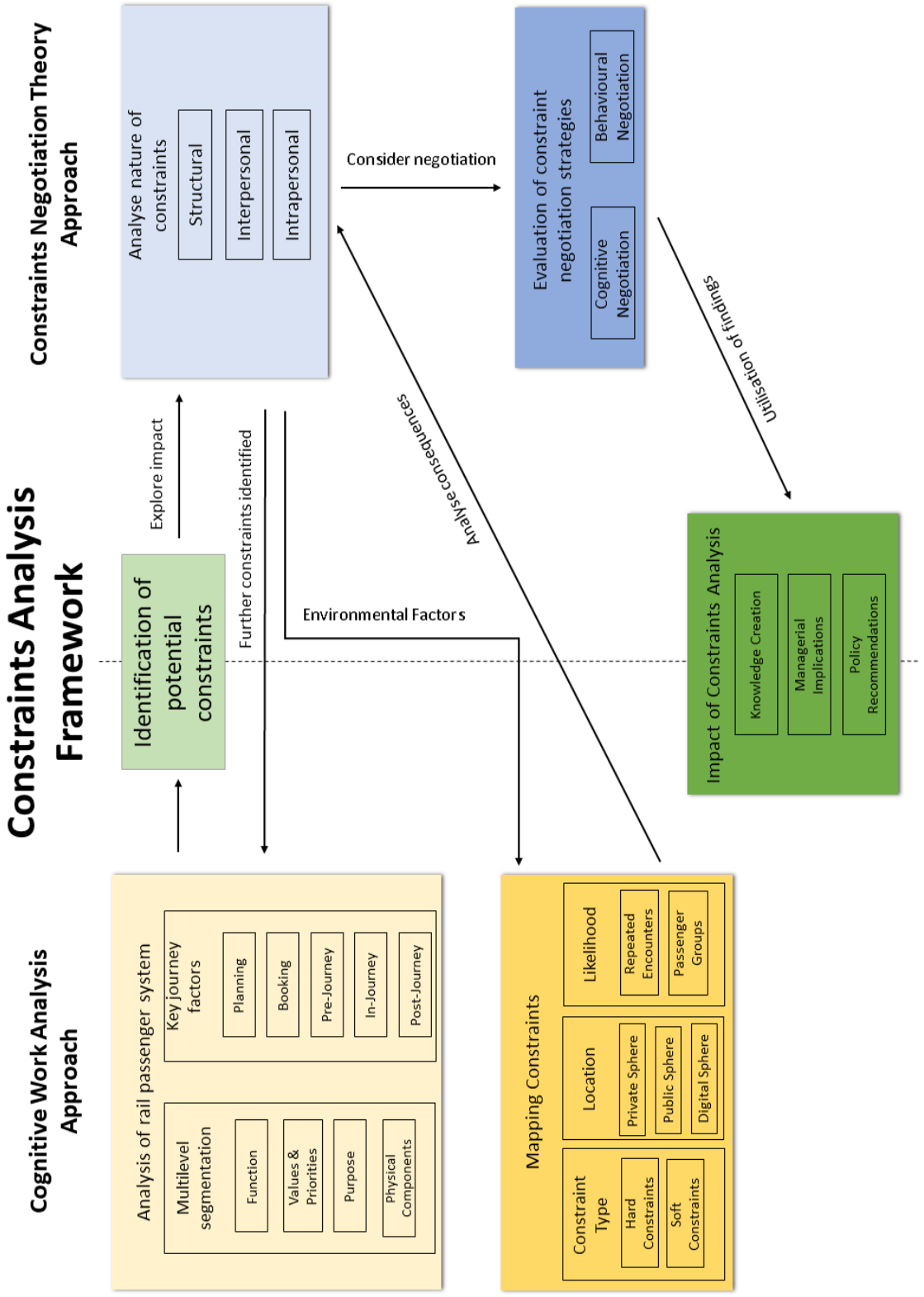


Figure 4.10 - The Constraints Analysis Framework for Combining the Approaches of Cognitive Work Analysis and Constraints Negotiation Theory

In the initial stages of data analysis, both approaches were applied independently to the data. The thematic analysis helped identify key functions, processes, and objects of the rail network, which were then used to populate the abstraction hierarchy generated in the first phase of the cognitive work analysis. Constraints negotiation theory was also applied separately to the thematic analysis, distinct from the development of the abstraction hierarchy. As the analysis progressed, overlaps between potential constraints identified through each method became apparent. The complementary nature of these analytical approaches is demonstrated in the analysis of support mechanisms and associated constraints. The abstraction hierarchy reveals links between 'physical objects' and other aspects of the rail passenger environment. For example, 'family and friends' are identified as 'objects' within the abstraction hierarchy that support various processes and functions of the rail network. These connections ultimately contribute to achieving the functional purpose – in other words, the main objective of the rail system.

Independently of this analysis, the thematic analysis also identified 'family and friends' as a support mechanism with associated constraints. Through the lens of constraints negotiation theory, this support mechanism was categorised as an intrapersonal and/or interpersonal constraint. This categorisation applies particularly in circumstances where individuals cannot contact friends and family for support, feel burdensome doing so, or when support is only available at certain times of the day. The application of this analysis to the abstraction hierarchy reveals how the nature of constraints can impact other aspects of the rail network (see Chapter 6 for further examples and demonstration of this analysis). The first phase of the constraints analysis framework, exploring the rail passenger system, combines phase one of cognitive work analysis with the constraints negotiation theory approach. The researcher moves between these two approaches in a cyclical manner, comparing the analysis, adding further detail to the nature of the constraints identified until saturation point is reached – i.e. no further constraints or detail about the constraints are identified at this stage. This brief example demonstrates how integrating these two analytical frameworks provides a multilayered understanding of the complex interplay of factors affecting travel for the passenger group in question.

Phases one, two, and four of cognitive work analysis employ various visualisations to explain the interconnections within complex socio-technical systems, revealing when and where activities occur and who performs them (Naikar et al., 2006; Jenkins et al., 2008a). When coupled with constraints negotiation theory, this approach offers a

powerful means of visualising the often-intangible travel constraints of the rail network. The visual representation of linkages between available resources, combined with a deeper exploration of potential constraints, renders these more tangible and comprehensible. The second and fourth phases of cognitive work analysis utilise a contextual activity template to illustrate various situations and/or locations where different activities occur, along with the actors involved, depicted through colour-coded shading. The shading, as used by Stanton et al. (2013) for demographic groups, and in this research for support mechanism types, illustrates which groups of people can perform specific activities in various scenarios, considering systemic constraints.

The second phase of the constraints analysis framework integrates the constraints negotiation theory approach with phases two and four of cognitive work analysis. This phase focuses on analysing activity and mapping constraints. Building on the contextual activity template developed during these cognitive work analysis phases, constraints are explored in greater depth through the lens of constraints negotiation theory (see Figure 4.11). This approach examines each activity from the contextual activity template individually, providing examples of applicable constraint types for each (i.e., intrapersonal, interpersonal, and structural constraints). The colour-coded shading in Figure 4.11 is used in this research to indicate which type of support mechanism the constraint is associated with. In other research the shading could also be used to demonstrate constraints influencing the behaviours of different demographic groups. This deeper level of analysis offers insights into the types of constraints that may exist for various user groups during specific activities and at particular situations or locations throughout a passenger's journey. However, it is important to note that this study does not include examples for situations where activities cannot take place, as these scenarios are considered ‘hard constraints’ and are not currently supported within the analysis (Stanton et al., 2013).

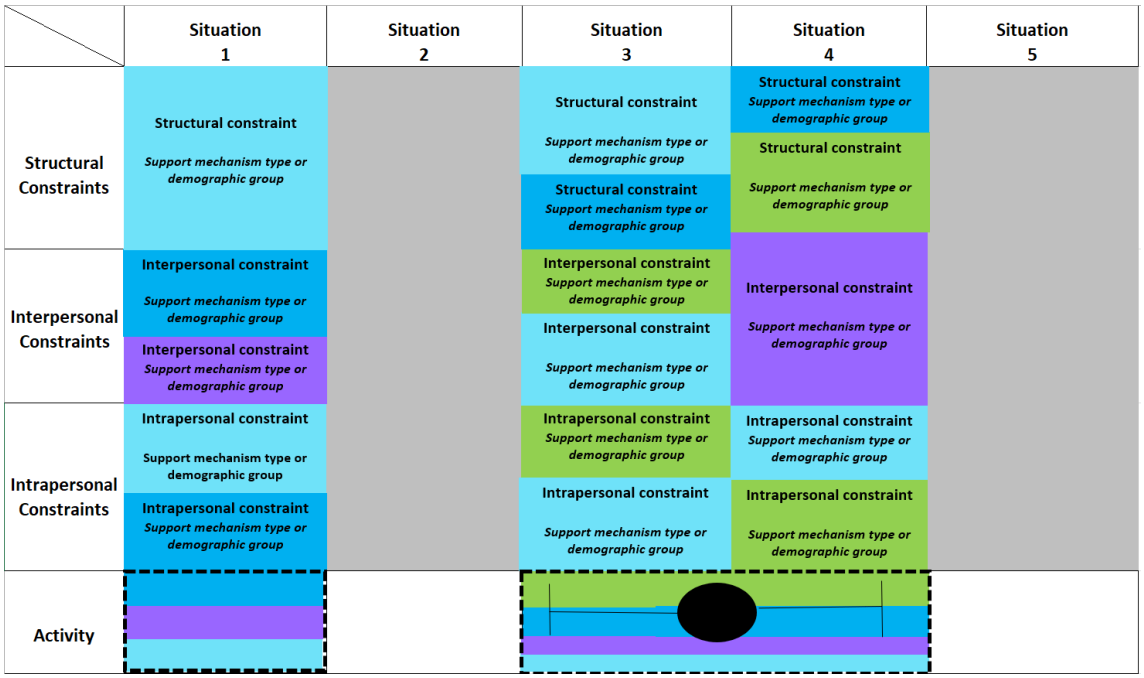


Figure 4.11 – Example Contextual Activity Template Structure with Social, Organisation, and Cooperation Analysis and Constraints Negotiation Theory Applied

This integrated methodology not only maps constraints throughout the passenger journey but also visually demonstrates their frequency. This aspect is particularly important, as the frequency of constraint encounters has been shown to mediate the effect of learned helplessness on the travel behaviours of people with disabilities (Lee et al., 2012). Similarly, research indicates that senior travellers' behaviour is influenced by repeated encounters with constraints that lead to negative consequences (Wen et al., 2020). Moreover, the multiplicative effect of different constraints can potentially overwhelm passengers, particularly when these constraints have negative consequences at various journey stages and are coupled with inconsistent support mechanisms (McKercher and Darcy, 2018). For example, Figure 4.12 demonstrates how hierarchical constraints—ranging from intrapersonal (most proximal) through to structural (systemic and least individual) —may be present in varying situations for the same activity, in this case ‘journey planning’. By visually representing these complex interactions, the combined approach provides valuable insights into the cumulative impact of constraints on passenger experiences and behaviours.

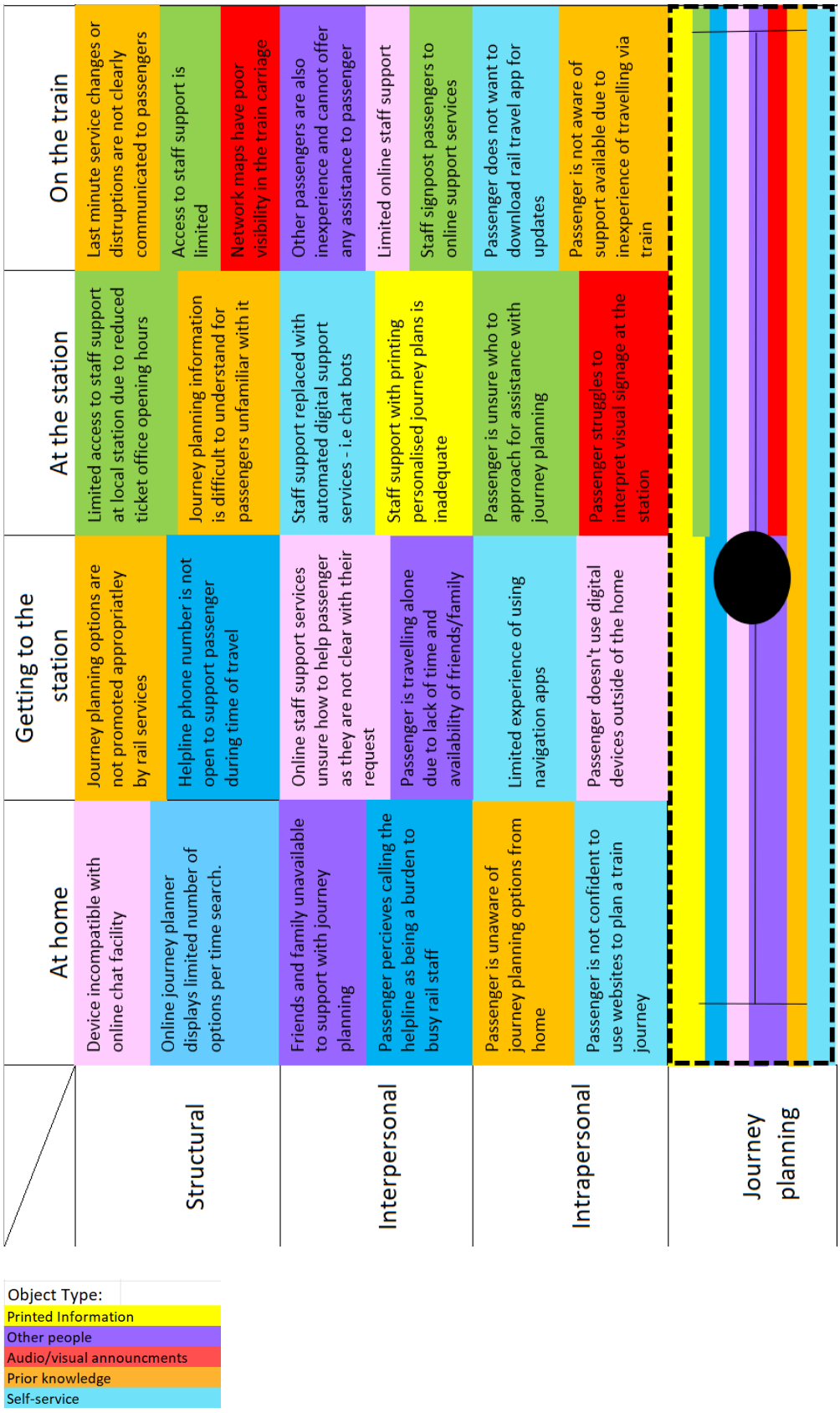


Figure 4.12 – Example Segment from Developed Contextual Activity Template with Social, Organisation, and Cooperation Analysis and Constraints Negotiation Theory Applied to the Activity of 'Journey Planning'

The third phase of the constraints analysis framework examines constraint negotiation strategies, which can be classified as either cognitive or behavioural according to constraints negotiation theory (Jackson, 2005). Although Jackson and Rucks (1995) suggest that behavioural negotiation is predominant, Karl et al. (2022) contend that cognitive negotiation can also prompt behavioural adjustments to overcome constraints. Thematic and discourse analysis of interviews with late technology adopters revealed their distinctive negotiation strategies. One notable example emerged regarding intrapersonal constraints: passengers with reduced confidence in using station self-service machines when alone adopted a behavioural strategy of travelling with companions to operate the machines together. It is also important to note that within constraints negotiation theory, even deliberate inaction, such as choosing not to travel, can paradoxically be considered a form of constraint negotiation. Understanding whether passengers employ behavioural, or cognitive negotiation strategies to negotiate constraints offers valuable insights for service design. For instance, the identification of late adopters' tendency to travel with companions could inform targeted marketing initiatives, such as companion discount schemes or joint loyalty programmes.

The insights derived from this multifaceted analysis inform the development of knowledge, managerial implications, and policy recommendations. This combined approach also challenges the positionality of constraints as a concept for research. Rather than beginning the research with a bias towards positive or negative outcomes of constraints, the constraints analysis framework encourages the researcher to be open to a greater number of possibilities and continuously challenge the differing standpoints of what constraints are, what impact these have on different passengers, and what negotiation of constraints means for the user, consumer, and the rail network. Thus, a more holistic understanding of the constraints experienced by the specified passenger group and potential strategies to address these is developed.

4.8 Researcher Positionality

Reflexivity is a key component of undertaking ethnographic research involving the critical questioning of experiences, fieldwork, and analysis (Draper, 2015). Reflexivity goes beyond descriptive reflections that occur in everyday life when a person experiences something. To engage in reflexive practice requires the researcher to reflect on the experience but also to take a step back from themselves to consider their own involvement, contribution, or influence (Pellatt, 2003). The reflexive process also involves the researcher explicitly documenting their positionality within the research such as their ethical standpoint, socio-economic circumstances, and political perspectives which helps to put the ethnographic account into context. Through engaging fully in this process of reflexivity, the validity and trustworthiness of the research is enhanced as the researcher is open and honest about their experiences and role in the study (Scott-Jones and Watt, 2010). Additionally, further insights into how the characteristics of the research albeit the personal characteristics of the researcher, the context of the study, or the people involved can influence the experience of fieldwork can be drawn out during the reflexive process (Manfreda et al., 2023). Thus, as a thesis based on ethnographic methods it is important to highlight the engagement of the author in reflexive practices throughout this research.

The insider versus outsider divide is something that all ethnographic researchers must address within their reflexive practice. Both of these positions bring with them differing levels of power, perceived trustworthiness, and access to research participants (Britton, 2020). Arguably, to be an insider during an ethnographic study is the most desired position for an ethnographer in terms of being able to relate to, access, and gain trust of participants (Symes, 2007). During the data collection for this thesis the researcher experienced being both an insider and outsider at different times and with different people. For example, during the industry focus group sessions it was abundantly clear that the researcher was an ‘outsider’ with little prior knowledge of the rail network. The researcher's industry partner, the Rail Safety and Standards Board, offered valuable support before the focus group sessions. They provided background information about the rail network, which helped the researcher avoid asking potentially naive questions that might have emphasised their outsider status. Additionally, a representative from the organisation assisted with notetaking during the sessions, further enhancing the researcher's credibility.

In contrast to the obvious feeling of being an outsider during the industry engagement part of this ethnographic research, the researcher experienced both being an outsider and an insider with the passenger participant group. Many of the passenger participants that were recruited to take part in the study were known or known of in some way by the researcher. The familiarity of the participants with the researcher bolstered the sense of insiderness as both parties had an established level of trust, prior acquaintance, and shared experiences (Wilkinson and Kitzinger, 2013). Aside from this, the researcher also felt like an outsider as they do not meet the criteria set out earlier in this chapter of a late adopter of technology. As the researcher is a female in her late 20s who is perceived to be tech-savvy the outsiderness was exacerbated. The stereotypical representation and understanding of late adopters of technology being old people who are disinterested and incapable of using modern technology was also unhelpful for the researcher to pass as an insider in this respect (Essen and Ostlund, 2011; Harvey et al., 2019). Other differences between the participants and the researcher such as their age, gender, and ethnicity also set them apart as a potential outsider to the group of interest. The fluid, and often contradictory, insider versus outsider positionality of the researcher as a friend or acquaintance, early adopter of technology, and a researcher of the University of Nottingham were continuously navigated and acknowledged during the fieldwork and data analysis.

Whilst designing this ethnographic study the researcher had to choose whether to conduct the fieldwork in an overt or covert manner. The ethics behind conducting covert ethnographic studies are fraught with contentious issues from deception to intrusion of privacy which remain contested by academics in multiple disciplines. Spicker (2011), Torres (2016), and Marzano (2018) are three examples of scholars who argue that it is possible to conduct ethical covert researcher however, the fact remains that this would be incredibly challenging to receive approval from the university ethics committee. The researcher also has to consider whether it is necessary to conduct the ethnography in a covert manner. For this research it was decided that the study would be conducted overtly with participants being fully informed of the research objectives and the nature of the study. It was decided that there would be no benefit for the research in deceiving or omitting any information from the research participants (Leopold, 2010). Whilst this is positive for the participants, it also presents further challenges for the researcher. For example, an unintended consequence of the travel along research being conducted

overtly was the influence of the researcher's presence. Several participants commented on the journey as being a test and feeling under pressure with the researcher observing them. To reduce the impact of this the researcher assured the participants that the journeys were not designed to test them or trick them in any way and there were no right or wrong things to do during the journey.

Whilst the researcher assured participants they were not being evaluated, there remained a suspicion that the researcher's presence occasionally influenced participant behaviour. This discrepancy between stated preferences and observed actions may stem from multiple factors, not solely the researcher's presence. For example, during interviews, staff availability to support passengers throughout their journey emerged as a strong preference. However, the travel-along study revealed a different reality: many participants sought in-person staff support only as a last resort. Instead, they primarily relied on smartphones, consulted station or train information displays, and even requested the researcher's assistance before approaching staff. This variance between interview responses and observed behaviour aligns with a recognised phenomenon in research. As Sweet (2018) notes, there is often a disparity between what people say during interviews and how they act in real situations. Reviewing critique of interviews in ethnographic research Hammersley (2006) notes that some suggest interviewees construct narratives through social discourse during interviews, potentially to present themselves more favourably, align with cultural expectations, or adhere to perceived social norms.

In this research, whilst not explicitly stated by participants, the researcher sensed that their presence might have encouraged the use of technology and self-help methods before seeking staff assistance. This behaviour could stem from participants' desire to avoid appearing as though they had "failed the test". Additionally, for solo travellers, the researcher's presence seemed to provide a level of reassurance. Some participants remarked that they would not have undertaken the train journey if they were entirely alone, suggesting that the researcher's company might have influenced their willingness to travel and their behaviour during the journey. These observations highlight the complex interplay between research methods, participant behaviour, and the challenges of capturing authentic experiences in studies involving human subjects.

Regardless of the familiarity, trust, and rapport built with the research participants there were still occasions where the researcher presence, equipment, or actions would create an unintended tension. During the interview phase of the research, the preamble discussion with the participants felt very relaxed and easy but the moment the digital audio recorder was placed on the table the atmosphere changed. The presence of the device seemed to be the elephant in the room with the participants glancing back at the small red recording indicator light throughout the interview. Answers to the interview questions, particularly at the beginning, were often short and required several prompts from the researcher. Whilst the participants seemed to become a little more relaxed as the interview went on, several participants breathed an explicit sigh of relief when the audio recorder device was packed away in the researcher's bag. Similarly, during the travel along journeys the researcher was aware that every time they took notes, no matter how subtle, the participants were aware that something was being jotted down about their journey or their actions. This also resulted in the researcher altering their behaviour slightly during the journey. For example, rather than taking notes every time something of interest happened or was said, they waited until a convenient moment to jot down several items at once such as when waiting for the train at the station or whilst seated on the train. In this sense the researcher also felt like their actions were being observed by the participant which allowed them to empathise with how the participants might be feeling during the course of being travelled along with by a researcher.

As this section has highlighted, the positionality and influence of the researcher has been considered and reflected upon during the data collection, analysis, and writing up phases of this thesis. In addition to enhancing the validity of the findings (Scott-Jones and Watt, 2010), engaging with reflexive practice has contributed to further developing the analysis conducted.

4.9 Chapter Summary

This chapter has outlined the comprehensive methodology employed to investigate the constraints faced by late technology adopters when using rail travel in Great Britain. Grounded in a social constructivist and interpretative approach, the research leverages a multi-stakeholder perspective to gain a holistic understanding of this user group. It explores their relationship with technology and the constraints they encounter when using or considering rail services. The research utilises a range of qualitative data

collection methods to gather rich insights, including focus groups, semi-structured interviews, and travel-along ethnography. To analyse this diverse data, the research employs an interdisciplinary approach, combining analytical methods from various fields. These include thematic analysis, cognitive work analysis, constraints negotiation theory, and discourse analysis.

A key contribution of this chapter is the introduction of a novel conceptual framework: the constraints analysis framework. This innovative tool was specifically developed to analyse the industry focus group data, enhancing the depth and breadth of insights derived from these sessions. The chapter concludes with a reflexive section, critically examining the researcher's positionality and influence throughout the research process, from data collection and analysis to the writing of this thesis. This reflection adds a layer of transparency and contextual understanding to the methodological approach.

The forthcoming chapters will present the findings from the analysis of the data collected. Findings will be discussed thematically. The first findings chapter will develop an understanding of the late adopter user group. This will be followed by a discussion of the constraints faced by late technology adopters in British rail travel using a novel analytical framework that combines industry and passenger perspectives. Finally, a third findings chapter will explore the provision of support for late adopters in rail travel, exploring industry perspectives on balancing digital advancement with inclusivity, analysing improvement strategies through thematic analysis of industry focus group data, and presenting solutions proposed by late adopters themselves, highlighting potential misalignments between industry perceptions and user realities.

CHAPTER 5: UNDERSTANDING LATE ADOPTERS OF TECHNOLOGY

5.1 Introduction

"If I can't do something technical, I'll grab a young person because they will know how" (Participant 10).

Late adopters of technology are somewhat of an enigma when it comes to understanding who they are and why they might be considered part of this group. On one hand, many people across all different age groups think they would be considered late adopters even though they are active users of digital technology. This could be because they do not feel overly confident using technology, or they feel they do not use it as much as they could for different activities. On the other hand, stereotypical representations of late adopters, and assumptions these will mainly be old people, proliferate literature and media. The same is also true for older people making assumptions that young people have a full interest and understanding of technology. Meanwhile, these stereotypical assumptions based purely on age are inconsistent with the findings of Rogers (2003) and Kim et al. (2010) where late adopters are identified across all age categories.

As the first of three findings chapters, this chapter addresses the issue of understanding who late adopters are and whether the academic literature is representative of this user group, or not. Late adopters in this research are the segments of the population, as categorised by Rogers (2003), that are in the last 50% of people to adopt or use an innovation or technology. Even though they are known as late adopters, it is likely that some people in these groups will never adopt certain technologies. Therefore, late adopter groups include people who are in the latter half to adopt as well as non-users. For simplicity and clarification, from herein the term late adopters will refer to both the late adopter and laggard groups as set out in Rogers' (2003) diffusion of innovation theory, as well as people who are non-users.

Late adopters are thought to be more resistant to change, less interested in technology, and hesitant to try or buy new products (Rogers et al., 2008). This has often led to research focusing predominantly on the earlier adopter groups or framing older and disabled adults as stereotypical late adopters (Woodcock, 2014; Vines et al., 2015). While Chapters 6 and 7 of this thesis explore late adopters in the context of rail travel,

this chapter focuses on exploring the diversity of the user group as well as analysing their preferences, concerns, and attitudes regarding digital technologies more generally. This is necessary as the boundaries between everyday life and travel are increasingly blurred through the proliferation of digital technologies which influence how people engage with travel (Wang et al., 2016). Therefore, it is likely that late adopters will be influenced by their everyday use, or non-use, of technology when they travel by train.

5.2 The Late Adopter Spectrum

Rogers' (2003) diffusion of innovation theory is based on the idea that innovations spread and become adopted throughout society as a result of social and communicative structures. The first half of the population to adopt new ideas and products are known as early adopters, whereas the latter half are late adopters. It would be an oversimplification of the diversity of users within adopter groups to suggest early and late adoption occur in a binary format. Rather, adopter categories range across a spectrum from innovators as the first of the early adopter group through to laggards as the last of the late adopters, which include non-adopters. Contrary to stereotypical representations of late adopters as elderly and disabled people who are disinterested in technology (Tobbin and Joseph, 2012), the late adopter group is diverse (Woodcock, 2014). This warrants further exploration into the spectrum of users, and non-users, with late adopter tendencies.

Previous empirical studies examining late adopters of technology have predominantly focused on older adults, often equating age with late adoption tendencies. For instance, Mattila et al. (2003) studied 220 participants aged over 65, examining their internet banking behaviours. Harvey et al. (2019) examined 32 participants aged 63-96, finding high levels of technology engagement among their sample - with 31 participants owning mobile phones, 29 having internet access at home, and 28 having laptops. Similarly, Essen and Östlund (2011) worked with 20 participants aged 63-89 who were actively engaged in the technology design process. These studies largely assumed late adopter status based on age alone and generally included participants with at least some technology engagement rather than complete non-users. This research takes a more theoretically aligned approach, using an adapted questionnaire from Kim et al. (2010) to identify late adopters across all age groups. This method more closely reflects Rogers' (2003) original diffusion theory, which suggests late adopters exist across age categories as adoption preferences are behavioural factors that people carry with them through the

ageing process rather than being confined to particular age-related groups. While the sample size is smaller than some previous studies, this more targeted approach to identifying late adopters through behavioural and attitudinal criteria, rather than age alone, allows for deeper insights into what truly characterises this user group.

Prior to their participation in interviews and travel along rail journeys, passenger participants were asked to complete a questionnaire, adapted from Kim at el., (2010), to establish to what extent they might be considered late adopters of technology (see Chapter 4 for questionnaire detail). A maximum of five points could be scored by participants. High scores indicate greater late adopter tendencies. While a score of three or more demonstrates a stronger tendency to align with being a late adopter, all scores of two or more could be considered to exhibit late adopter tendencies to some extent. As the majority of participants were directly recruited by the researcher it is unsurprising that none of the participants scored less than two for late adopter tendencies when completing the questionnaire. The results segmented by age group are displayed in Figure 5.1.

As the purpose of the questionnaire was purely to determine candidate suitability, these results were not intended to be presented as findings in the thesis per se. However, it is interesting to note that in line with Rogers (2003) and Kim et al. (2010) late adopters are represented across a range of age categories. For example, participants from both the oldest (over 71 years) and youngest (under 40 years) age groups scored between three and five on the adopter scale.

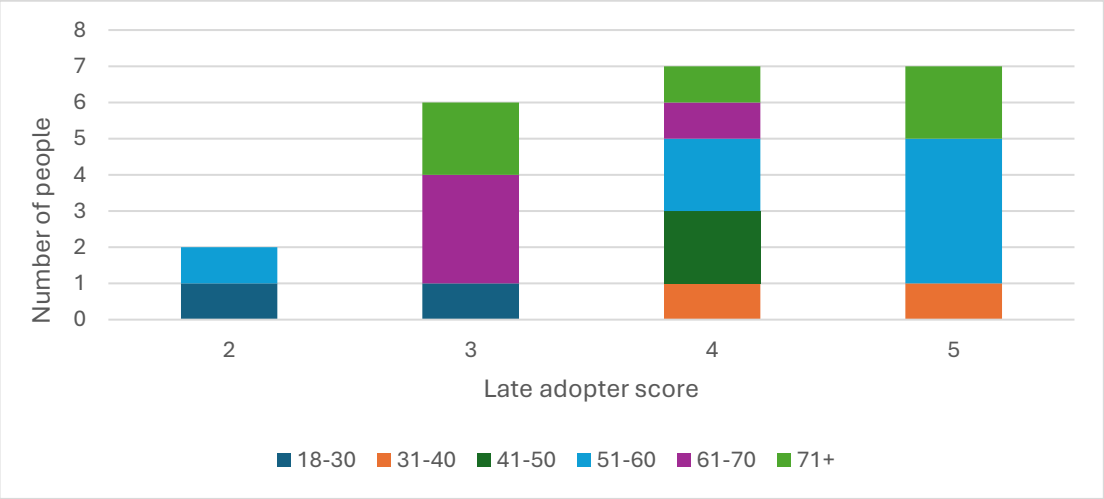


Figure 5.1 – Stacked Column Chart Showing Late Adopter Participant Scores Segmented by Age Group

Those with the lowest score of two points indicated they are generally interested in new technology, like trying new products, and usually feel confident when learning to use new technologies. However, they also indicated they would describe themselves as 'traditional' and tend to wait for their friends to try and buy new products before they do so themselves. This suggests that whilst they are interested and open to new technologies, they still exhibit late adopter tendencies as they do not purchase new products before others in their social circles (Rogers, 2003). For that reason, these participants indicating more marginal late adopter tendencies were still invited to participate in the research.

Jahanmir and Lages (2016) suggest slow speed of adoption, resistance to innovation, and scepticism are three major attributes of late adopter users. When asked whether they would describe themselves as 'innovative' or 'traditional', all participants selected 'traditional' which suggests they may be resistant to engaging with or adopting innovations. Similarly, all except one participant indicated they would prefer to wait until their friends had bought, tested, and recommended a new product before buying it themselves. This suggests they are slower than the majority of people within their social circles to adopt new products or technologies. Around half of the participants said they were not generally interested in technology and would prefer to use things they are familiar with. Four participants said they would feel confident to use new technology. These responses demonstrate that while half of the sample are interested in technology and enjoy trying new things, the majority of people lack confidence to be the first to buy or adopt. These results are shown cumulatively in Figure 5.2.

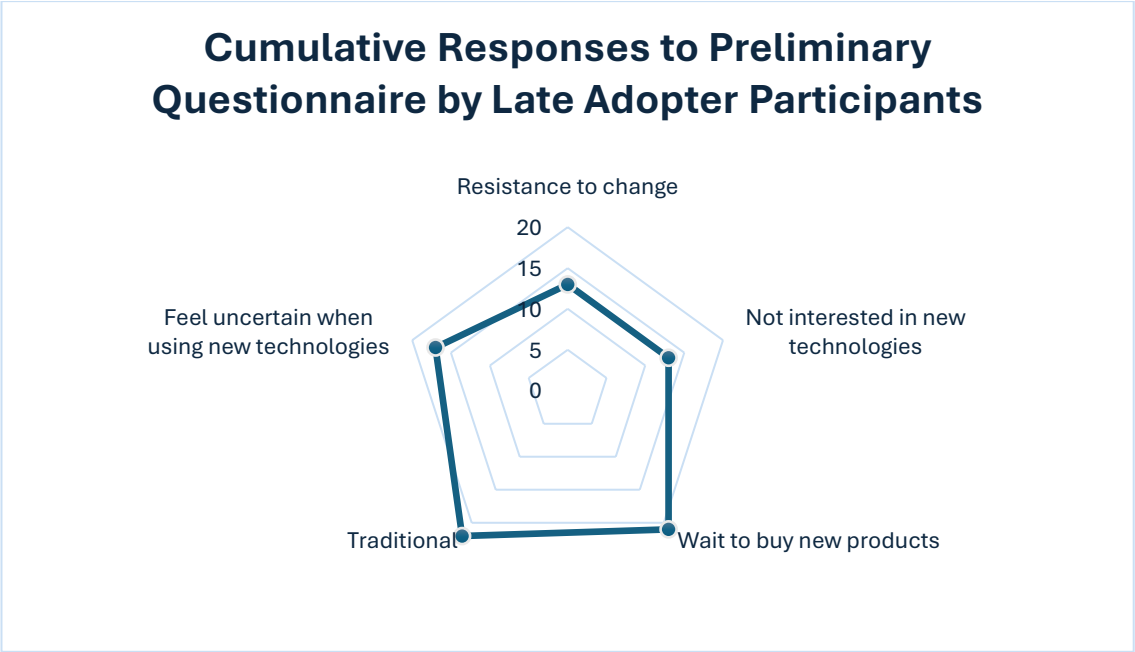


Figure 5.2 – Radar Chart Showing the Cumulative Results of the Preliminary Late Adopter Questionnaire

5.3 Understanding the Late Adopter Perspective

A thematic analysis of the interview data collected from late adopter participants during the second study identified seven overarching themes and a further 35 sub-themes. The semi-structured interviews were divided into two main sections: Technology in daily life and an actual or hypothetical train journey. The themes discussed in this section were identified through analysis of the first part of the interview focusing on daily life and technology (see Appendix 3 for question details). Table 5.1 details the themes and sub-themes identified as well as providing an interpretation of these.

Table 5.1 – Interpretation of Themes and Sub-Themes Identified During Thematic Analysis of Passenger Participant Interviews

Interpretation	Sub-Theme	Overarching Theme
Most people used smartphones, but the majority of these did not make full use of the device features.	**Redundant device features**	**Devices**
Several people preferred using larger devices (e.g. tablets, iPads, laptops) for more involved and/or higher risk tasks – online banking, purchasing items, Zoom calls.	**Large screen for tasks**	
In terms of different communication applications, late adopters are influenced by other people and will download/use certain applications because that is what their friends are using.	**Influence of others**	
Technology is an enabler for connecting with friends and family remotely in a realistic and meaningful way.	**Connection with others**	
Technology has evolved to become easier and more convenient for people to use. Examples include, the compactness of a smartphone, ease of speaking to smart devices (e.g. Alexa), and speed of finding information.	**Convenient technology**	
One device (i.e. a smartphone) cannot always be used to complete tasks. Some people suggest this causes them issues when they have to source a laptop to be able to do something they expect to be able to do using the devices they have at home.	**Device inconsistency**	

Where cost is a factor, several people consider digital technologies to be expensive and out of budget. They also wait for the price to reduce before buying or will rely on others to hand down their old technology to them.	**Expensive**	**Cost of technology**
	Reluctance to upgrade	
Several people are concerned that new technologies are a gimmick and/or will become obsolete very quickly so will delay purchasing/using new technology.	**Concern of obsoletion**	
Weighing up the cost of new technology and the benefits of using it is of concern to most people.	**Value for money**	
Actual and perceived time constraints are a factor for many people in terms of having time to learn something new, navigating unfamiliar systems, setting up new technology.	**Time constraints (actual)**	**Time and patience**
	Time constraints (perceived)	
Some people expressed a lack of patience with using, learning, or exploring new technology.	**Patience**	
The urgency of the situation is influential when deciding which technology to use. For example, if a message needs to be relayed quickly people prefer to speak on the telephone. Likewise, if a message is too long to put in a text message the telephone is quicker and easier.	**Urgency**	
Whilst some people were very opposed to learning how to use new technologies, several others commented on how much effort is required of the user to learn new things. This also linked into their	**Reluctance to learn**	**Learning and practicing**
	Effort of learning	

motivation to using and learning how to use a new technology which was often a combination of personal interest and external compulsion to do so.	**Motivation to learn**	**Learning and practicing**
Some people are also influenced directly and indirectly by other people in their learning how to use new technologies. The reluctance of others to teach people and/or other people doing things for them leads to the person not being taught or having an interest in learning how to do/use certain technologies.	**Influence of others in learning**	
The practicalities of learning how to use new technologies and/or systems is a challenge for most people. Some people struggle with understanding written instructions and several assume that they will be too complicated for them to follow. Most people expressed a preference for other people to show them how to use new things albeit in-person or by watching a video.	**Understanding written instructions**	
	Preference for in-person or video demonstrations	
The actual and perceived complexity of digital technologies deters several people from engaging with technology. Simplicity is referred to as a thing of the past whereas modern technology is designed to be complicated. Some people assume that technology will be too complicated for them to use. Others commented on the challenge of keeping up with upgrades in modern technology.	**Complexity of technology**	**Attitudes and beliefs**
	Perceptions of technology	
	Pace of technology	

Several people indicated their acute awareness of the intrusiveness of technology in their daily lives be it in the use of their personal data, security of technology or persistent notifications.	**Intrusiveness of technology**	**Attitudes and beliefs**
The fear of something bad happening as a result of user error is shared by several people – e.g. being scammed online, losing/theft of a smartphone, and online banking fraud. Some people also find it difficult to trust the systems to keep them and/or their belongings safe.	**Fear of losses**	
	Lack of trust	
Not knowing how to use something, navigating unfamiliar technologies, or getting to where they want to be on a system induce feelings of anxiety and nervousness amongst several participants.	**Uncertainty**	
Technology can be perceived as both secure and insecure by late adopters. Additional security features of payments made using online services is reassuring to some people. Meanwhile, some believe online banking to be less secure than traditional methods.	**Security of technology**	
Having confidence in themselves to be able to use a new technology is more of an issue for some people than others. Whilst some people indicate they are not interested in technology they comment on how they believe they would be able to use new technologies. Others express concern that they would do something	**Personal confidence**	**Confidence with technology**

wrong which could result in negative consequences.		**Confidence with technology**
The fear of technology letting people down is a concern for several people which generates questions in people's minds about what happens when technology fails.	**Confidence and reliability of the system**	
Doubts about their ability to complete tasks using technology because of the complexity of the system, their physical ability, and being nervous about doing something wrong.	**Perceived ability**	
Some people have reduced fear and levels of concern around making mistakes when using technology. Rather, they see this as a positive way of being able to learn how to use a new technology.	**Trial and error**	
Several people commented on how they would feel more confidence in using technology the more they used it, and they would also be able to navigate other systems if they felt they recognised the layout and/or the icons.	**Confidence to use**	**Frequency of use**
	System familiarity	
Motivation to use or continue using a technology is reduced when frequency of use is less often. This is related to the effort of setting up something new, or resetting up something if it has malfunctioned, as well as the cost associated with buying or subscribing to a technology or service.	**Motivation**	

The overarching themes relate to different aspects of people's (dis)engagement with technology. This includes the cost and frequency of using technology through to more personal factors such as patience, learning, and confidence. These factors intersect with one another to influence the individual's perspectives and their use, or non-use, of technology. The influence of different types of factors can vary between late adopters with some people being influenced by a small set of factors such as time, effort, and the pace of technology. Whereas other late adopters have a much broader set of factors influencing their decisions and attitude towards technology. For example, Participant 21 is primarily concerned with the time associated with setting up a new piece of technology, the effort of learning how to use something new, and the pace of technological advancement meaning they will need to engage in these processes more frequently:

> "I do find it a big pain when you have to set something up again. I dread changing my phone for that reason. I'm a good couple of weeks sorting it out before I get everything right again." (Sub-theme: Time constraints (actual)).

> "There's so much to learn about them and it would put me off a bit sometimes. You just learn what you can and that's it really." (Sub-theme: Effort of learning)

> "They're moving so fast now [technologies] and they're getting that technical, it's keeping up with everything… it's not getting any easier, put it that way." (Sub-theme: Pace of technology)

For other people, such as Participant 16, there was a much broader range of factors influencing their engagement with technology ranging from the influence of other people in their life and cost-related factors through to their perceived ability to use technology and fear of losses which could be incurred through using technology:

> "[Talking about son] He mostly phones me. I'll text him, but he phones me. He doesn't like texting… he likes to phone me" (Sub-theme: Influence of others – Devices)

> "It's my nerves mainly because I think I would do something wrong" (Sub-theme: Perceived ability)

> "I used to go to computer classes when I first lived on my own, but it went up [the cost] and it became quite dear" (Sub-theme: Expensive)

> "[Talking about new technologies] Well if it's not going to help me then I don't need to learn how to use it and I won't change to something new just for the sake of it" (Sub-theme: Motivation to learn)

> "I never order off the internet. No, no I am too frightened to do that… I hear too many things about it and scammers" (Sub-theme: Fear of losses)

The variety of themes identified, level of knowledge about technology, and the interest in technology expressed by late adopters suggests the relationship between this user group and technology is complex. If, as the literature suggests, these people are disinterested in technology and highly resistant to change it would be reasonable to expect these two factors to be prominent themes identified in this research (Rogers et al., 2008). However, the two examples above (Participant 21 and Participant 16) show there are a number of factors influencing engagement with technology. There are also several differences and intersecting factors influencing the decisions, perceptions, and behaviours of two individuals who have both been identified as being late adopters. Additionally, only two sub-themes related to disinterest in technology and resistance to change (reluctance to learn and no desire to change) are identified. This is in contrast to the stereotypical narrative in the literature suggesting disinterest is the prominent factor influencing late adopters (Essen and Ostlund, 2011; Harvey et al., 2019). The next section of this chapter applies the constraints negotiation theory approach to further explore these factors, their influence on late adopters, and the negotiation of these by the user group.

5.4 Constraints of Technology Use and Engagement

A deeper examination of the identified themes provides valuable insights into the knowledge, perspectives, and behaviours of late adopters regarding their engagement with and adoption of technology. These themes can be reframed as constraints, acting as influential factors shaping the attitudes, decisions, and behaviours of the late adopter group. To further analyse these behaviour-shaping factors and understand the nature of the identified constraints, the constraints negotiation theory approach is applied to the thematic analysis. Each sub-theme is categorised into one of three types of constraints: intrapersonal, interpersonal, and structural. This categorisation provides a structured approach to understanding the complex interplay of factors that influence late adopters' relationship with technology, offering a more comprehensive view of their decision-

making processes and adoption patterns. The categorisation of the themes into different types of constraint are detailed in Table 5.2 and discussed in more detail in the following sections.

Table 5.2 – Application of the Constraints Negotiation Theory Approach to the Thematic Analysis of Late Adopter Interview Data

Constraint Type	**Sub-Theme**	**Theme**
Structural	Confidence and reliability of the system	Confidence with technology
	Understanding written instructions	Learning and practicing
	Actual time constraints Perceived time constraints	Time and patience
	Value for money Expensive Concern of obsoletion	Cost of technology
	System familiarity	Frequency of use
	Large screens for tasks Redundance device features Device inconsistency	Devices
	Intrusiveness of technology Pace of technology Complexity of technology	Attitudes and beliefs
Interpersonal	Influence of others Preference for in-person or video demonstration	Learning and Practicing
	Connection with others Influence of others	Devices
	Reluctance to learn Effort of learning Motivation to learn No desire to change	Learning and practicing

Intrapersonal	Reluctance to upgrade	Cost of technology
	Convenient technology	Devices
	Motivation Confidence to use	Frequency of use
	Trial and error Personal confidence Perceived ability	Confidence with technology
	Patience Urgency Perceived time constraints	Time and patience
	Lack of trust Perceptions of technology Fear of losses Uncertainty Security of technology	Attitudes and beliefs

5.4.1 Intrapersonal Constraints

Intrapersonal constraints, the most immediate type of constraint affecting individuals or groups, encompass personal and psychological factors that shape behaviour, choices, and perceptions (Crawford et al., 1991). For late adopters of technology, four key themes emerge as intrapersonal constraints, all connected to emotional responses: fear of losses, lack of trust, security of technology, and uncertainty. Given their more sceptical stance towards technology (Rogers, 2003), it is unsurprising that these themes are identified as influential constraints for this user group. Late adopters experience anxiety when faced with unfamiliar technological interfaces or processes. For instance, the inability to navigate back to a familiar webpage after clicking an incorrect button can be a considerable source of stress. This uncertainty about how to use technology and apprehension about potential outcomes contribute to a pervasive sense of fear among users in this group, ultimately affecting their willingness to engage with new technologies.

> “I go off and do all these other things, but I can never get back so then I am lost. I don’t know how it happens, and I don’t know how to retrace my steps” (Participant 18)

> “I am good at what I can do, but after that I get nervous” (Participant 20)

Even when late adopters are familiar with technology and capable of completing certain tasks, they still exhibit hesitancy and nervousness. This apprehension stems from a dual lack of trust: in the technological systems they interact with and in their own abilities. Their caution is further fuelled by fears of potential negative consequences, such as financial loss or compromise of personal data, should they make a mistake or encounter a system failure:

> “I suppose I think, heaven forbid if I lost my phone or anything, how much I would lose, you know, how much data and stuff would be gone with it” (Participant 20)

This persistent unease highlights the complex relationship late adopters have with technology, where competence does not necessarily equate to confidence:

> “I know how to shop online, I can remember how to do that, but I don’t because I don’t trust it… I never order off the internet, I am too frightened. I hear too many things about it and scammers” (Participant 16)

Karl et al. (2022) propose that cognitive constraint negotiation often involves some degree of behaviour modification. This concept is exemplified by the example above where Participant 16 considers a behavioural adjustment to undertake shopping online but decides to avoid it due to concerns about potential financial losses. The cognitive strategy demonstrated here results in a secondary behavioural negotiation: opting to continue physically visiting high street shops to purchase items they could have otherwise bought online. This example illustrates how late adopters’ perceptions and fears can lead to changes in their interaction with technology, shaping their daily habits and decision-making processes. Participant 16's case also demonstrates the perception that shopping online is less secure than visiting physical stores. The perceived security of technology emerges as a further constraint, often eliciting an emotional response to innovation. While Harvey et al. (2019) highlight this constraint to technology adoption,

they discuss it only from a negative perspective. However, this research also reveals security features of technology as positive outcomes of constraints:

> "I prefer to use my phone to pay in shops because it just feels a bit safer than getting my purse out" (Participant 13)

> "With the banking on my iPad they always send me an email as soon as anything goes out of my account so I can instantly check up on what it is going on" (Participant 14)

> "I do check and confirm the [bank account] numbers several times, but now you can actually check the person you are paying is the right on before you do it which is good" (Participant 20)

These examples highlight the positive outcomes for late adopters when technology is perceived to have additional security benefits over more traditional methods.

Two further intrapersonal constraints influence late adopter engagement with technology: the perception of technology as inherently complex and their own self-assessed ability to navigate it. Notably, even individuals with prior technological experience perceive modern innovations as too complicated for them to understand. The disconnect between past familiarity and current perceived complexity influences late adopters' willingness to embrace new technologies. This gap between technological advancement and perceived ability can lead to hesitation or outright avoidance, even among those who have successfully used technology in the past:

> "Even though I have used computers in the past, I find now with the phone that one button done in different ways does all sorts of things and I can't get my head around that" (Participant 11)

> "Technology nowadays is probably too complicated for me anyway" (Participant 16)

> "I am not quite a dinosaur yet, I can use the apps [applications], but it's when things kind of go wrong, then I have got to call my grandson for help" (Participant 18)

While some late adopters' hesitation stems from assumptions about technology's complexity, others base their doubts on negative past experiences. This is evident in the

accounts of two participants who encountered difficulties while using laptops to make holiday arrangements. Their prior struggles with technology have shaped their perception of their own abilities to navigate modern digital tools. These experiences illustrate how past technological mishaps can influence late adopters' confidence and willingness to engage with new or similar technologies during travel planning:

> "I was doing the ESTAs for our holiday and I lost it all just by pressing one thing that I don't even know what I pressed but it lost everything" (Participant 5)

> "It's my only time I booked airport tickets online and I booked it to the wrong airport… that experience put me off booking online again. It makes me question my ability to do it, I think" (Participant 6)

Four of the seven sub-themes related to learning new technologies are categorised as intrapersonal constraints: motivation to learn, effort of learning, reluctance to learn, and no desire to change. Given that late adopters are commonly perceived as resistant to change, it is unsurprising to find high levels of reluctance associated with learning new technologies. Participants express various attitudes reflecting this reluctance, ranging from self-described laziness to a lack of patience for figuring out new systems. For instance, Participant 3 considers themselves "too lazy to learn something new," while Participant 19 "just couldn't be bothered with sitting around trying to figure it out," and Participant 5 "wouldn't want to learn either."

These attitudes towards learning new technologies are shaped by several interconnected factors:

1. Individual motivation
2. Desire (or lack thereof) to use the new technology
3. A cost-benefit analysis weighing the effort of learning against the perceived benefits of using the new product

When interest in a new technology is low, users tend to avoid learning it, preferring to continue their activities using familiar methods. This decision-making process reflects a complex interplay of personal attitudes, perceived utility, and the mental and emotional investment required to adopt new technologies. These internally constructed constraints are further reinforced when alternative methods for completing an activity are available. As Participant 7 observes:

> "If you want to learn something, that is actually half the battle because you will persevere, whereas if you're not interested you will give up a lot easier and just try to get away with not having to do it with the technology" (Participant 7)

However, the motivation to learn how to use a new technology can be influenced by external factors, particularly when alternative services are reduced or eliminated. In such cases, the cost-benefit analysis for late adopters may shift, making them more motivated to learn new technologies to save time, effort, or money. This dynamic is reflected in a discussion with Participant 8 about ordering repeat prescription medication:

> "I cannot order repeat prescriptions now in any other way than to get the app. The only other option is taking the piece of paper and walking two and a half miles to my doctors surgery" (Participant 8)

This example illustrates how external pressures or changes in service delivery can prompt late adopters to reconsider their stance on new technologies. When the perceived benefits of adopting a new technology outweigh the effort of learning it, or when the costs of not adopting become too high, late adopters are more likely to overcome their initial reluctance.

This understanding of late adopters' reluctance to learn new technologies challenges traditional notions of resistance to change (Bagozzi and Lee, 1999; Rogers, 2003). Instead, it reveals a more calculated approach where individuals describe the influence and consideration of multiple factors when deciding whether to invest time and effort in learning new technological skills. These constraints are not exclusively negative, although much of the literature tends to explore these as having an adverse impact on technology adoption among late adopters (Jahanmir and Lages, 2016; Harvey et al., 2019). Rather, some constraints have positive outcomes leading to increased engagement and use of technology as a novel method for completing daily activities such as banking and shopping. Likewise, these findings suggest that attitudes towards new technologies by this user group are not fixed but flexible and responsive to both internal motivations and external circumstances. It suggests that strategies to encourage technology adoption among late adopters should focus not only on making technologies easier to learn but also on clearly communicating the benefits and necessity of adoption, especially in contexts where traditional alternatives are becoming less available or less convenient.

5.4.2 Interpersonal Constraints

The influence of other people in the engagement with and use of technology by late adopters is an important interpersonal constraint. This was identified twice in the thematic analysis, once in relation to the use of certain devices and/or applications and then again in relation to learning and practicing how to use digital technologies. In both cases, late adopters friends and relatives play an important role in which devices and/or smartphone applications they will use and how they will use them. For example, several participants highlighted their use of various different messaging platforms to be able to keep in touch with different friendship groups:

> "I contact my friends using WhatsApp because that's what they use" (Participant 1)
>
> "I use a bit of all of them [messaging platforms], it just depends on who it is I am trying to get in touch with really as to which app I use" (Participant 3)
>
> "I generally use the mobile nowadays to get in touch with people… because that's how my kids like to get in touch with us" (Participant 10)

Participant 13, whose son lives in Japan, spoke about their experience of getting to know how to use Line, a Japanese social media and messaging platform, likening it to more familiar platforms such as WhatsApp.

The interpersonal constraint identified in these examples is the messaging and communication platform of choice being dictated by the late adopters' friends and family. As expected with interpersonal constraints, the negotiation strategy is most commonly behavioural (Jun and Kyle, 2011; Stodolska et al., 2020). In these cases, the behavioural negotiation is the adoption of the messaging platform used by their friends to be able to remain in contact with them. This constraint was also identified as an influencing factor, though to a lesser extent, in communications between businesses and the late adopters. Participant 10 commented that they use their phone to do online banking and sorting bills with online chat facilities now because businesses "don't like to post things out to you now". The willingness and openness of late adopters to be influenced by businesses to negotiate this constraint through adopting new technologies is reduced in comparison to the influence of their friends and family:

> "If someone is telling me 'You've got to change' and I don't want to, then I won't be interested in learning or using it [new technology]" (Participant 6)

This process of adopting different messaging platforms through the influence of friends and relatives is unsurprising as Rogers' (2003) theory is based on the premise that innovation diffusion is a highly social process. The degree of flexibility, adaptability, and willingness to explore new technologies shown by these participants when influenced by their friends and family is notable. While traditional diffusion theory suggests late adopter groups tend to be more resistant (Rogers et al., 2003), recent empirical research has found that this 'resistance' may actually reflect unmet needs rather than inherent reluctance to adopt new technologies (Essen and Östlund, 2011; Matzler et al., 2014). The participants' engagement aligns with these newer findings suggesting late adopters can be quite receptive when technologies are designed appropriately for their needs and social contexts.

The influence of other people is also identified in relation to late adopters learning and practicing how to use new technologies. The constraint in these circumstances is knowing how to do, use or fix something, such as logging on to a certain system, setting up a new device, or completing tasks for online banking. While some participants have an interest in learning how to use something the reaction of their friends or family is an influential factor in how they negotiate the constraint. For example, Participant 18's grandson refused to show them how he fixed an issue with their iPad:

> "I say to him [grandson] well show me what you did, and he just goes 'well what's the point?' He said I wouldn't know what he was talking about anyway so there's no point, just call him" (Participant 18)

In this case, the participant would have liked to have been able to learn how to fix this issue themselves so they could do it next time it happened. However, the reaction of the grandson blocked this learning process meaning the participant remains reliant on him for support with the iPad. To negotiate this constraint, the participant engages in a combination of cognitive and behavioural strategies here. Firstly, they accept this situation and reluctantly agree that it would probably be too complicated for them to learn how to fix these issues (cognitive negotiation). Then, the behavioural negotiation is in place for next time they experience the issue because they will call their grandson to come fix it for them.

Some other participants also admitted to allowing younger people in their lives to do tasks for them instead of learning how to do it for themselves:

> "My son sets up new things for me, so I just leave it to him" (Participant 20)

> "If I can't do something technical, I'll grab a young person because they will know how" (Participant 10).

Family and gender roles also appear to have an influence in some people's negotiation of this constraint. For example, family dynamics for some of the participants mean that home administration tasks are allocated to their wives, so they do not have to concern themselves with learning how to do or use certain systems or applications:

> "I can see my bank account, but I don't do much with it because I leave that for my wife, that's more her department" (Participant 21)

> "I don't have email on mine [phone] because I just use my wife's, it's just easier to do it through her phone" (Participant 19)

Participant 17's experience illustrates how family dynamics and others' influence can shape late adopters' decisions to engage with or avoid new technologies. When asked about their non-use of technology, the participant recounted an incident from 30 years ago. Their husband had attempted to force them to learn computer skills for managing family business administration. Although the participant was interested in using a computer for personal entertainment, they resisted taking on business responsibilities. As a result, they rejected the computer entirely and refused to learn how to use it, effectively negotiating this constraint through avoidance. When asked about the long-term impact of this experience on their interest in and use of technology, the participant responded:

> "I mean if I accepted it back then I would have learnt various bits and how to use it. So, I mean, I could have then carried on, enjoying myself, if you like, with the with the use of them [computers], but I just didn't want the responsibility of taking on the farm work so, I called it to do altogether [refused to buy the computer]" (Participant 17)

The influence of other people on late adopters' engagement with digital technologies produces both positive and negative outcomes. In terms of learning and practising technology use, this study found the external influence of other people often negatively

impacts late adopters. Despite their initial interest in learning, late adopters are discouraged when others, intending to help, complete tasks for them instead of teaching them how to do it themselves. This demonstrates there can be right and wrong ways of trying to help or influence people. The examples in this study suggest that this constraint can reduce motivation to learn and, in extreme cases, even lead to a complete refusal to use technology, like computers, tablets, and smartphones. These findings partially align with the traditional representation of late adopters as hesitant, resistant, and uninterested in technology (Rogers, 1962; Guttentag and Smith, 2022). However, the academic literature often overlooks an important aspect: late adopters' initial interest in learning and using technology, which is subsequently constrained by the influence of other people.

Late adopters' engagement with technology is often negatively impacted when others influence their learning and practice. However, the influence of friends and family with the encouragement to use different devices or applications can yield more positive outcomes. The examples in this section reveal that late adopters can be surprisingly adaptable, flexible, and open to various technologies when encouraged and supported by their social circle. In some cases, the adoption of certain applications is seen as a necessity in order to be able to maintain contact with specific friendship groups. These traits are traditionally associated with early adopters rather than late adopters (Rogers, 2003; Lu et al., 2015; Jahanmir and Lages, 2016). Interestingly, this openness contrasts sharply with late adopters' reluctance to embrace new technologies when influenced by businesses. This suggests that late adopters are more receptive to change and technological experimentation when guided by people they know and trust.

5.4.3 Structural Constraints

There are 14 sub-themes categorised as structural constraints. These have been grouped into three categories, namely cost, time, and design. Individuals generally have less control or influence over structural constraints compared to constraints in the interpersonal and intrapersonal categories (Crawford et al., 1991; Jackson et al., 1993). Time and cost are common examples of structural constraints in the literature which are also identified in this study (Nyaypane and Andereck, 2008). For example, participants cited technology being expensive to purchase as a factor that would deter them from buying new devices or software. While alternative and cheaper options are available for

the user group, the negotiation of cost-related constraints are to continue using existing devices, seek alternative ways of completing an activity, or ask their friends and family to support.

The two other sub-themes related to the structural constraint of cost are 'value for money' and 'concern of obsoletion'. While the expensive cost of technology will deter some participants, if the benefits outweigh the cost this may influence their purchasing decisions and produce more favourable perceptions of technology. For example, Participant 5 suggests they would be less likely to purchase technology because the cost is often very high however, if the device will offer good value for money they may consider purchasing or adopting:

> "It's a lot of money so that would put me off, everything is expensive" (Participant 5 – Sub-theme: Expensive)

> "I would have to research it a lot [new technology] and make certain that it was something that would be right for myself. I mean, we did research the laptops for the kids, so I do buy new things, but its got to be right" (Participant 5 – Sub-theme: Value for money)

Literature suggests that structural constraints are commonly negotiated with behavioural strategies (Jackson and Rucks, 1995; Stodolska et al., 2020). As expected, the negotiation of the example constraint above by Participant 5 is behavioural. This type of negotiation strategy is implied by other participants who also go through a process of questioning themselves and the product to determine its value:

> "I guess it would depend on what the gain is, you know, what you're using it for as to how much I would want to spend on it" (Participant 15)

> "You know, do I really need it? How often will I use it?" (Participant 18)

> "I do that a lot [watch films] so I don't mind paying for it if I am going to use it" (Participant 19)

Through taking a step back, questioning the product, and engaging in research the participants feel more confident the product will be right for them and will offer them enough value for money to warrant the expense. Likewise, if they decide it will not be value for money the behavioural negotiation outcome could be not purchasing the technology: "I just wouldn't spend the money" (Participant 18). This pause between

being introduced to a technology and decision to purchase is characteristic of late adopters who are thought to be more sceptical than their early adopter counterparts (Rogers, 2003; Mikl-Horke, 2004). The delay in purchase time through checking that the product will offer value for money is also related to the third sub-theme, 'concern of obsoletion', as a structural constraint. Some participants delay their purchasing as they are concerned the technology will be replaced very quickly by something else:

> "A year later no one was using them [laser discs]" (Participant 12)

> "Is it going to be out of date in six months' time?" (Participant 19)

Time constraints are divided into two categories: 'actual' and 'perceived'. These constraints are the source of much frustration amongst late adopters. This is usually in relation to learning how to use a new technology or using technology to complete a task. For example, participants perceive the learning process to be long and complicated:

> "It's just if you've got the time to learn as well, isn't it? That's the thing" (Participant 12 – Sub-theme: Actual time constraints)

> "It takes too long [to learn] and everything is too long winded, and you don't know what you're doing. Then you might have to call someone or watch a video to find out how to do it" (Participant 19 – Sub-theme: Perceived time constraints)

Time constraints are generally spoken about in negative terms by the late adopter group referring to elongated learning processes as a "waste of time" (Participant 10) and "a load of rubbish" (Participant 11). This is also the case with computerised processes such as website help pages and automated telephone and online chat facilities. Not knowing where to find information or help and being too busy to spend time trying to work it out results in the late adopter seeking assistance in alternative ways:

> "I don't bother with it [online chat], you just think, 'oh I've not got time to mess around with that'. There's too much happening in my life. That's why I go back to just ringing them [the company]" (Participant 1)

'Design' is the final category of structural constraint identified, comprising 8 of the sub-themes belonging to 5 different overarching themes. The sub-themes in this category relate to the design of technologies including features and functions. Privacy is a structural constraint identified through the sub-theme relating to the intrusiveness of technology. Concerns around data privacy are influential in the product adoption

decisions of some late adopters. Being able to restrict access to data, set communication preferences, and fully understand what data is being shared is important to this user group. This level of understanding and concern around privacy and security of technology demonstrates that late adopters make more informed decisions about which technologies they adopt than the literature gives them credit (Dabphet et al., 2012; Zhang et al., 2020; Guttentag and Smith, 2022). For example, several participants suggest they understand the collection of their data as a transaction in which they are able to benefit in some way. However, clear boundaries are required for this user group who will withdraw their consent, delete applications, or cease using a device if they feel it is too intrusive:

> "I want to be able to limit how much data I give to this app... I understand there's no such thing as a free lunch and if we are getting a product for free its because we are the product, so I am aware of that, but I want to be able to set the boundaries. There was a shopping app I withdrew from because I felt it was too intrusive" (Participant 8)

> "Like Morrisons, they know everything. Everything I buy, and everything I don't buy. But that's fine because that's not going to change my life… but sometimes I think the more personal details I don't like sharing" (Participant 9)

These two examples highlight that privacy and data sharing as a structural constraint can have both positive and negative outcomes for late adopters. On one hand the participants are happy to share data with companies if they receive loyalty points, free gifts, and special offers in exchange. On the other hand, late adopters are highly sceptical of what data is being collected and how it is being used; when this is unclear, they will revert to more traditional processes or cease using certain applications and devices. In this respect, the structural constraint of privacy is a neutral factor with positive or negative outcomes depending on other variables such as the willingness of the individual to share data, transparency of the company collecting data, and ease of setting privacy preferences. Confidence and reliability of the system is another structural constraint which can have positive and negative outcomes for late adopters. While several participants highlight the benefits of using technology in their daily lives making some tasks and activities easier, they also have reservations about becoming over reliant on it. For example, additional security and failsafe features in mobile banking applications are

cited as being “very reassuring” (Participant 20). However, concerns are also raised about technology being unreliable and users not knowing what to do in these situations.

In relation to device and/or application design, factors such as screen size, the inconsistency of applications and devices, and redundant features are identified as constraints for this user group. For example, screen size matters for late adopters as confidence is increased when the screen is larger and more accessible. This is particularly important when using technology to do online banking and other activities where the cost of completing the task incorrectly could result in losses:

> “Sometimes it’s just easier to do things on the laptop because the screen is big” (Participant 5)

> “It’s more convenient as the controls are easier to operate [iPad] as well because phones are pretty tiny” (Participant 14)

Behavioural negotiation strategies are deployed here as all participants citing a preference for a larger screen had access to multiple device types such as smartphones, tablets/iPads, and laptops. As such they select the device of choice depending on the task or activity they are about to complete. However, if they did not have access to multiple devices, they may have to seek assistance from friends and/or family to support with the task or borrowing their device. Alternatively, they may seek more traditional ways to complete these activities. Similarly, the inconsistency of which tasks are able to be completed on different devices is identified as a constraint requiring access to multiple device types to be negotiated:

> “You can’t always do everything on your phone. Sometimes it will say you can do it on the app but sometimes it will say you need a computer” (Participant 5)

> “Some apps [applications] don’t let you use the [Apple] wallet for some reason” (Participant 14)

While late adopters describe their frustration at not being able to do all of the things they need to do on one device, they also highlight the redundant features often pre-installed on their devices. Several participants described how their devices contain “all singing, all dancing stuff” (Participant 9) that they would never need or use. Technology producers often pre-install popular applications and software onto devices however, for this user group much of this is rendered totally redundant:

> "I've got Facebook, Netflix and music, but I don't use any of these. They were just on the phone when I got it" (Participant 9)

Redundant device and preferences for simple digital solutions have also been highlighted in the literature (Jahanmir and Lages, 2016; Harvey et al., 2019). Additional features such as those highlighted by Participant 9 are problematic for late adopters as they take up storage space within the device and some users may be unaware of how to uninstall these pre-installed features. There are also several applications and features which have been made mandatory by technology companies meaning they are unable to be removed by the user even if they do not want or need that feature. While these are structural constraints imposed through the design choices of the technology companies there is also an element of cost. The cost factor implied here links to the sub-theme associated with technology being expensive as higher prices can be charged for technology with additional features, even if these are not desired or needed by this user group:

> "[iPad with 3G] It was wasted on us because we never used it outside of the house, so that's just completely wasted on us" (Participant 19)

Design-related structural constraints reveal key factors contributing to late adopters' hesitation towards new technologies. Contrary to previous assumptions, privacy concerns among these users indicate a higher level of technological awareness and interest than initially suggested (Vines et al., 2015; Neves et al., 2018). Users who prioritise privacy are cautious about adopting new technologies. When they perceive a technology as overly intrusive or when companies lack transparency about data collection practices, these users pause to reevaluate the benefits of adoption. This careful approach may lead to delayed or even non-adoption, not due to disinterest or lack of understanding, but rather because of their keen interest in how applications and devices respect their privacy and handle their personal data. These users seek a balance between technological advancement and maintaining control over their information, demonstrating a nuanced and informed perspective on the role of technology in their lives. This misunderstanding of late adopters as being disinterested and resistant has been cited as a reason why researchers and technology companies focus more of their time seeking feedback from early adopters as they are perceived to be easier to recruit (Rogers, 2003; Essen and Ostlund, 2011; Harvey et al., 2019).

The lack of engagement with late adopter users results in further structural constraints including the redundant device features constraint identified here. Many late adopters use smartphones, tablets, and laptops, but often desire streamlined versions of these devices with fewer unnecessary applications and features (Matzler et al., 2014). This preference aligns with the automotive industry's approach, where consumers can choose from various specification models when purchasing a new car. The cost of the model is associated with the amount of advanced technology included. A similar customisation option for digital devices could allow users to select the number of applications and features their smartphone or tablet includes at the point of purchase. This approach would cater to late adopters' desire for simplicity and control. In line with Harvey et al. (2019) calling for more user-centric inclusive design approaches, this is just one example of how better engagement with late adopters during the earlier stages of designing and developing new products could enhance user adoption.

5.5 Chapter Summary

This chapter presents a nuanced exploration of late adopters of technology, challenging long-held assumptions and stereotypes about this user group. Contrary to common perceptions that late adopters are primarily elderly or disabled individuals resistant to change, the research reveals a diverse demographic spanning various age categories (Essen and Ostlund, 2011; Neves et al., 2018). A complex and interconnecting network of factors have been identified as influential in the decisions, behaviours, and perceptions of late adopters in relation to their engagement and adoption of technology. None of the themes or constraints identified were specifically related to restricted access to technology, although this could be due to the participant sample including few complete non-adopters. More importantly, late adopter engagement with technology has been found to be influenced by various types of constraint. This mirrors the arguments of the OECD (2016) and Harvey et al. (2019) suggesting that while most people will soon be able to access technology, if they want to, engagement with and ability to use technologies will remain an issue for 80% of the population for at least the next 30 years. This is largely due to the disparity between tech-savvy and non-tech savvy users (Guo et al., 2017), a skills gap exacerbating the digital divide (OECD, 2016), and the aging population (ONS, 2022).

Unexpected levels of adaptability and openness to new technologies, especially when influenced by people within trusted social networks, have been demonstrated by people in this user group. The empirical evidence shows that rather than being disinterested or resistant to technology as traditionally portrayed (Rogers, 2003), these users are thoughtful and strategic in their adoption choices. Late adopters conduct research and actively evaluate the benefits of new technologies against their specific needs (Essen and Östlund, 2011; Matzler et al., 2014). This aligns with recent research challenging the stereotype of late adopters as technology-averse, showing instead that when technologies are appropriately designed for their needs and contexts, these users engage actively and purposefully with new innovations (Essen and Östlund, 2011; Kim et al., 2010). These findings suggest a need to move beyond traditional characterisations of this user group as simply resistant to change, and instead recognise them as selective technology users who make considered adoption decisions based on their particular requirements and circumstances.

Categorising constraints as intrapersonal, interpersonal, and structural provides a valuable framework for examining the multi-layered challenges late adopters face in relation to technology adoption (Jackson and Rucks, 1995; Chen et al., 2020; Halpern et al., 2021). At the intrapersonal level, individuals grapple with immediate psychological constraints such as fear, anxiety, and lack of motivation to engage with new technologies. Interpersonally, social circles play a crucial role, either encouraging or discouraging technology adoption and digital skill development. Structural constraints encompass broader factors like cost, time, and technology design that often fail to meet late adopters' specific needs. Godbey et al. (2010) suggest the model may be suitable for use outside of examining leisure-related behaviours. This is the first time the model has been used to explore behaviours and perceptions of technology in everyday life in terms of engagement with and adoption of technology by late adopters.

The concept of learned helplessness suggests that frequent encounters with constraints can reduce an individual's motivation to negotiate them (Lee et al., 2012; McKercher and Darcy, 2018). Research exploring learned helplessness in tourism contexts demonstrates the compounding effect of multiple constraints, such as low perceived ability, fear of making mistakes, and discouragement from others, could potentially lead to learned helplessness among late adopters (Fang et al., 2019; Wen et al., 2020; Ying et al., 2021) aligning with the findings presented earlier in this chapter. Within leisure and

tourism studies, some researchers have challenged the assumption that constraints are universally negative (Samdahl, 2005). Some constraints can have positive outcomes, prompting late adopters to engage more critically and thoughtfully with new technologies. This challenges the traditional view of constraints as purely limiting factors and suggests that certain constraints may actually foster a more considered and purposeful approach to technology adoption. This multi-faceted understanding of constraints offers valuable insights for designing more inclusive technologies and developing strategies to support late adopters in negotiating constraints to technology use. It emphasises the need for a holistic approach that addresses not only the technical aspects of design but also the psychological, social, and structural factors influencing technology adoption among this diverse user group.

Wang et al. (2016) propose that travel activities are influenced by an individual's daily routines, habits, and behaviours. Building on this concept, it can be inferred that the constraints and preferences observed in daily activities may also manifest in travel-related decisions and behaviours. The findings discussed in this chapter provide valuable insights into the general constraints to using and engaging with technology for the late adopter user group. With this foundation established, the next chapter shifts focus to explore how these constraints specifically apply to and potentially transform within the context of rail travel. This transition allows for an examination of whether the patterns observed in everyday life persist in the unique environment of the Great British railway, or if new, context-specific constraints emerge. By analysing these factors, this research aims to develop a more comprehensive understanding of the late technology adopter user experience in rail travel, informing future improvements in service design and accessibility.

CHAPTER 6: ANALYSING TRAVEL CONSTRAINTS OF LATE ADOPTERS OF TECHNOLOGY

6.1 Introduction

This chapter presents the multifaceted constraints of rail travel in Great Britain for late adopters of technology - a passenger group representing the latter half of society to engage with and adopt innovative technologies. By employing a novel constraints analysis framework that combines cognitive work analysis and constraints negotiation theory, this research offers a comprehensive exploration of the rail passenger environment from both industry and passenger perspectives.

The chapter begins by examining the rail industry's viewpoint, utilising data from focus groups with industry representatives to construct an understanding of the rail passenger environments and associated support. Constraints relating to travel for this passenger group are identified using the constraints analysis framework which applies cognitive work analysis and constraints negotiation theory in conjunction with one another. The combined approach allows for different aspects of the rail sociotechnical system, intersectional characteristics of late adopter passengers, and the conceptual understanding of the constraints to be analysed from multiple research perspectives. Furthermore, this research takes a multi-contextual approach to exploring travel constraints. Unlike previous studies that typically focused on single contexts (Mattila et al., 2003; Min et al., 2019), this research compares late adopters' technology use across different environments, particularly contrasting home-based technology engagement with that in rail travel settings. This comparative analysis reveals differences in behaviour and preferences, highlighting the contextual nature of technology adoption among late adopters.

Following exploration of potential constraints relating to rail travel from the industry perspective, the chapter shifts focus to the passenger viewpoint, drawing on thematic analysis of interviews with late adopters of technology. Insights from travel-along ethnographies, providing real-world observations of late adopters navigating rail environments is also incorporated into the thematic presentation of findings from the passenger perspective. Additionally, discourse analysis is employed to uncover deeper

insights and implications of the constraints identified. This reveals how late adopters construct narratives, arguments, and attach meaning to technology use in rail travel, often positioning it as unnecessary. By combining these diverse analytical approaches through the constraints analysis framework, this chapter provides an in-depth analysis of the constraints of rail travel for this passenger group.

6.2 Understanding Rail Travel Environments for Late Adopters of Technology

Thematic analysis of industry focus group data identified 15 core themes and a further 19 sub-themes associated with the four main topics of discussion: constraints of travel, improvements, supporting late adopters, and barriers to technology use. This section presents the key findings from analysis of the constraints of travel topic using the constraints analysis framework presented in Chapter 4 combining cognitive work analysis and constraints negotiation theory (see Table 6.1 for brief description of constraints relating to travel themes and sub-themes). The 'constraints of travel' focus group topic reveals key insights into the rail environment for late adopters, examining travel constraints and available support. These insights inform the analysis of data using the cognitive work analysis and constraints negotiation theory approaches. Support provision and improvement topics are addressed in Chapter 7.

Phases one, two, and four of cognitive work analysis are presented in order coupled with analysis from the perspective of constraints negotiation theory. Specifically, this section demonstrates how the combination of the two approaches to analysing constraints reveals a greater richness of the data than using the two of them in isolation.

Table 6.1 – Themes and Sub-Themes Associated with the Constraints of Travel Topic Identified Through Thematic Analysis of Focus Group Data

Topic	Theme	Sub-Theme	Description
Constraints of Travel	Accessibility of Information	Knowing how to access information	Passenger knowledge and experience with finding or accessing information
		Timeliness of information	Speed and efficiency information is passed through the system to the passenger
		Finding train-related information	Accessibility and availability of train-specific information for both passengers and staff
		Accuracy of information	The accuracy of information passed between staff and to passengers impacts the passenger journey
	Authorisation to Travel		Processes associated with booking tickets to travel by rail
	Wayfinding		Navigating the built environments
	Consistency Across the Network		Consistency across the rail network between operators and industry bodies impacts travel information and processes passengers encounter
	Availability of Assistance	Access to Staff	Staff presence in-person, over the telephone and/or online
		Staff Knowledge and Training	Having knowledgeable staff in the right place at the right time to support passengers

6.2.1 Analysis of the Rail Passenger Environment

The rail passenger environment includes both built and digital spaces used by passengers as part of their rail journey. These spaces are the ‘work domain’ analysed in the first phase of cognitive work analysis. Due to the complex structure of the rail network and intertwining activities across network providers, the work domain is not restricted to an individual train operator (Rasmussen et al., 1994). Rather, this study includes all passenger-facing aspects of the rail network in the analysis of rail passenger environments. The next section focuses on development of an abstraction hierarchy through phase one of the cognitive work analysis approach while also applying

constraints negotiation theory to explore the nature of travel constraints for the late adopter passenger group.

6.2.1.1 Developing a Visual Understanding of Travel Constraints in the Rail Passenger Environment

An abstraction hierarchy has been developed using insights developed through a thematic analysis of data from the industry focus groups and key industry documents including the Rail Technical Strategy (2021) (see Figure 6.1). To maintain focus on passenger aspects of the rail network, the Easy-to-Use priority of the Rail Technical Strategy is used to formulate three functional purposes of the railway as the top, and most abstract, level of abstraction in the abstraction hierarchy. This foundational layer articulates the fundamental purpose of passenger rail travel, defining both its reason for existence and its essential objectives. In this case, the Rail Technical Strategy (2021) recognises three core priorities for passenger rail service: accessibility, efficiency, and convenience.

The key constraints of rail travel in Great Britain identified through thematic analysis of focus group data (presented in Table 6.1) are used to develop five categories highlighting value and priority measures. Progress toward the functional purposes of the system is guided by these value and priority measures (Stanton et al., 2013). Below this layer are the purpose-related functions, which outline the core activities needed to fulfil the system's overall objectives. These include the provision of staff, ticketing structure, methods for obtaining authorisation to travel, delivery of accurate information, and passenger knowledge of service provision.

The final two layers in the abstraction hierarchy represent the object-related processes and physical objects. The capabilities of physical objects within the system, known as object-related processes, determine how effectively overall objectives can be met (Stanton, et al., 2013). A total of 10 objective-related processes are identified through analysis of the focus group data. These include activities such as journey planning, purchasing tickets, navigating the station, and preparing to alight. The physical objects at the bottom of the hierarchy are mechanisms and services that are available to support the passenger journey. It is at this lowest level of abstraction in the hierarchy that the passenger engages (or not) with the services and support mechanisms existing to aid

passenger journeys. Twenty-seven physical objects were identified from the focus group data.

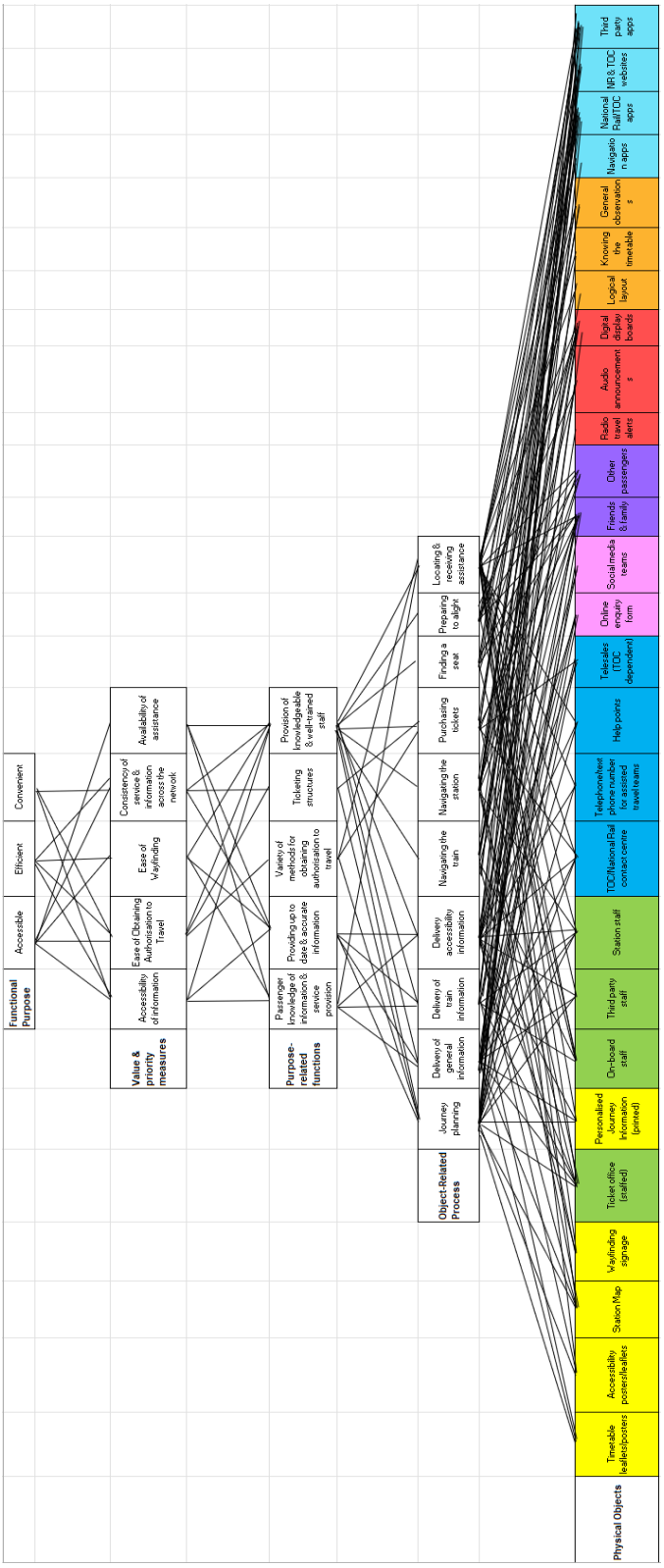


Figure 6.1 – Abstraction Hierarchy Analysis Focusing on the Passenger Journey Aspects of Rail in Great Britain

The example section of the abstraction hierarchy in Figure 6.2 demonstrates the segmentation of passenger-related elements of the rail network revealing links between the functions, purposes, and objects of the system via a means-ends why-what-how relationship matrix (Bisantz and Vicente, 1994). For example, taking the function 'providing up to date and accurate information' as the 'what' can be achieved, linkages to the constraints at the lower level of the hierarchy explain 'how' these are achieved. In this example, timely and accurate information is provided at journey planning and through the delivery of general, train specific, and accessibility information. Moving further down the layers, the physical objects at the bottom of the hierarchy then explain how this is imparted to passengers through a variety of resources including staff (in-person, over the phone, and digitally), printed information, and self-service mechanisms such as smartphone applications and websites.

Again, focusing on 'providing up to date and accurate information' as the 'what' can be achieved, the layer above explains 'why' this function is important and relevant to the work domain. In this example, the accessibility of information, consistency of service and information across the rail network, and availability of assistance are identified as the value and priority measures linked to this function. This matrix can be repeated at any stage upward or downward in the abstraction hierarchy to describe the relationships between the different aspects of the rail network (Vicente, 1999). Examining this example reveals how and why the provision of up-to-date and accurate information for passengers is important for maintaining the functional purpose of the rail network to be accessible, efficient, and convenient.

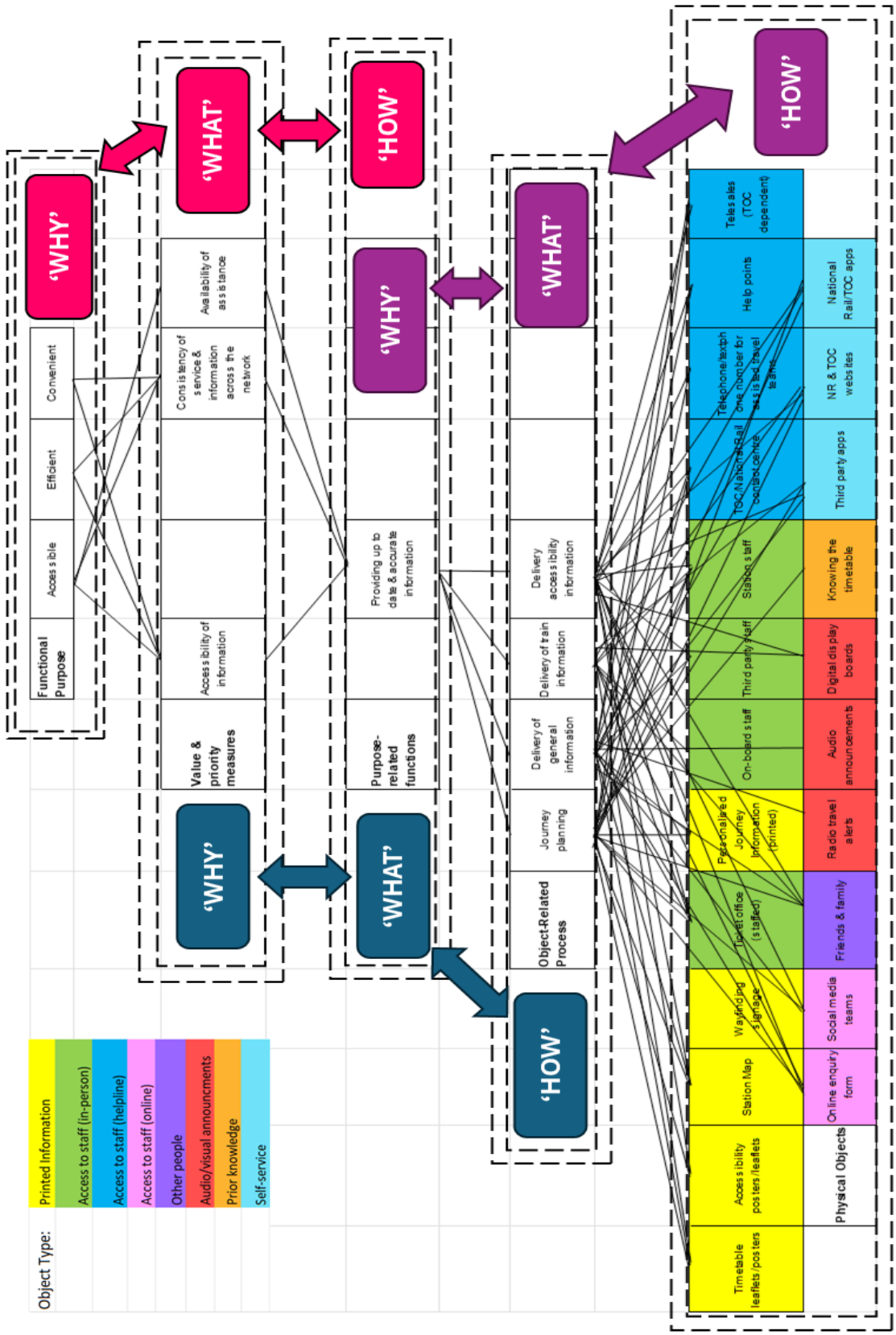


Figure 6.2 - Example Section of the Abstraction Hierarchy Demonstrating the Links Between the Provision of Up to Date and Accurate Information with the Other Hierarchical Layers of the Work Domain

This research focuses on the passenger-facing aspects of the rail network with a view to identifying and understanding constraints of travel for the late adopter user group. Wayfinding is identified in the focus group data as one of the core themes highlighted as a potential constraint for this passenger group by industry representatives. Applying this theme to the abstraction hierarchy analysis as a value and priority measure allows the constraint to be explored in more depth. Figure 6.3 demonstrates why wayfinding is important for achieving the functional purpose of accessible and efficient rail travel, and how this can be achieved in the work domain. The purpose-related functions layer explains how wayfinding is made possible: Through passenger knowledge of information and service provision, up-to-date and accurate information being provided, and provision of knowledgeable and well-trained staff. More detail about the services and mechanisms available to deliver this are demonstrated at the bottom of the hierarchy as physical objects. In this example, all of the physical objects identified through analysis of the pre-focus group task sheet are linked to the wayfinding value and priority measure through object-related processes and purpose-related functions. Examination of this example, focusing on wayfinding as a constraint, demonstrates the complexity of the rail network and how it supports passengers to use its services in an accessible and efficient manner.

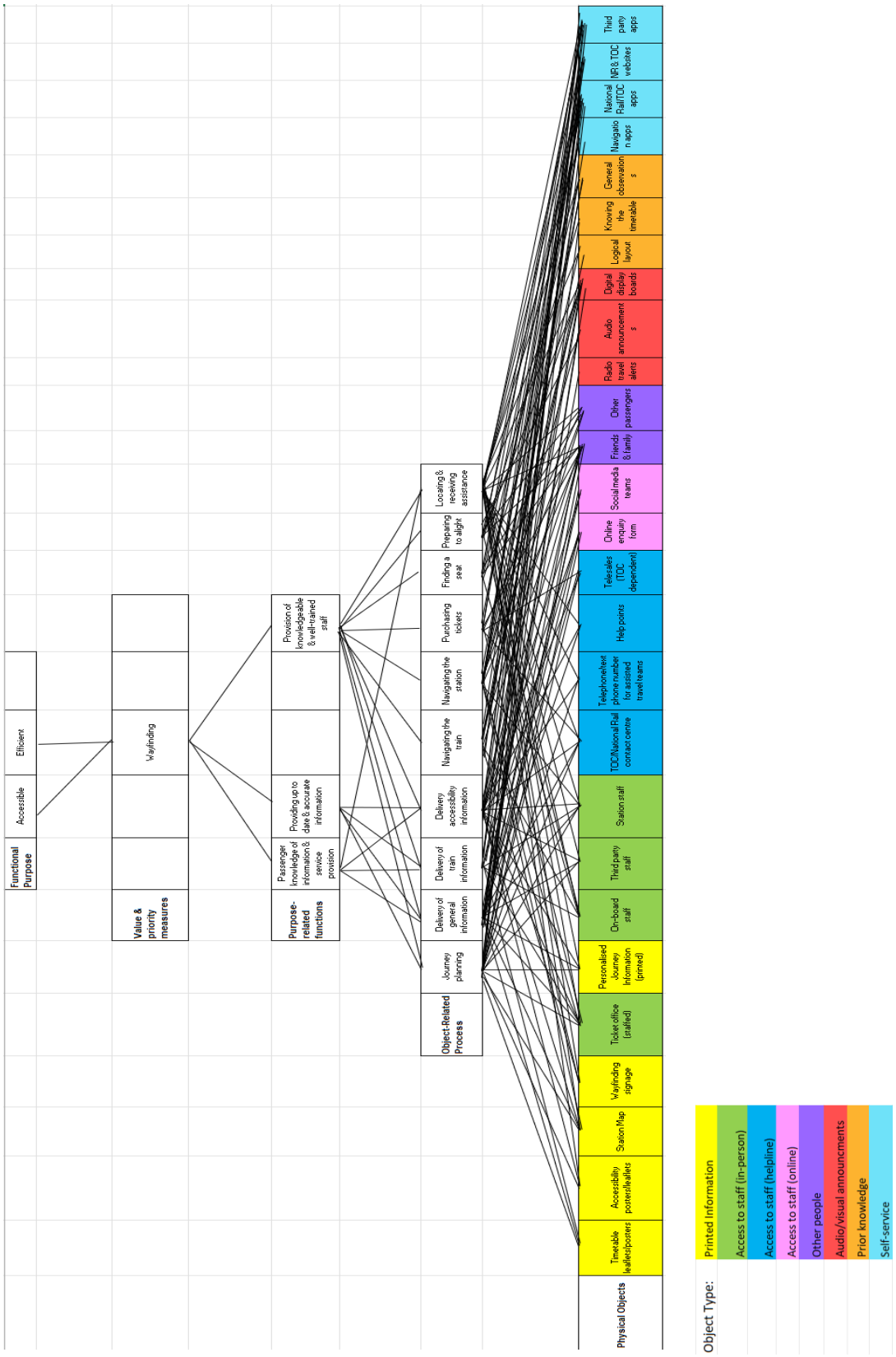


Figure 6.3 - Extract from the Abstraction Hierarchy Focusing on 'Wayfinding' as the Value and Priority Measure of Interest While Demonstrating the Links Between Each Layer

Figures 6.2 and 6.3 illustrate the diverse options available to passengers for obtaining and processing information, wayfinding, and seeking support during their travels. Industry representatives emphasised the importance of choice and multiple support delivery methods in creating inclusive passenger experiences. From the perspective of constraints negotiation theory, access to information could be viewed as an intrapersonal, interpersonal, or structural constraint, depending on the specific circumstances. For instance, the absence or inaccessibility of audio/visual announcements may create structural or interpersonal constraints. Similarly, reducing staff-based support could lead to intrapersonal constraints, as passengers might need to interpret alternative forms of information and assistance. This sentiment was echoed by several industry participants, as exemplified by the following quotes:

> "One of the main worries and areas of focus that I worry about is that we remove the wrong types of people and reduce the passenger experience and actually reduce their [staff] ability to respond to the needs of people who are trying to travel by rail" (Industry Participant 10)

> "I think there will always be someone who needs that [alternatives], so we just need to make sure we've kind of got options available for customers and just have a broad range of everything." (Industry Participant 7)

The abstraction hierarchy analysis reveals that over one-third of its physical objects relate to staff provision, encompassing in-person, telephone, and virtual support. Notably, in-person and telephone-based staffing constitute 80% of all staff-related physical objects. As industries, including rail (Transport for All, 2022), shift towards automated and digital services, the abstraction hierarchy becomes a valuable tool for understanding how system changes, such as staff reductions, affect relevant functions. Analysis indicates that wayfinding, as a value and priority measure, remains supported even if in-person and telephone staffing provision is removed (see Figure 6.4). This resilience stems from the necessary functions of 'up-to-date information' and 'passenger knowledge of services' being supported by non-staff related objects and object-related processes at the lower layers of the hierarchy. Despite this analysis of the rail passenger system demonstrating resilience in the hypothetical scenario of limited staff support, the subsequent discussion, employing constraints negotiation

theory, highlights how diverse passenger needs could be compromised while highlighting the value passengers place on staff support provision.

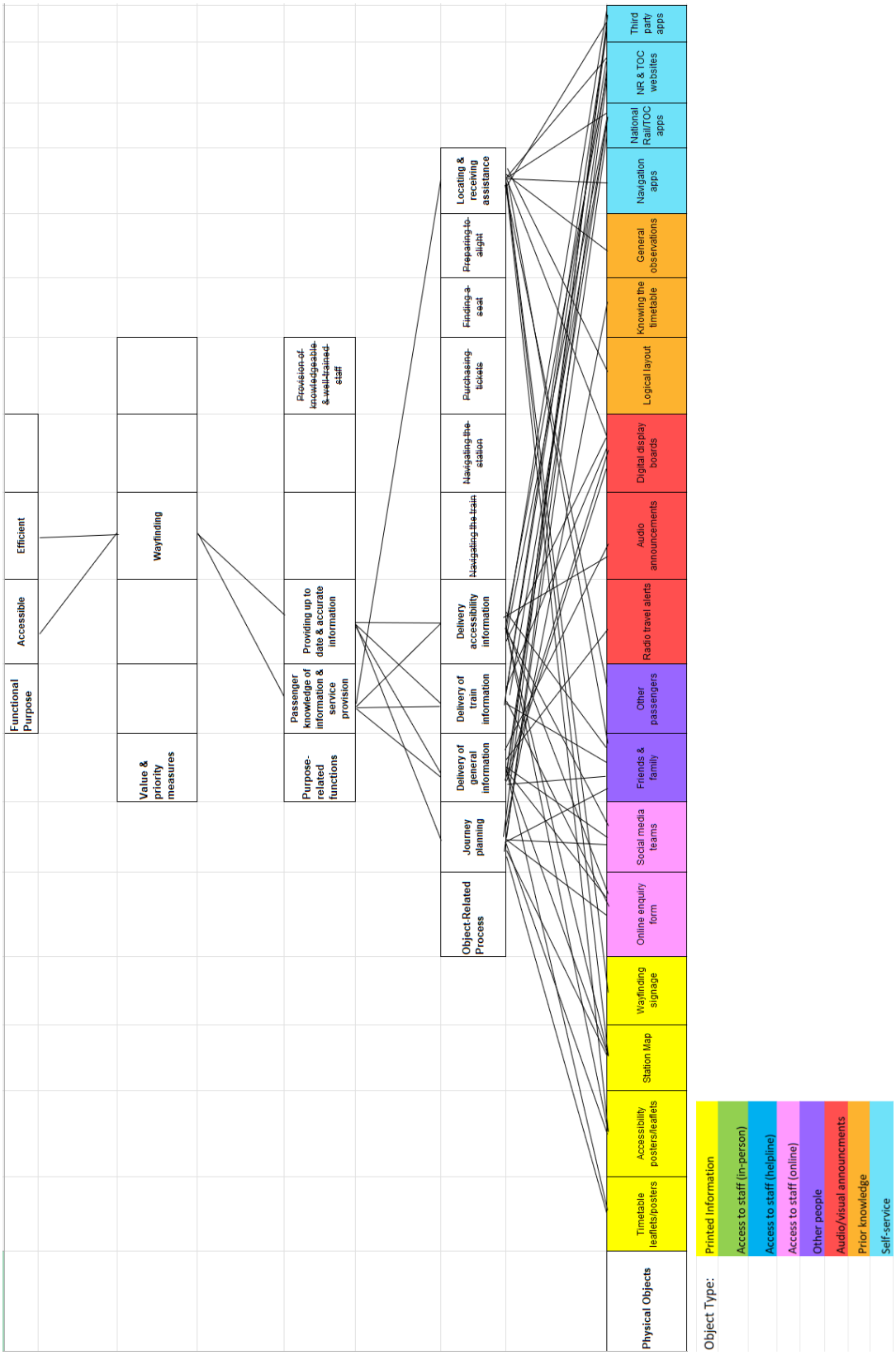


Figure 6.4 - Extract of the Abstraction Hierarchy Taking the 'Wayfinding' Value and Priority Measure as the Focus with Provision of Staff Removed at the Purpose-Related Function and Physical Object Layer

Applying constraints negotiation theory to the remaining content of the rail passenger system analysis, for the scenario where telephone and in-person staff support is absent (demonstrated in Figure 6.4), additional consequences are revealed. This change would likely lead to intrapersonal, interpersonal, and structural constraints, with potentially negative consequences for late adopter passengers, as well as others. These include individuals with additional needs, infrequent travellers, and those less comfortable with technology, who may struggle to use or lack confidence in using the remaining support mechanisms (see Table 6.2 for specific examples).

Table 6.2 - Examples of Constraints Identified Using a Constraints Negotiation Theory Approach to the Removal of In-Person and Telephone Staff Support Scenario

Object-Related Purpose	Physical Object Type	Physical Object	Constraint Type	Example
	Self-Service	Navigation Applications	Structural / Intrapersonal	Application requires recent software update only available on latest model of smartphone / Passenger has limited confidence with using navigation applications.
Journey Planning	Other People	Other Passengers	Interpersonal	Other passengers are also unfamiliar with the journey so cannot help.
	Prior Knowledge	Knowing the Timetable	Structural / Intrapersonal	The timetable is unavailable or written in an inaccessible format / The passenger is an infrequent traveller who has not learnt this information.

	Printed Information	Wayfinding Signage	Structural / Intrapersonal	Inadequate signage leads to confusion / Ability to read and interpret signage.
Delivery of General Information	Self-Service	National Rail/Train Operating Company websites	Intrapersonal	Passenger is unsure about using online resources to find out information due to a lack of trust in online systems / Passenger confidence using the website for finding general information is enhanced through clearly labelled security measures and page update information.
		Third Party Applications	Structural	App has been designed to work predominately with Apple smartphones resulting in inaccessible and difficult to use experience for passengers with other type of smartphone.
Delivery of Train Information	Other People	Friends and Family	Interpersonal	Friends and family assist the passenger with finding out basic train information but do not have time to offer further support closer to the date of travel.

	Online Staff	Online Enquiry Form	Intrapersonal / Structural	Passenger is wary of using online enquiry forms due to previous experience involving fraud online / Rail operator provides visual symbols to reassure customers the online communication channels are secure.
Delivery of Accessibility Information	Printed Information	Station Map	Structural / Intrapersonal	Printed signage is available with additional option to scan a QR code for better support / Passenger could benefit from additional support via QR code but has read about scams involving QR codes in public places so does not use this service.
	Audio and/or Visual Information	Digital Display Boards	Structural	Accessibility information is available via digital display boards around the station, but these are limited and spaced a long way from where the passenger is waiting for the train.
	Self-Service	National Rail/Train Operating Company Websites	Structural / Intrapersonal	Website is difficult to navigate, and assistance pages are not prominent / The passenger doesn't feel confident they are

				selecting the correct options.
Locating and Receiving Assistance	Other People	Friends and Family	Intrapersonal / Interpersonal	Passenger perceives themselves as a burden to their friends so is reluctant to ask for support / The passenger is dependent upon the availability of others to travel.
	Printed Information	Station Map	Structural / Intrapersonal	The map is easy to interpret and provides the passenger with the confidence to board the train / The passenger perceives they do not have enough time available to interpret the map and seek support.

Thematic analysis of the data revealed concerns about the implications of reduced staff support in favour of automation and digital services. Participants highlighted intrapersonal, interpersonal, and structural constraints when discussing the role of staff in supporting passenger journeys. For example, Industry Participant 3 notes:

> "Access to people is the most effective way of finding information, it's often asking the right informed person who's been trained appropriately with dealing with people with different needs... You know, making sure we stay a people focused business" (Industry Participant 3)

This comment highlights both structural and intrapersonal constraints that arise when knowledgeable staff are unavailable. It suggests the structural aspect of the constraint could be mitigated through appropriate staff training and availability. The statement

also indicates intrapersonal constraints, as passengers must identify the "right" person for assistance—a task that could prove challenging for those lacking confidence or knowledge about whom to approach. In 2023, train operating companies proposed closing rail ticket offices and relocating some staff to platforms and concourses (Rail Delivery Group, 2023). Analysis of the abstraction hierarchy, combined with the constraints negotiation theory approach, demonstrates how this plan could have further complicated the process of identifying appropriate assistance, particularly for vulnerable passenger groups and infrequent travellers. While train operators argue that staff would remain accessible on platforms and station concourses, ticket offices serve as easily identifiable, fixed locations for seeking support. Their removal could create additional challenges for passengers in need of assistance, potentially intensifying the negative consequences of both structural and intrapersonal constraints. However, following objections from transport charities, industry watchdogs, and a direct request from the UK Government, these proposals were withdrawn in October 2023 (Transport Focus, 2023).

In addition to constraints occurring in scenarios where staff are unavailable or not easy to identify, Industry Participant 7 highlights how interpersonal and structural constraints can occur during interactions with staff:

> "If any of our members of staff said you need to contact customer relations, they're probably going to say go online and look for contact details on there" (Industry Participant 7)

While it is possible for staff to assist passengers with providing passengers with contact details, this response illustrates how signposting to online services by rail staff can lead to constraints through the assumption of universal ability and access to online mechanisms. Such an approach could be particularly problematic for late technology adopters or those unable to access digital platforms.

6.2.1.2 Section Summary

This section has explored the rail passenger system through the lens of cognitive work analysis and constraints negotiation theory. The analysis focused on understanding the complexities of the rail network and identifying potential constraints for passengers, particularly late adopters of technology. The abstraction hierarchy, developed from industry focus groups and key documents including the Rail Technical Strategy

(2021), revealed the complex relationships between the rail network's functional purposes, value priorities, purpose-related functions, object-related processes, and physical objects. This demonstrated the multifaceted nature of passenger support systems and highlighted the importance of providing diverse options for information access, wayfinding, and assistance.

A key finding was the significant role of staff in the rail passenger environment. Over one-third of the physical objects in the abstraction hierarchy related to staff provision, with in-person and telephone-based staffing accounting for 80% of all staff-related objects. This highlights the importance of human interaction in supporting passengers, particularly those who may struggle with digital alternatives. The analysis also explored the potential impact of reducing staff support in favour of automated and digital services. By manipulating the abstraction hierarchy to remove staff-related elements, the research demonstrated how such changes could significantly reduce the available support mechanisms, potentially compromising the accommodation of diverse passenger needs.

To further explore the impact of these hypothetical system alterations insights from the thematic analysis using the constraints negotiation theory approach were applied. This revealed how the removal of staff support could lead to intrapersonal, interpersonal, and structural constraints for passengers. These constraints could have particularly negative consequences for late adopters of technology, individuals with additional needs, and infrequent travellers. For instance, in circumstances where online support provision is the only method available for undertaking a particular function late adopter passengers may be unable to access or feel confident enough to use the facility. Industry participant responses also highlighted concerns about the negative impact of some constraints through the reduction of staff support. They emphasised the value of knowledgeable, well-trained staff in providing effective information and assistance.

This first phase of the analysis employed an iterative process that combines cognitive work analysis with constraints negotiation theory. The process is illustrated within the dotted box in Figure 6.5, which shows the flow map for conducting a constraints analysis framework assessment of the rail passenger environment. It is important to note that throughout each of the phases of the constraints analysis framework shown

in Figure 6.5, the process of undertaking cognitive work analysis and constraint negotiation theory analysis of the data is undertaken concurrently. Thus, this is an iterative and cyclical process where the researcher moves between the two approaches identifying and analysing constraints until saturation point is reached – i.e. no further constraints are identified for analysis at this stage.

In this section, the first phase of cognitive work analysis generated a visual representation of the rail system's interconnected elements and their associated travel constraints. Further investigation of these constraints through negotiation theory revealed their impact and the nature of constraints for late technology adopters. These insights informed additional abstraction hierarchy testing, examining how passengers could be supported if staff support was absent. Furthermore, depending on the research agenda, the findings could inform the testing of other scenarios such as power outages or cyber-attacks, when self-service facilities are likely to be unavailable.

In this initial phase, constraints were examined solely within the context of the rail passenger system - more formally known as the work domain in cognitive work analysis. The subsequent phases will expand this investigation through analysis of activities in the rail passenger environment. These phases will further explore rail travel constraints by examining activities, locations and support mechanisms available throughout the passenger journey.

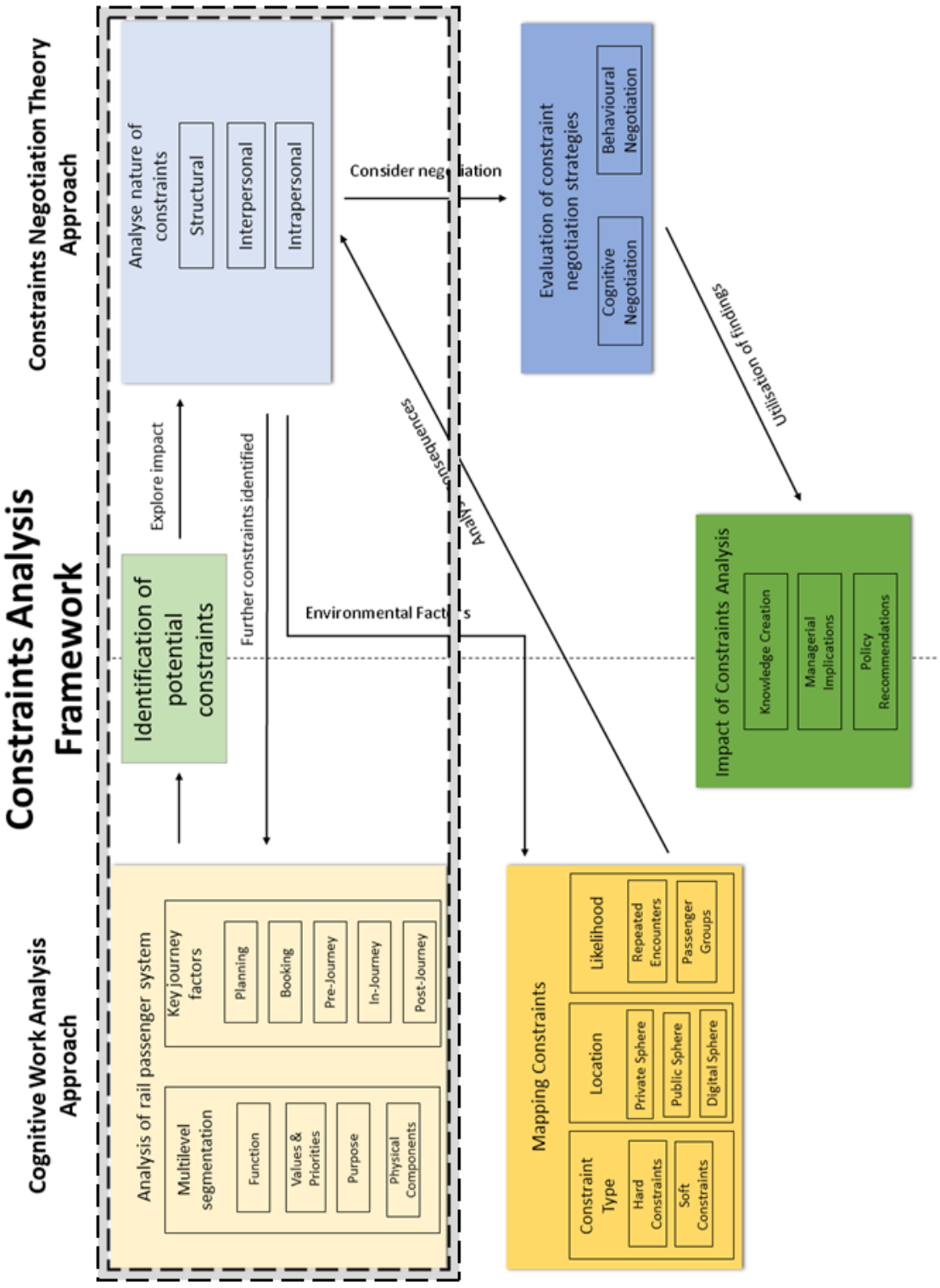


Figure 6.5 - The Constraints Analysis Framework for Combining the Approaches of Cognitive Work Analysis and Constraints Negotiation Theory with Dotted Box Outlining the First Phase Analysing the Rail Passenger System

6.2.2 Activity Analysis of the Rail Passenger Environment

This section uses phases two (control task analysis) and four (social, organisation, and cooperation analysis) of cognitive work analysis in conjunction with the constraints negotiation theory approach to explore which activities can take place at certain locations and phases of a rail journey (Naikar et al., 2006). Firstly, control task analysis is used to examine the object-related processes such as journey planning, purchasing tickets, and finding a seat. These are explored as activities in a series of built environments such as the home, station, and train. In this sense, the activities are mapped in line with the different environments they might occur. This part does not consider who can undertake an activity, nor does it consider which objects are used to support activities. This is explored later during the fourth phase of cognitive work analysis which is discussed under the heading 'user constraint mapping' in this thesis.

6.2.2.1 Mapping Constraints

This analysis uses the contextual activity template developed by Naikar et al. (2006) to visually represent the relationship between activities and locations in the rail passenger environment. To better reflect the context of this research, 'work functions' are renamed 'activities' and 'work situations' are termed 'locations'. The activities, derived from the object-related processes layer of the abstraction hierarchy analysis, form the rows of the template. These include tasks such as journey planning, information delivery, ticket purchasing, and station navigation. The columns represent various locations where these activities might occur, ranging from home to the train station itself. Figure 6.6 illustrates the developed contextual activity template. Within this diagram, solid ball and whisker icons indicate locations where an activity both can and frequently does occur. Dashed outlines denote spaces where an activity could potentially take place but does so infrequently. Blank spaces signify locations where particular activities are currently not possible. This visual representation allows for a comprehensive understanding of how and where passengers interact with the rail system, highlighting both common and potential activity-location combinations. It serves as a valuable tool for identifying areas where passenger support might be enhanced or where new opportunities for service delivery could be explored.

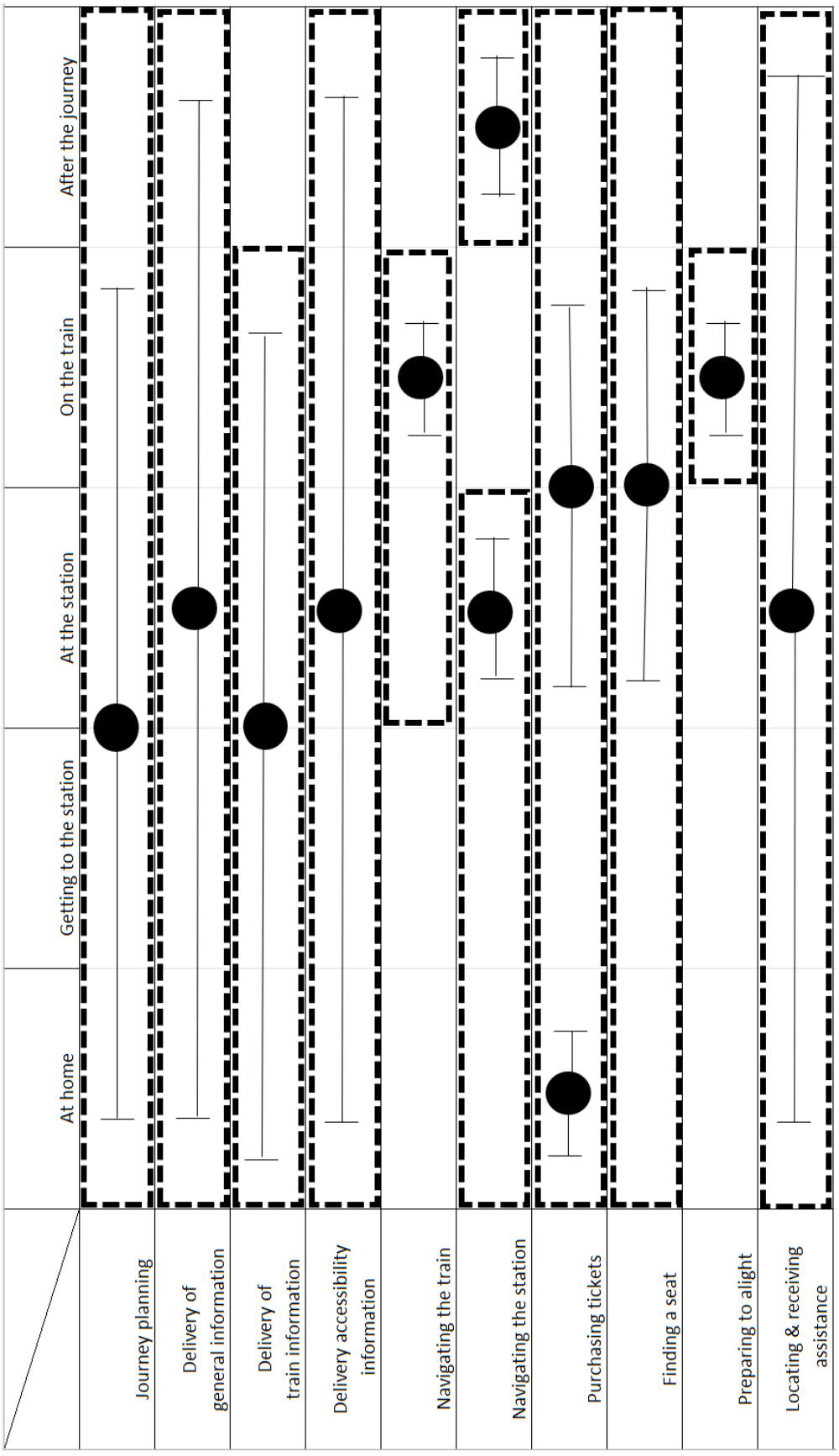


Figure 6.6 - Example of Complete Contextual Activity Template

Stanton et al. (2013) introduces the concept of soft constraints to describe areas where activities are possible but not commonly performed. These constraints are considered relatively simple and low-cost to negotiate, as the infrastructure for the activity exists but is not typically utilised, supported, or promoted for passenger use. This analysis can be expanded using the constraints negotiation theory approach to better understand the nature of soft constraints identified in the contextual activity template. Figure 6.6 illustrates two examples of how the combined approach can reveal further insights into the implications of these constraints. The activity 'navigating the train' in the 'at home' and 'getting to the station' environments may seem unnecessary for many passengers. This could also suggest changes to expand existing services or encourage passengers to use them for completing the activity in the home environment would be an unviable investment for the industry. However, applying the constraints negotiation theory approach reveals potential intrapersonal and structural constraints for certain groups. Infrequent travellers, unfamiliar with train layouts or reservation policies, might experience anxiety about seating arrangements. Here, the constraint could have negative consequences for some passenger groups leading to heightened concern or worry prior to travel. Providing enhanced information about seat location and reservation options during the at-home booking process could alleviate these concerns. This example demonstrates how addressing soft constraints can enhance the passenger experience, particularly for those with diverse needs.

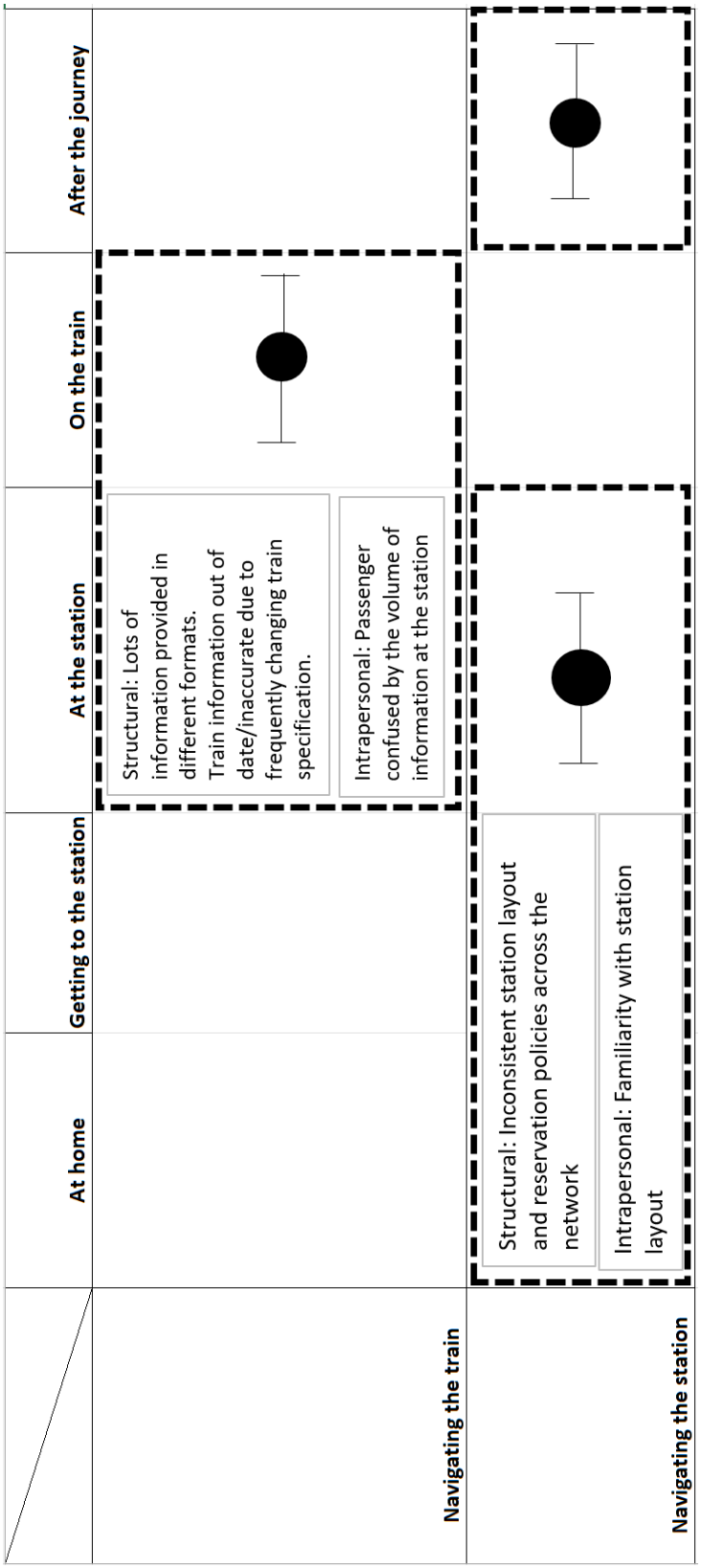


Figure 6.7 – Example of the Contextual Activity Template with Constraints Negotiation Theory Applied to Explore the Implications of Soft Constraints for the Activities Relating to Navigating the Station and Train

The previous example showed how modifying the system to better utilise home-based services for station navigation could reduce the negative effects of both intrapersonal and structural constraints, thus improving the passenger experience. However, when examining how passengers navigate trains in the station environment (see Figure 6.7), a different approach emerges. Here, the industry might consider reducing available information to minimise the negative impact of soft constraints. By applying constraints negotiation theory, it becomes apparent how an abundance of information can actually hinder passengers. In this case, limiting train-related information in stations—effectively creating a different kind of soft constraint—could prevent the confusion and overwhelm that passengers experience when faced with excessive information.

In addition to soft constraints, the contextual activity template also reveals hard constraints, represented by blank spaces without dotted lines. Stanton et al. (2013) defines these as more challenging to address, as they indicate activities that are currently not possible in certain locations. A prime example is the delivery of train-specific information in the post-journey phase. At this stage, obtaining such information for a journey that has already been undertaken is neither possible nor necessary, illustrating a hard constraint in the passenger journey. This distinction between soft and hard constraints provides valuable insights into the structure of the rail passenger environment. It helps identify areas where alterations might be feasible (soft constraints) and where fundamental limitations exist (hard constraints). This understanding can guide efforts to enhance the passenger experience within the bounds of what is practically achievable. Moreover, the application of constraints negotiation theory can reveal additional consequences of these constraints by identifying intrapersonal, interpersonal, and structural constraints that might not have been apparent through the contextual activity template analysis alone.

6.2.2.2 Constraint Mapping by User Group

The contextual activity template in Figure 6.6 illustrates journey areas constrained by hard and soft factors, but it doesn't specify who these constraints affect or what resources support various activities. To address this, the fourth stage of the cognitive work analysis framework—social, organisation, and cooperation analysis—applies

coloured shading to the template. This step is typically used to identify which actors can perform certain activities and who might be impacted by the constraints.

Figure 6.8 presents the contextual activity template with a variation of this analysis applied. Rather than attempting to predict user specific activities—which would oversimplify the diverse needs of late adopters—the coloured shading indicates where support mechanisms are available at each journey stage. This visualisation helps identify potential constraint points that could affect members of this user group. The diagram suggests that all aspects of the passenger journey not subject to activity-bound constraints (represented by blank spaces) are supported by self-service mechanisms, such as smartphone applications, train operator websites, and ticket machines. Notably, the analysis shows that no other support mechanism category universally supports every passenger activity in this way. While technological advancements benefit many passengers, these solutions may not be accessible or desirable for late adopters. Industry focus group participants expressed concerns that investments in technology, when coupled with reduced staff numbers and capabilities, could disadvantage late adopters and other passenger groups. For instance, Industry Participant 2 highlighted the interpersonal and structural constraints that passengers might face when technology fails to understand their individual needs:

> "You can design an app all you want, but it's never going to understand the differences between two people who are both autistic, but their autism impacts them differently, whereas a person can differentiate between the two." (Industry Participant 2)

The social, organisation, and cooperation analysis shows where and how various support mechanisms can assist passengers during their rail journey. However, it does not account for how individual users within the passenger group might be affected by other constraints that enable or restrict their access to these mechanisms. Constraints negotiation theory offers a deeper exploration of this. It explicitly considers differences between individuals and groups that might induce intrapersonal, interpersonal, or structural constraints influencing behaviour (Godbey et al., 2010; McKercher and Darcy, 2018). Applying this theory to the analysis reveals deeper insights into both the interconnections between constraints and their nature, as identified through the control task analysis and social, organisation, and cooperation

analysis. It also helps explore potential weaknesses in the support mechanisms. For instance, Figure 6.8 indicates that printed information to support passengers is widely available throughout the journey. This can help passengers negotiate constraints in journey planning and receiving assistance while at home. However, this assumes that passengers have either printed this information themselves or collected it from the station beforehand. This scenario could present additional challenges for late adopter passengers, which are not explicitly considered in the initial analysis. For instance, there could be structural constraints relating to obtaining printed information, such as lack of time to collect information leaflets from the station and/or not owning a printer to produce the information at home.

Another example highlighted by Industry Participant 3 indicates that the rail industry in Great Britain assumes all passengers will know where and how to access information about their journey. However, intrapersonal constraints such as confidence and prior knowledge, could be present for passengers with little experience using rail services:

> "There is an assumption that people will know that information exists but I'm not sure that everyone does… they [passengers] just assume that information doesn't exist because in the past you wouldn't have access" (Industry Participant 3)

Similarly, someone that experiences difficulties with communication could be constrained with accessing staff support because of interpersonal factors. For example, Industry Participant 2 suggests that technology is improving interactions between rail staff and passengers with disabilities, however, these technologies might not be accessible or desirable for late adopters of technology:

> "For people with disabilities, technology is improving the way they interact [with staff]. Whether its people with hearing impairments being able to have live translation through an app, or navigation for people with visual impairments… we could take these [technologies] on, but then leave other people behind" (Industry Participant 2)

Figure 6.9 illustrates the application of constraints negotiation theory to the contextual activity template, incorporating social, organisational, and cooperation analysis. Through applying this theoretical lens to the analysis, it is possible to observe how

constraints compound and influence one another. This figure builds upon the ticket purchasing activity segment presented in Figure 6.8. Examples are colour coded based on support mechanism types and categorised as intrapersonal, interpersonal or structural constraints. This approach helps identify and understand the consequences of constraints for late adopters accessing or using available support mechanisms at various stages of their journey. For example, while the analysis in Figure 6.7 assumes continuous availability of support from other people throughout the passenger journey, Figure 6.9 offers a more comprehensive perspective. It highlights intrapersonal and interpersonal constraints associated with this assumption. For instance, it considers scenarios such as the unavailability of friends and family to assist with ticket purchasing at home, or passengers feeling hesitant to approach strangers for help at the station due to perceiving themselves as a burden. See Figure 6.9 for further examples illustrating how the application of constraints negotiation theory can reveal the more subtle constraints of rail travel that certain passenger groups may negotiate, even when support mechanisms appear to be widely available.

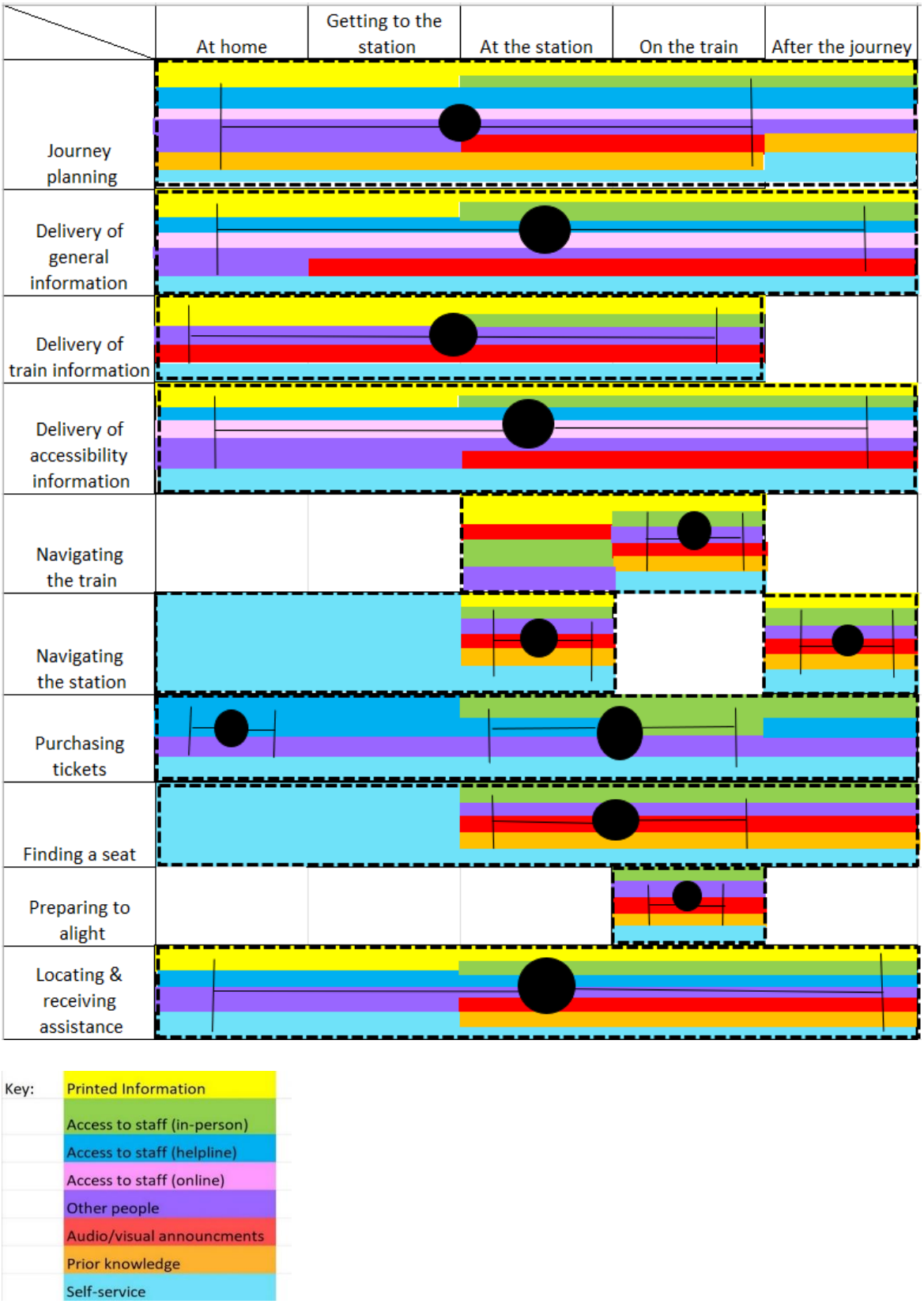


Figure 6.8 - Social, Organisation, and Cooperation Analysis Applied to the Contextual Activity Template with Colours Indicating Availability of the Different Support Mechanisms at Each Stage of the Journey

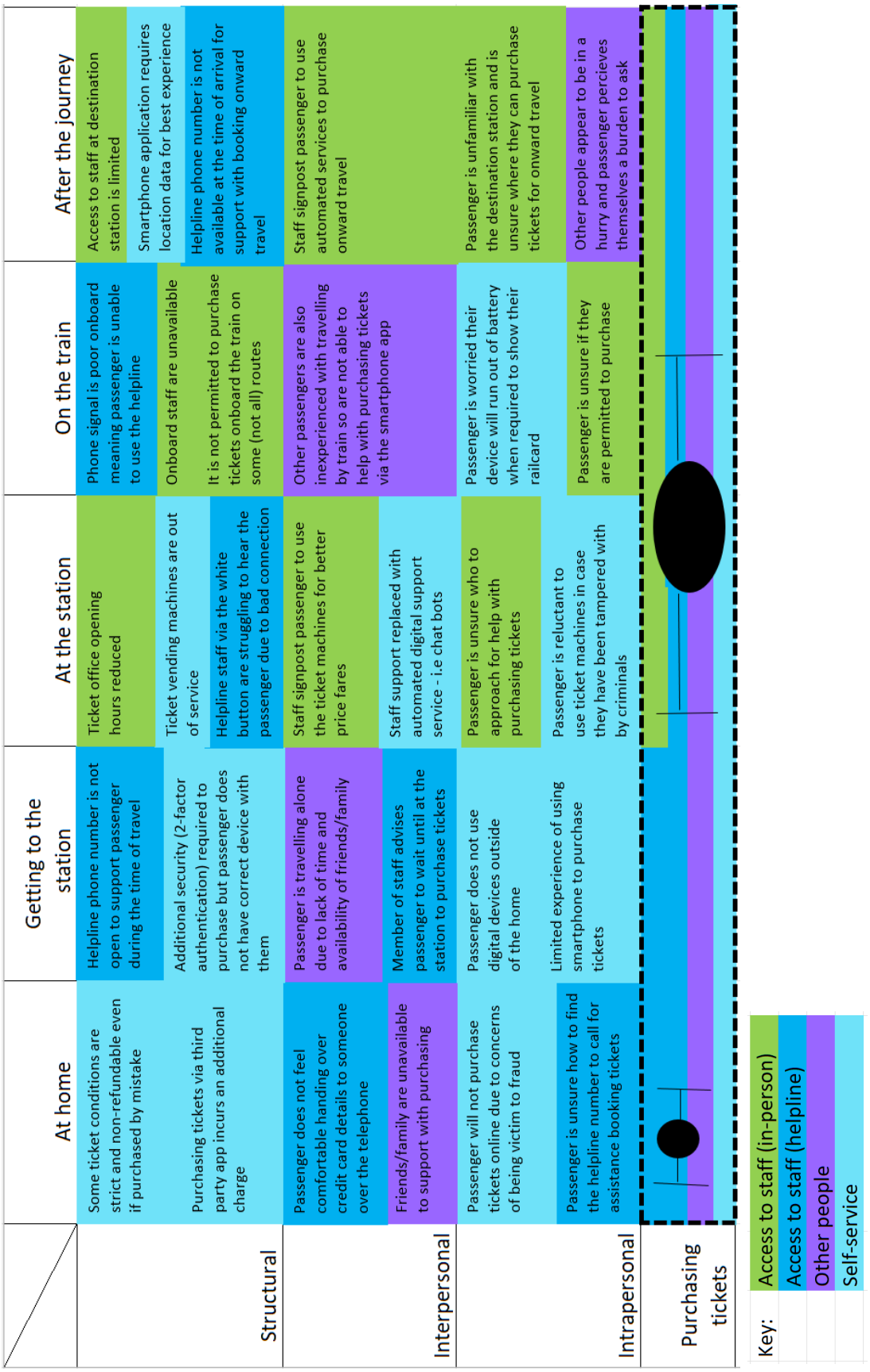


Figure 6.9 – Example Segment of the Social, Organisation, and Cooperation Analysis with Constraints Negotiation Theory Analysis Applied

6.2.2.3 Section Summary

This analysis provides valuable insights for improving rail services, emphasising the need to consider diverse passenger needs and potential negative consequences of constraints when implementing changes to support systems. This is particularly important for passengers belonging to groups that are often considered homogenous, namely late adopters (Essen and Ostlund, 2011; Harvey et al., 2019). This section has presented the findings from the second phase of the constraints analysis framework (Figure 6.10). Through combining phases two and four of cognitive work analysis with the constraints negotiation theory approach the research highlights the complex nature of the rail passenger environment and the importance of support provision in both digitalised and human-centred formats to ensure inclusive rail travel. This iterative process going back and forth between two approaches is shown within the dotted ring in Figure 6.10.

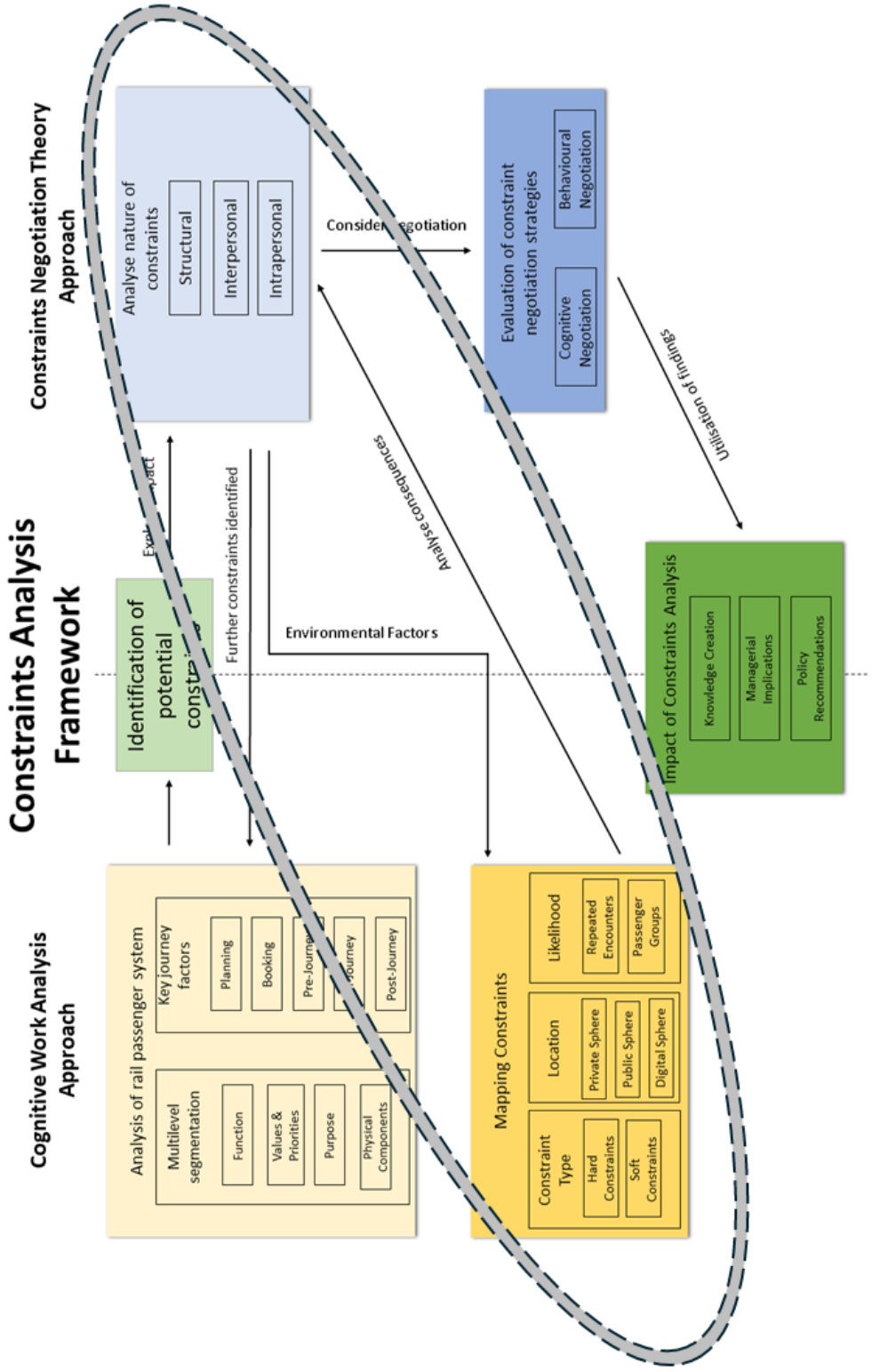


Figure 6.10 - The Constraints Analysis Framework for Combining the Approaches of Cognitive Work Analysis and Constraints Negotiation Theory with Dotted Ring Outlining the Second Phase Analysing Activities in the Rail Passenger Environment

While the contextual activity template from cognitive work analysis effectively maps both hard and soft constraints across different locations and activities, the addition of constraints negotiation theory reveals deeper implications of these constraints through identifying intrapersonal, interpersonal, and structural factors that might otherwise remain hidden. This dual approach demonstrates how soft constraints can be addressed in contrasting ways: either by expanding services, such as enhancing home-based navigation options, or by intentionally limiting information, as seen in reducing train-related information in stations to prevent being passenger overwhelmed. This reveals how constraints themselves are neutral elements within the system, with their impact varying based on context and implementation, highlighting the importance of careful consideration in how these constraints are managed.

Furthermore, the combined methodology provides a comprehensive view of how support mechanisms affect different passenger groups. While cognitive work analysis shows where various support mechanisms are available, constraints negotiation theory reveals additional, often inter-related, factors that might influence passenger behaviour (Kennelly et al., 2013; McKercher and Darcy, 2018; Karl et al., 2022). Consider how seemingly straightforward support mechanisms can involve multiple interconnected constraints. For instance, whilst printed information is widely available to assist with journey planning at home, accessing these materials is associated with various constraints. These include structural considerations such as printer access or the ability to visit a station to collect information beforehand. These aspects connect to both intrapersonal constraints, such as awareness of alternative journey planning options, and interpersonal constraints, like staff availability to help create and print personalised travel plans. This example illustrates how a single support mechanism can encompass multiple, interrelated factors.

As the industry continues to evolve, these findings can guide efforts to enhance the passenger experience while accommodating the needs of all user groups, including late adopters of technology. It is important to note that as these findings have been developed through discussion with industry representatives, they are hypothetical. The following section of this chapter explores constraints of rail travel from the perspective of late adopters analysing data from passenger participant interviews and travel-along ethnographic journeys. It is through analysis of this data that the third phase of the

constraints analysis framework, the evaluation of constraint negotiation strategies, is undertaken.

6.3 Understanding Rail Travel Constraints for Late Adopters of Technology

The perspective is shifted in this section to focus on identifying and understanding the constraints of travel as perceived and experienced by late technology adopter passengers. Analysis of the semi-structured passenger participant interview and travel along ethnography data is discussed thematically. Four core themes were identified during the thematic analysis of late adopter interview data: Technology use in rail travel, passenger behaviours and general perceptions of travel, passenger support, and perceptions of rail travel. Table 6.3 details the codes associated with each theme including a description (see Appendix 4 for description of travel-along journey data themes identified).

Table 6.3 – Themes and Codes Identified from Passenger Interview Data

Theme	Code	Constraint Categories	Description
Technology Use in Rail Travel	Technology failure	Intrapersonal	Concerns around the 'what if' technology fails during the journey.
	Trusting technology	Intrapersonal	Trust issues with the information provided via technology, online transactions, and incurring losses.
	Technology as an after thought	Intrapersonal	Using technology to support the journey in any way is not the first thought. Participants are more likely to use traditional methods to seek support or undertake a journey.
	Use of smartphone applications	Intrapersonal	Frequency of train travel is not enough to warrant downloading specific applications.
	Technology for journey preparation	Intrapersonal Structural	Using technology is predominantly for the preparation of using rail services.
	Forced transition	Structural	Will only change habits and ways of doing things if forced to do so.

Passenger Behaviours and General Perceptions of Travel	Just in case a) Money b) Printed documents	Intrapersonal Intrapersonal	Being prepared: a) Having extra money with them b) Printing out documentation in case of technological breakdown
	Self-help first	Intrapersonal Structural	Expectation to help yourself using technology before seeking help from a member of staff or anyone else.
	Online only	Intrapersonal Structural	Assumptions that all rail-related tasks and activities can only be completed online.
	Show and tell (Training)	Intrapersonal Interpersonal	Preferences for being shown how to use technology and/or rail-related activities by someone in-person.
	Generational assumptions	Intrapersonal Interpersonal	Assumptions that older people are not able to use technology to support journeys – younger people can do that.
	How it's always been done	Intrapersonal	Doing things a certain way because that is how they have always done it in the past.
	Travel worries	Intrapersonal	Behaviours influenced by travel concerns and anxieties.
Passenger Support	Reliance on others	Interpersonal	Passenger usually relies on other people to organise, manage, and lead travel plans.
	Strength in numbers	Interpersonal	Feeling more confident when travelling with friends and family.
	Unaware of support	Intrapersonal Structural	Passengers do not know about the support mechanisms they could access to help them.
	Preference for staff support	Intrapersonal Interpersonal	Passenger prefers to speak to a member of staff when experiencing problems during the journey.
	Seeking reassurance	Intrapersonal	The passenger may be informed by technology (e.g. applications/website info) but

		Interpersonal	will also seek reassurance from staff or others.
Perceptions of Rail Travel	Passenger expectations	Intrapersonal Structural	Passengers expect certain services or support when using the railway in Great Britain.
	Knowledge of rights	Intrapersonal Structural	Varying levels of passenger knowledge of their rights when using rail services.
	Complexity of rail travel	Intrapersonal Structural	Rail travel is perceived or experienced to be complicated at any stage in the journey (e.g. booking, platform changes, train delays)
	Flexibility of travel	Structural	Altering behaviour to allow greater flexibility with travel plans or travel plans and demands influencing amount of flexibility required.
	Remaining alert	Intrapersonal Structural	The need to be alert throughout the journey – inability to fully relax (e.g. to avoid missing destination station, being alert to last minute changes).
	Frequency of travel	Intrapersonal Structural	The passenger doesn't travel enough using the train so perceives the journey to be challenging. If they travelled more they expect it would become easier.

6.3.1 Technology Use in Rail Travel

As explored in Chapter 5, late adopters of technology comprise a diverse group who approach new technologies with greater caution and scepticism compared to early adopter groups. However, this hesitancy does not necessarily translate to a complete avoidance of digital technology during rail travel. In fact, the majority of interview participants reported using some form of technology to support their rail journeys, whether before, during, or after travel. Online search engines emerged as particularly valuable tools for this user group when seeking information and support. Google, in particular, was frequently cited by participants as their primary platform for finding

information. As Participant 5 noted, "I'd Google anything really and just go from there in the hope that a website would come up where I could book it [train ticket]". In reference to checking for delays, cancellations, and possible strike action several participants suggested they would undertake an online search for information:

> "I would do a last-minute check on Google just to be careful, to be sure" (Participant 13)

> "Well, I could use my phone to like look on Google or whatever to check there was no strikes or delays" (Participant 20)

Use of familiar digital tools suggests that while late adopters may be cautious about adopting new technologies, they do incorporate established digital resources used for everyday tasks into their travel behaviour when they find them useful and accessible (Wang et al., 2016). This is supportive of Xiang et al. (2015) and Lamsfus et al. (2015) arguments that internet search engines and everyday habits influence the way travellers find information, plan journeys, and book tickets.

The home environment emerged as the primary setting for this type of technology use among late adopters, particularly during pre-journey preparation. When discussing different journey phases, participants consistently identified their homes as the place where they felt most comfortable using digital tools. Many reported using smartphones, tablets, and laptops at home to find information, seek support, and purchase tickets. However, a notable shift in behaviour was observed when participants were asked about using these devices in other rail travel environments, such as stations or on trains. In these settings, participants expressed a reluctance to use their digital devices:

> "No, I wouldn't be using my phone [at the station] because it's too old and faulty to help in that way I suppose" (Participant 6)

> "I don't really use my phone for sort of internet purposes and that. I don't think, well it probably has got Google on it, but I have never tried to be honest. I've never used my phone for that sort of purpose. I have never found it necessary" (Participant 7)

Supporting Durand et al. (2023a) argument that digitisation of transport services can both advantage and disadvantage users, these findings suggests that the familiar and

secure home environment plays a crucial role in late adopters' willingness to engage with technology for travel-related tasks. Intrapersonal, interpersonal, and structural constraints are influential in the decisions by late adopters to restrict their device usage to the home environment. For example, time and cost factors involved with upgrading a personal device (structural constraint) coupled with the familiarity of the older device (intrapersonal constraint) can deter users from buying a new smartphone with a better battery life and enhanced functionality for on-the-go use. Intrapersonal and interpersonal constraints are noted by Participant 13 in relation to being cautious about using their smartphone in public, reflecting broader concerns about smartphone theft which has seen a dramatic rise of over 150% in the UK according to the Home Office (2024):

> "If it was crowded, I wouldn't want to get my phone out anyway, just in case you know, somebody might take it out of your hand and that would be your phone gone" (Participant 13)

This contrasts the arguments of Wang et al. (2014) and Mouratidis et al. (2021) that smart devices influence traveller behaviour in built environments creating greater travel flexibility and reduced journey planning requirements at home. However, observations during actual journeys with late adopters revealed a discrepancy between stated preferences and real-world behaviour regarding the use of personal smart devices outside the home. Contrary to their initial claims, several participants were observed using their smartphones while travelling to search for information and book return journey tickets. Furthermore, some of those expressing reluctance to use their personal devices outside the home environment were willing to use station-based technology provided by the rail network. For instance, four participants used their smartphone to obtain the collection code while collecting tickets using the station vending machines. In one notable case, a participant used the station's ticket vending machine to purchase tickets, despite having previously explored online purchasing options at home (see Figure 6.11).

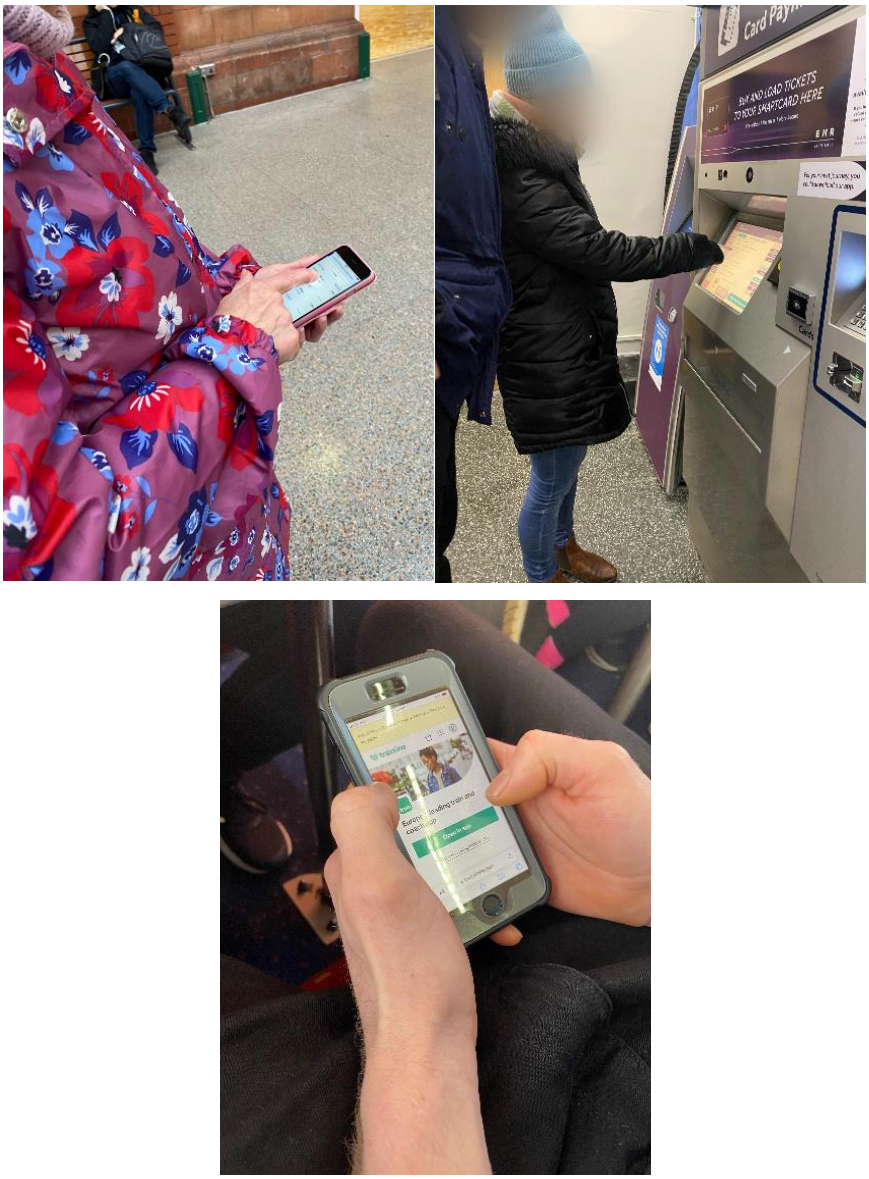


Figure 6.11 – Photos of Late Adopter Travel-Along Participants Using Smartphones and Ticket Vending Machines During Travel to Search for Platform Information and Purchase Tickets

These findings highlight a complex relationship between late adopters and technology in different travel contexts. While there may be a stated preference for avoiding personal device use in public travel settings, the convenience and necessity of these tools often lead to their use during rail travel (Mouratidis et al., 2021). This observed behaviour aligns with the widespread availability of self-service support mechanisms throughout the journey, as identified in the social, organisation, and cooperation analysis in section 4.2.2 of this chapter. Moreover, industry-driven changes, such as reduced ticket office hours, have effectively coerced passengers into adopting new

travel behaviours. This phenomenon also emerged in the analysis of interview data, where ‘forced transition’ was identified as an analytical code related to the theme of ‘passenger behaviour and general perceptions of travel’. When presented with a hypothetical scenario where all train tickets would be issued electronically to smartphones, several participants expressed initial resistance but ultimately acknowledged they would adjust their behaviour to accommodate such a change. For example:

> “If they do away with paper tickets and that’s the only way you can have a ticket then you got to do it, but you will still have to print something out because you cannot trust it” (Participant 18)

> “I’d have to do it [digital ticket] because that’s what it would be for everybody. Then I will just have to have the confidence of knowing that it will be on my phone… but I would rather have a printed ticket in my hand sort of thing” (Participant 20)

This reluctant acceptance highlights the tension between personal preferences and the evolving landscape of rail travel technology. However, industry representatives caution against using technological advancement to completely replace alternative methods for undertaking activities. As Participant 1 from the industry focus groups emphasised, "we can never ever over emphasise the importance of having people on platforms". This sentiment highlights a continued need for human-centred support that compliments the efficiencies afforded by technological innovation in the sector (Durrand et al., (2022). This perspective underlines the importance of a gradual approach to technological transitions in rail travel to accommodate the needs of late adopters as a diverse user group. This approach is also necessary to meet the objectives of the Rail Technical Strategy (2021) and the Great British Railways Transition Team (GBRTT, 2022) in ensuring rail is easy to use for all and meets the needs of customers, both now and in the future.

Two codes related to trust and failure of technology were identified through thematic analysis of the interview data. As cautious users of technology, it is unsurprising these codes emerged from engagement with the late adopter passenger group (Rogers, 2003). Several participants highlighted their preference for purchasing tickets from a member of staff at the ticket office and more personal service. For example, when

asked about why they would prefer to purchase tickets from a staff member, Participant 18 responded “it’s not because I am old fashioned, it’s because I know that works better”. Similarly, Participant 20 also hints at a lack of trust in digital systems:

> “I think I would sooner buy it in-store from someone because then I would have it [train ticket] there in my hand” (Participant 20)

Participants in the travel-along study also exhibited behaviour suggesting a lack of trust in technology, particularly regarding the accuracy of information displayed on digital screens and smartphone applications. For instance, during the first travel-along journey, the participant was observed verifying train information multiple times: first at the station concourse's display board, then at another digital display on the platform, and finally on the side of the arriving train. Despite these checks, uncertainty persisted. Ultimately, the participant's companion sought confirmation from a member of the cleaning staff onboard to ensure they had boarded the correct train to Leicester calling at Newark, their destination station. While not unusual behaviour, this persistent checking multiple sources of information was observed throughout all seven travel-along journeys completed with late adopter passengers and their travel companions, particularly in the moments just before boarding the train (see Figure 6.12).

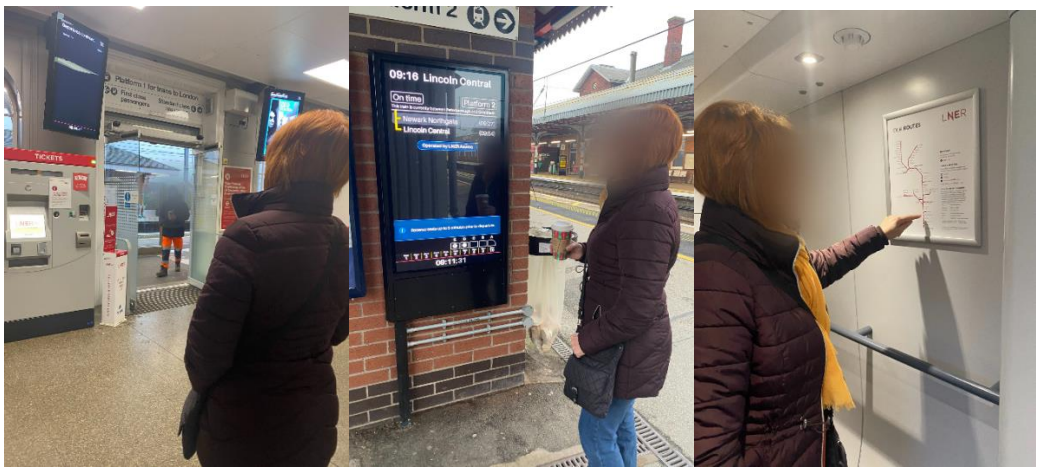


Figure 6.12 – Photos of Participant Undertaking Multiple Information Verification Checks in the Station Entrance, on the Platform, and on the Train

The following excerpts from the travel-along fieldnotes highlight further experiences of participants engaging in multiple information checks before boarding the train:

> “The participant’s **friend explained that Grantham wouldn’t be our train’s final destination, so they were better off looking at the train timings to**

locate the correct train and platform number from the board. Once the platform was identified by the participant we walked over to where the train was waiting. Unsure whether we were allowed to board or not, we **walked further down the platform to look in the train window to see if other people were already inside**. The participant then also **asked a member of staff near the train if the train would be calling at Grantham and that it was ok for us to board** now" (Travel-along journey 4)

"The ticket machine was out of service when we arrived meaning we were unable to collect tickets before the train arrived as the ticket office was also closed. The participant noted how they felt a bit anxious about boarding the train without being able to collect their ticket **even though they had the confirmation email on their phone and the sign on the machine said to speak to a member of staff in the office or on the train**. As the train arrived the guard stepped onto the platform. The **participant walked over to the guard to ask** if it would still be ok for us to get on the train" (Travel-along journey 2)

These findings suggest passenger confidence could be enhanced if the rail industry made information regarding train departures readily accessible and easy to find across multiple locations. This could include clear, consistent displays throughout the station concourse and platforms, visible information on approaching trains, and synchronised real-time updates via online channels. By ensuring information consistency and accessibility, operators could help reduce passengers' perceived need to repeatedly verify journey details, potentially leading to a more confident and seamless travel experience.

Passenger behaviours indicating scepticism towards technology also emerged as a recurring theme in the industry focus group data. Participants recounted personal experiences with customers they identified as late adopters during their work interactions. For example, Industry Participant 3 highlighted the perceived inconsistency of information provided through digital display boards and smartphones in the rail sector, stating:

"The number of times you see people asking someone whether the train is going to the destination when it clearly says on the side of the train it's going

> there. The customer information system says it's going there. The announcement on the station says it's going there. But they still walk up to the dispatcher and say, 'is this train going to London' because they don't have confidence in the information systems" (Industry Participant 3)

Passenger interview participants expressed concerns about the reliability of station-based technologies. Interestingly, many preferred digital tickets on their smartphones over using ticket vending machines. This preference stemmed primarily from a lack of trust in the machines and fears about potential malfunctions. Participant 4 exemplified this sentiment, stating, "I would prefer a digital ticket over using the machine, definitely... I think I just trust my own phone more". Echoing this view, Participant 12 explains:

> "I prefer a digital ticket because then I don't have to mess about trying to get the ticket. If the machine isn't working or something like that, how do you get your tickets then? If it's out of ink or there's a malfunction, you know." (Participant 12)

These responses and observations of distrust in station-based technologies highlight a general wariness towards their use and a greater confidence in personal devices and ticket office staff. In circumstances where the passenger does not have their own smartphone capable of being used for these activities or feels uncomfortable using one in public places, reductions in staff support availability and ticket office opening hours could create additional constraints.

In conclusion, this analysis provides detailed insights of late adopters' relationship with technology in rail travel. While these passengers exhibit caution towards new technologies, they do incorporate established digital tools into their travel routines, particularly in the comfort of their homes. However, their behaviour in public travel settings is more complex, often involving multiple checks of information sources and a preference for human interaction. This highlights a disconnect between stated preferences and observed behaviours, as well as the impact of 'forced transitions' in the evolving rail industry. The findings suggest the need for an approach that embraces innovation while maintaining human-centred support systems in order to deliver the strategic objectives of the Rail Technical Strategy (2021) and GBRTT (2022). As the rail industry continues to digitalise, it must consider the diverse needs and comfort

levels of all passengers, including late adopters, to ensure inclusive and accessible travel experiences. This may involve gradual technological transitions, maintaining alternative service options, and providing adequate support and education for those less comfortable with digital solutions.

6.3.2 Passenger Support

Late technology adopter leisure passengers rely on and are influenced by others throughout their rail journeys, including staff, friends, family, and fellow passengers. This finding emerged from both the thematic analysis of interview data and travel-along ethnographic narrative data. The interview data revealed four codes related to support from others during rail journeys: preference for staff support, reliance on others, strength in numbers, and seeking reassurance. Observations during travel-along journeys demonstrated staff providing reassuring support to late adopter passengers, particularly when they faced challenges. A notable instance occurred during the second journey when a participant struggled to locate the correct platform for their Newark-bound train using digital information screens at the station's main entrance. After unsuccessfully watching the screens for five minutes, the passenger sought assistance at the ticket office, where a staff member promptly directed them to the right platform. This example features a sentiment expressed by several passenger interview participants, including Participant 9, who stated, "it is just easier to go and ask a member of staff" rather than attempting to solve problems independently. Other participants also echoed this preference:

> “I guess it’s just the easiest way to get an answer by talking to someone rather than having to go through your phone finding it that way… You just know that the human person is going to give you the answer first time and more accurately” (Participant 3)

> “It’s as easy to ask someone as it is to look around yourself sometimes. So, in my experience I would just ask someone if I wasn’t sure.” (Participant 21)

Staff support was also credited by passenger interview participants as being more efficient, effective, and reassuring than support offered through alternative means or independently completing the activity:

> “My only thing against it [technology] is that it fails. Yes, the human person can fail too but nine times out of ten they can rectify the problem quicker” (Participant 18)

> “I would rather buy them from someone at the desk because there’s less chance of making a mistake for a start… someone telling you, who knows what they’re talking about, telling you what to do is a bit more of a back-up” (Participant 7)

Late adopters not only prefer staff support but also express a preference for travelling with familiar companions. These passengers often rely on their travel companions to handle various aspects of the journey. For example, Participants 12 and 21 shared their experiences:

> "I didn't have to worry about getting the ticket because someone else did that. I just got given the ticket, so it was fine” (Participant 12)

> "I generally leave it to somebody else because it's a bit confusing [booking tickets]. Some people can figure that out easily, but I haven't been that many times and it takes a bit to get used to it. So, I tend to leave it to somebody else" (Participant 21)

This tendency to defer to others aligns with the analysis of late adopter characteristics discussed in Chapter 5. The influence of more tech-savvy individuals in their social network often determines whether late adopters learn to use or engage with new technologies. The examples above demonstrate how this behavioural tendency extends to rail travel activities, with late adopters often allowing friends or family members to organise everything for them. This reliance on companions was also observed during the travel-along ethnographies, particularly when participants encountered unfamiliar technology in the station environment. In these situations, the main passenger participants consistently received assistance from their travel companions when using ticket vending machines and station car parking payment systems (see Figure 6.13). A notable example of the influence of others occurred when one participant struggled with a ticket vending machine. Despite the participant's suggestion to queue at the ticket office for staff assistance, their travel companion encouraged them to persevere with the machine. This instance highlights how companions can shape the late adopter's interaction with technology, sometimes pushing them beyond their comfort zone.



Figure 6.13 – Photos of Participant with Companion Supporting the use of Station-Based Ticket Collection and Car Parking Payment Machines

Interview participants also indicated that the presence of familiar people while using rail services provides a sense of reassurance. While many stated they would travel alone, they expressed feeling more confident when accompanied by familiar companions, especially if problems arose. Two participants articulated this sentiment clearly:

> "Being with some friends would make me feel better because I wouldn't be alone in the situation. We would all be in the same situation and get through it together" (Participant 5)

> "Having someone with you is the second opinion, and two heads are better than one if you are sort of working out the timetable and things" (Participant 7)

These findings suggest that travelling with companions not only offers emotional support but also practical assistance in navigating rail services and potential challenges.

The cognitive work analysis of industry representative focus group data, presented earlier in this chapter, reveals a wide range of support mechanisms available throughout the passenger journey. However, late adopter participants, being infrequent rail users, were often unaware of these support options, particularly technological ones

such as smartphone applications and websites. Interestingly, several participants suggested the development of smartphone applications for information and assistance, unaware that such applications already existed. For example:

> "I suppose if there was an app you could use to tell you about any delays or disruption that would be good." (Participant 2)

> "Well, maybe they should have billboards on the station just saying, you know, 'use our app to help you along your journey' should anything not go straightforward." (Participant 1)

These comments highlight a gap between available technological support and late adopters' awareness of these resources. Participant 5 draws specific attention to the need for better communication and promotion of existing support mechanisms to ensure all passengers, regardless of their technological proficiency, can access and benefit from these services:

> "If there was more information out there for people and where to look for this information, then if you know where to look for it then you can find it and know what you're doing or have some sort of idea what you're doing. That would make it a lot easier for someone who hasn't travelled before" (Participant 5)

6.3.3 Section Summary

This analysis of passenger interview and travel-along data builds upon the hypothetical findings from the industry focus group data using the constraints analysis framework. Employing phase three of this approach (see Figure 6.14), this section explored the nature of travel constraints for the late adopter passenger group, both confirming and challenging the findings presented earlier in this chapter.

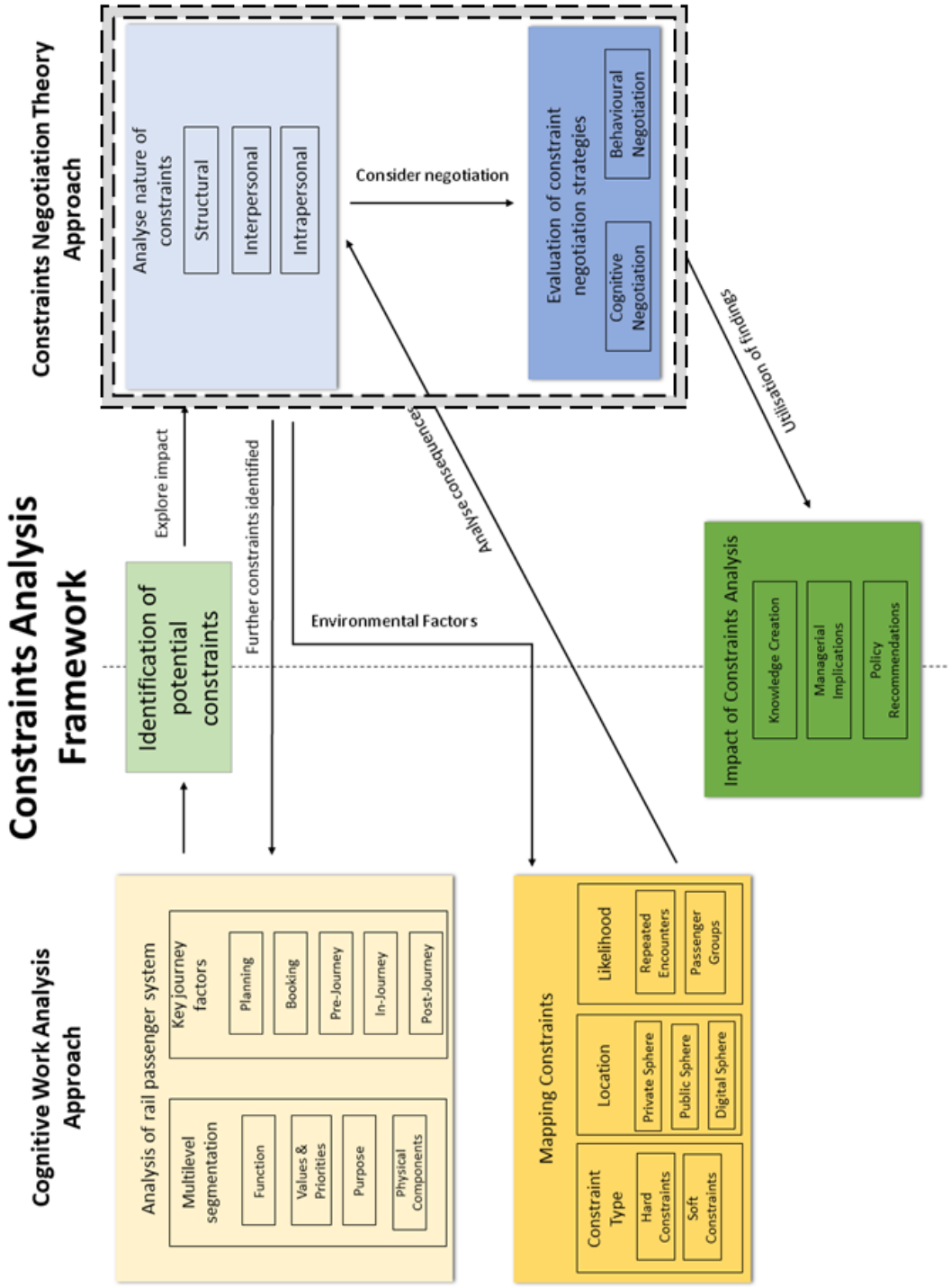


Figure 6.14 - The Constraints Analysis Framework for Combining the Approaches of Cognitive Work Analysis and Constraints Negotiation Theory with Dotted Box Outlining the Third Phase Analysing the Nature of Constraints and Evaluating Negotiation Strategies

A key finding is the identification of a gap between available technological support options and late adopters' awareness and use of these resources. Through analysis of passenger interview data, both actual and perceived constraints of rail travel for this user group were identified. This enabled comparison between hypothetical insights from industry focus groups and late adopter participants' perspectives. While phases one and two of the constraints analysis framework revealed numerous support tools throughout the passenger journey, thematic analysis of passenger interviews showed that late adopters often prefer not to use these, favouring staff-based assistance instead. Moreover, late adopter passengers frequently remain unaware of these available resources. Future strategies to bridge this gap could focus on targeted information, more intuitive interfaces, and maintained staff presence, thereby addressing the disconnect between available technology and late adopter awareness.

Whilst the primary focus of this section was identifying and analysing constraints, the thematic analysis also unveiled insights into late adopters' negotiation strategies. One notable example emerged around technology failure and trust, particularly regarding digital displays in the concourse and on platforms. Late adopters exhibited a lack of trust in the accuracy and reliability of digital information, leading them to repeatedly verify details across multiple locations before boarding trains. Following the constraints analysis framework, the examination of behavioural and/or cognitive behaviours constitutes the second part of the third analytical phase: the evaluation of constraint negotiation strategies. The next section highlights further constraints and negotiation behaviours through discourse analysis.

6.4 Insights and Implications of Constraints Relating to Rail Travel

Thematic analysis of passenger interviews revealed key themes, constraints, and negotiations associated with rail travel for late adopters of technology. Discourse analysis was then employed to examine these findings in greater depth, as well as exploring how constraints were negotiated within the data. As an analytical approach, discourse analysis explores how language functions as a socially constructed tool for achieving specific objectives within broader cultural contexts (Bryman, 2016). This includes the way someone shapes their use of language to attach meaning while creating or aligning with a particular discourse can be used to justify an action, behaviour, or consequence (Dickinson et al., 2010). For example, in the context of this

research, participants constructed an anti-technology discourse - termed the 'technology as an unnecessary distraction' implication - by positioning technology as untrustworthy, inaccessible, and/or problematic (example discussed in detail later in this section).

This approach yielded 15 distinct codes, termed 'insights' and nine categories of discourse, referred to as 'implications'. In this research, the insight codes represent the construction of discourse, while the implications embody the constructed discourse (Gill, 2000). This approach helps to identify further implications of the constraints uncovered through the constraints analysis framework and thematic analysis of the data. For example, 'dependence' emerged as one of the nine discourses identified as an implication of constraints relating to rail travel. This discourse was revealed through a series of insight codes identified during the discourse analysis of the themes and sub-themes. Insight codes such as vulnerability, othering, uncertainty, resistance, and lack of knowledge contribute to the construction of this discourse (see Figure 6.15).

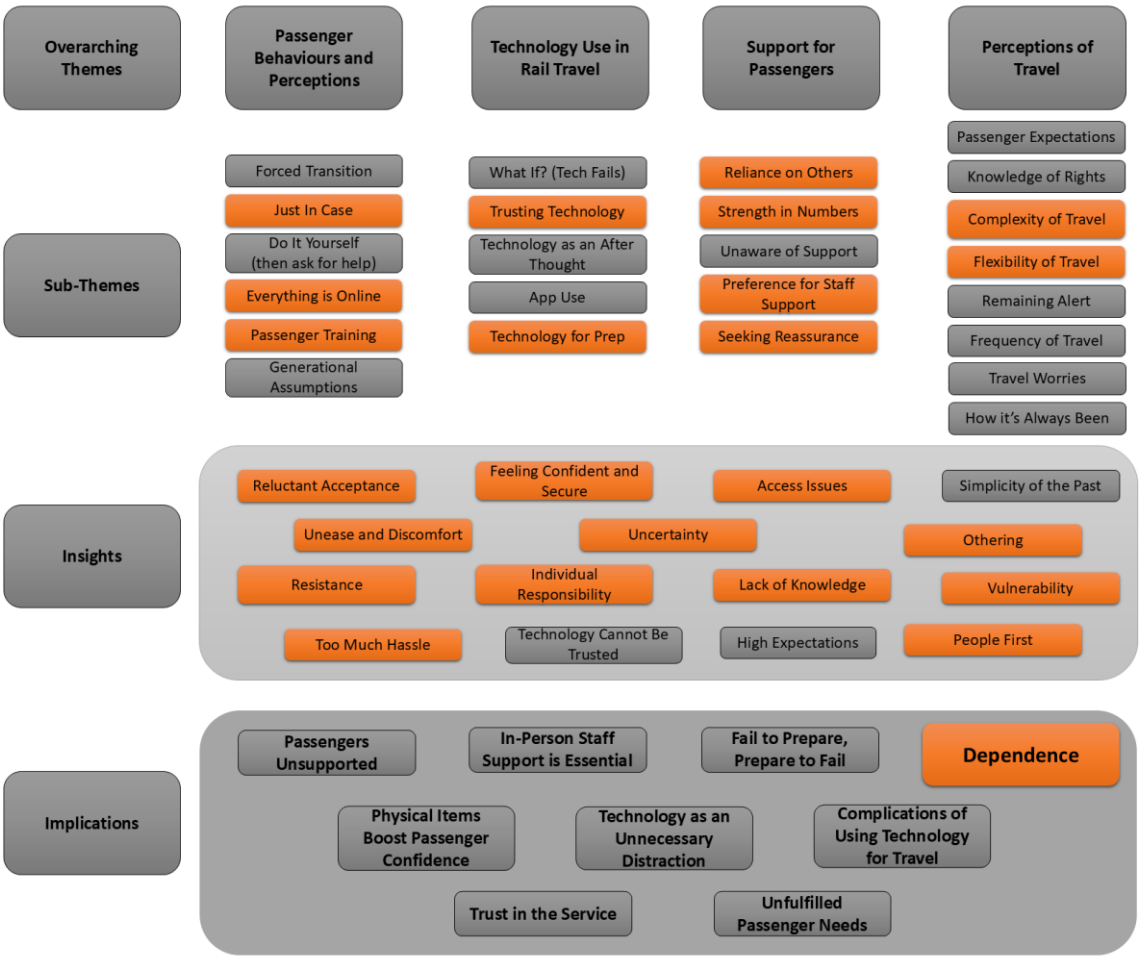


Figure 6.15 – Diagram Demonstrating the Construction of the 'Dependence' Implications (Discourse) Through Identification of Insights (Codes Constructing the Discourse) Associated with the Thematic Analysis of Passenger Interviews

To illustrate, several participants expressed a preference for travelling with companions when using rail services, while also indicating their unease, lack of knowledge, and uncertainty in situations where they might need to travel alone:

> "I would be more comfortable with somebody else [**unease**]… It's more fun with somebody else, they can take over and tell me where to go [**lack of knowledge**] … and if you weren't sure, you have got somebody to rely on and chat about it and you can both make that decision together [**uncertainty**]" (Participant 1)

> "If it's at night and it's dark and you're, you know, the only one there, it could be a bit scary [**vulnerability**]" (Participant 10)

While participants do not explicitly mention ‘dependence’ in these examples, their expressed preference for travelling with companions suggests an underlying issue. The contrast between their confidence when accompanied and their discomfort when alone implies that some passengers feel unable to travel independently, would experience unease doing so, or might choose to forgo travel altogether if unaccompanied. Similarly, in connection with the reliance on others and frequency of travel sub-themes, participants suggest access issues, a lack of knowledge, and vulnerability in circumstances where staff-based ticket sales are unavailable. These insight codes all contribute to the construction of ‘dependence’ as a discourse, and in this case, as an implication of the constraints of rail travel. The examples provided illustrate how various types of constraints intersect to create dependence on others for some people in this passenger group. For instance, the statement by Participant 11 highlights multiple levels of constraints:

> "If I needed to use technology to get a ticket, I would ask someone to do it for me [**access issue**]. It would be too complicated for me [**vulnerability** and **lack of knowledge**] to use a computer of phone to do it"

This single statement encapsulates:

- Intrapersonal constraints: The participant's perceived lack of knowledge and feelings of vulnerability when faced with technology.
- Interpersonal constraints: The reliance on others to complete a basic travel task (purchasing a ticket).
- Structural constraints: The access issues created by the implementation of technology-based ticketing systems without adequate alternatives.

These behavioural patterns and emotional responses, stemming from the interplay of various constraints, ultimately result in a sense of dependence on others for these passengers. The discourse of ‘dependence’ thus emerges not from a single factor, but from a complex interweaving of personal, social, and systemic issues that collectively impede passengers' ability to travel autonomously. This analysis reveals how seemingly distinct issues (like technology use, personal confidence, and system design) converge to create broader, more pervasive challenges for late adopter rail passengers (Neves et al., 2018).

The statement also reveals insights into the participant's negotiation strategies. By accepting their perceived inability and knowledge to use technology for ticket purchases, the participant demonstrates a cognitive strategy. They dismiss any attempt to engage with such systems, instead opting for a behavioural approach: asking someone else to complete the task on their behalf. This combination of cognitive and behavioural strategies aligns with Karl et al.'s (2022) argument that these negotiation methods are often interconnected rather than independent. The participant's response illustrates how individuals may adapt to technological constraints by leveraging both cognitive and practical adjustments.

Several overlapping factors contribute to the construction of the identified discourses. For example, the 'just in case' and 'trusting technology' sub-themes influence both the 'loss of independence' and 'physical items boosting passenger confidence' implications, among others (see Figure 6.16). Many participants expressed a need to carry printed documents, extra credit cards or cash when travelling, 'just in case' of unforeseen circumstances:

> "I'd have [**individual responsibility**] my printed-out ticket [**trusting technology**] just in case [**feeling confident and secure**]" (Participant 1)

> "I think I'd rather have a printout. If you could print it out yourself at home, I would be much happier [**feeling confident and secure**] than having it on my phone [**trusting technology**]. You've then got a physical barcode to scan. It would save the messing about trying to find it or losing your emails or something [**hassle**]" (Participant 19)

These examples highlight the diminished confidence passengers may experience when relying solely on technology throughout their journey. The additional precautions taken by these participants—ensuring they have printed paperwork and readily available funds—demonstrate how they behaviourally negotiate this constraint when travelling by rail in Great Britain. Their actions highlight a preparedness for all eventualities, reflecting a complex interplay between technological trust and the desire for tangible security measures.

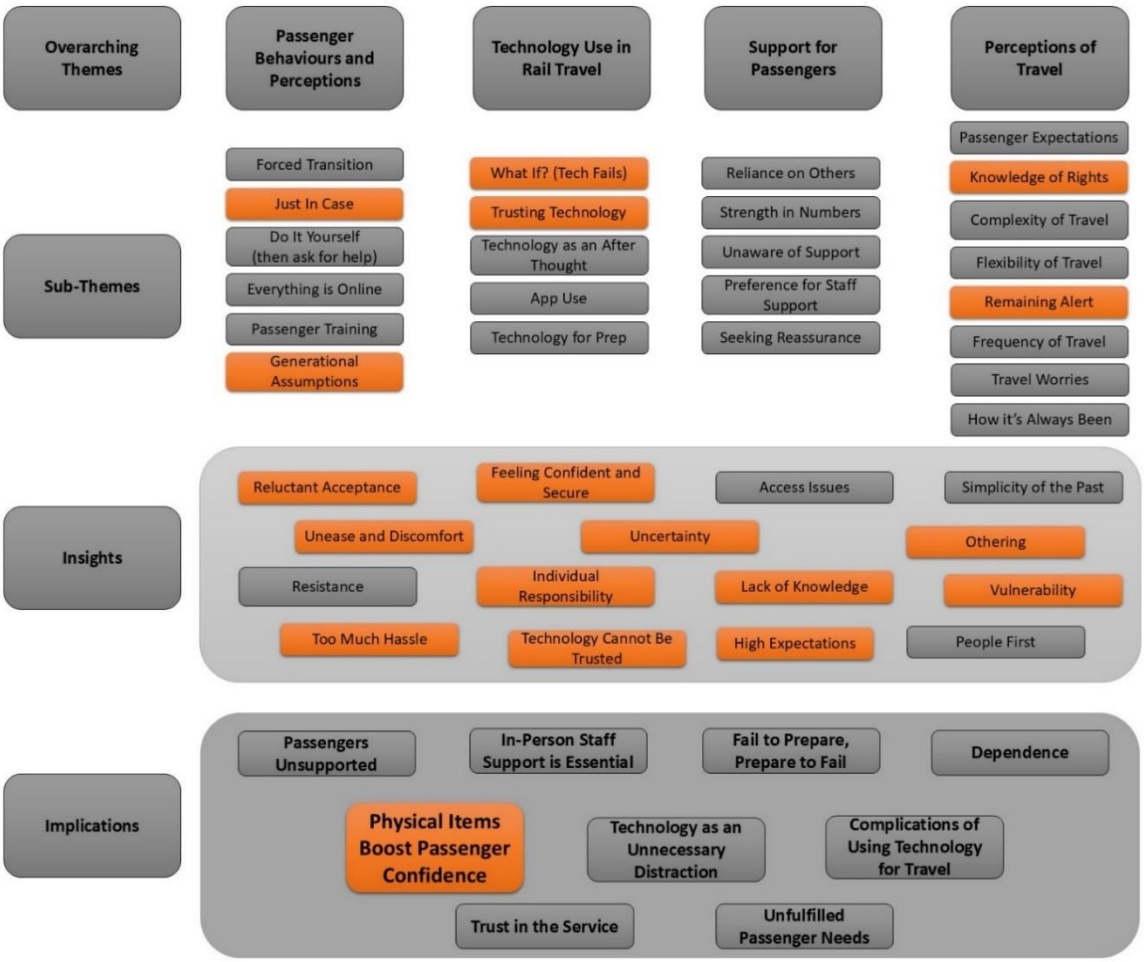


Figure 6.16 – Diagram Demonstrating the Construction of 'Physical Items Boost Passenger Confidence' Discourse

As more sceptical and hesitant users of technology, it is unsurprising that late adopters construct the discourse of 'technology as an unnecessary distraction', aligning themselves with broader anti-technology rhetoric that questions the value of digital integration in daily life. The construction of this discourse is underpinned by seven key insights: access issues, resistance, perceived hassle, individual responsibility, distrust of technology, lack of knowledge, and a preference for human interaction (see Figure 6.17). Participant 21 demonstrates this, pairing the hassle of using technology with resistance and a preference for seeking help from others:

> "I don't use them [trains] enough to warrant an app [**hassle**], so I wouldn't use it personally [**resistance**]"

> “It’s easier just to ask someone [**people first**] rather than look at your phone and other technology trying to work it out [**hassle**] for yourself” (Participant 21)

These quotes illustrate the participant's reluctance to engage with technology, favouring instead more traditional, human-centred approaches to problem-solving. By framing technology as an optional and often unhelpful addition to rail travel, Participant 21 constructs a discourse that positions technology as an unnecessary distraction for the activity in hand. They suggest that traditional methods, such as asking for assistance, are more straightforward and efficient. This approach reinforces the notion that technology, rather than streamlining the travel experience, can complicate it unnecessarily. Notably, this example demonstrates the intersectionality of constraints contributing to the formulation of this discourse. Within these brief statements, the participant references several interrelated sub-themes: frequency of travel, reliance on others, preference for staff support, (non)use of applications, and the perception of technology as an afterthought. These factors combine to create a robust argument against the necessity of technology in this context. The participant's language choices, such as "easier just to ask someone", imply that technology creates an additional layer of complexity in what could otherwise be a simple interaction. Through this multifaceted framing, the participant effectively portrays technology as a potential hindrance rather than a helpful tool in the context of rail travel, thereby contributing to the broader discourse of technology as an unnecessary distraction.

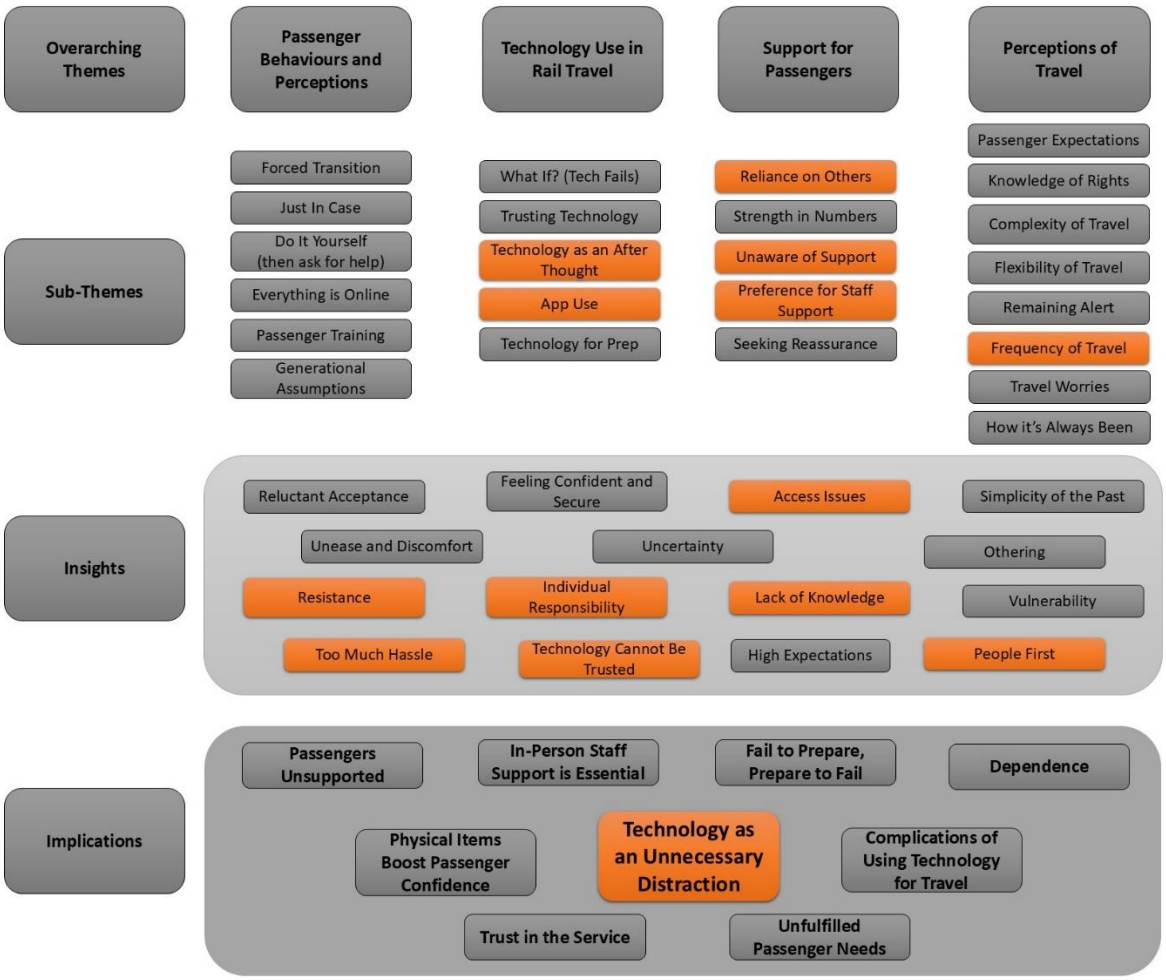


Figure 6.17 – Themes, Sub-Themes, and Insights Identified as Connected to the Construction of 'Technology as an Unnecessary Distraction' Implicatory Discourse

Building upon this discourse, the role of human support for late adopters in navigating rail services emerges as a key insight code. Throughout this chapter, it is evident that friends, family, fellow passengers, and particularly rail staff play a significant role in assisting these individuals. This preference for human interaction is further highlighted in the discourse analysis, where participants consistently construct rail staff as the primary and most reliable source of information. For instance, Participant 18 expresses confidence in seeking staff support over technological solutions, stating, "I know that works" when discussing this approach. This language choice not only reinforces the perceived reliability of human assistance but also implicitly contrasts it with the potential uncertainties or complications associated with technology use. Such phrasing suggests a level of trust and comfort with traditional, face-to-face interactions that

technological alternatives have yet to match in the minds of late adopters of technology.

This continued emphasis on human support further solidifies the discourse of technology as needless in the context of rail travel. It highlights a persistent preference for personal, direct communication over digital interfaces, reflecting a broader reluctance among late adopters to fully integrate technology into their travel experiences. Interestingly, while many participants actively use digital technologies in their daily lives, particularly within their home environment, this analysis reveals a notable distinction between every day and travel activities for late adopters. To some extent, this analysis supports the notion that the internet has altered travel behaviour, allowing for greater flexibility and dynamic decision-making in different environments (Wang et al., 2014; Lamsfus et al., 2015). For instance, late adopters often utilise technology at home to prepare for travel reducing the need to make additional trips to the train station to obtain information and support. However, the use of technology for rail travel itself, especially outside of the home and in preference to staff support, is met with resistance by this passenger group. These findings challenge Linton and Kwortnik's (2019) assertion that readily available technology reduces pre-trip planning. Late technology adopters remain reluctant to use unfamiliar systems like ticket vending machines and interactive information points while travelling. Consequently, they either plan their trips at home using familiar technology or visit stations early to seek assistance from ticket office staff.

Guided by the third phase of the constraints analysis framework, this approach offers valuable insights into the constraints shaping late adopters' behaviours in rail travel as leisure passengers. Through discourse analysis, the intricate interplay between different types of constraints emerged. A compelling example in relation to 'dependence' was shown, where within just a couple of sentences, the participant implicitly captured intrapersonal, interpersonal and structural constraints, revealing their profoundly interconnected nature. This example further illustrated how the participant employed a combination of cognitive and behavioural negotiation strategies – notably, accepting their situation whilst seeking assistance from a friend.

Importantly, this research has explored the technology engagement of late adopters across different contexts, representing a significant advancement in the understanding

of their behaviour. Previous research on this user group has typically been confined to single contexts (Mattila et al., 2003; Min et al., 2019), neglecting to compare constraints, behaviours, and preferences across diverse environments. Whilst Shin and Baek (2023) made progress by examining differences between journey stages (travel planning, on-site, and post-travel), they did not explicitly investigate the environmental context of these phases. This research addresses this gap by adopting a more comprehensive approach to understanding late adopters' technology use across various settings and stages of their travel experience.

By examining how late adopters navigate the transition from familiar, home-based technology use to the more challenging context of rail travel, the research develops a better understanding of their decision-making processes and support preferences. This multi-contextual approach reveals the situational nature of technology adoption and resistance among late adopters, highlighting the influence of environmental factors and familiarity on their choices. This suggests that strategies effective in encouraging technology adoption in one setting may not necessarily translate to another, particularly when the frequency of engagement varies significantly, as is often the case between home and travel environments. This insight is crucial for developing more targeted and effective approaches to support late adopters in various technological contexts.

6.5 Chapter Summary

This chapter has explored the complex landscape of constraints relating to rail travel for late adopters of technology, employing a multi-faceted analytical approach that combines cognitive work analysis and constraints negotiation theory – the constraints analysis framework. This innovative methodological approach develops a better understanding of the constraints faced by late adopters, revealing how intrapersonal, interpersonal, and structural factors intersect to influence behaviour in rail travel environments.

The application of constraints negotiation theory to the cognitive work analysis framework in this research has yielded valuable insights into the complexities of late adopters' interactions with rail travel environments. By mapping constraints onto the abstraction hierarchy and contextual activity template, the research provides a comprehensive view of where and how constraints manifest throughout the passenger

journey. This integrated approach not only identifies the potential constraints of rail travel for late adopters but also highlights opportunities for intervention. It reveals 'soft constraints' – areas where support is possible but underutilised (Stanton et al., 2013) – offering valuable insights for service improvements. Moreover, this combined methodology enables a deeper exploration of the negotiation strategies employed by late adopters, shedding light on how they adapt to and navigate an increasingly digitalised rail environment. The analysis reveals that late adopters often employ a combination of cognitive and behavioural strategies when negotiating constraints in rail travel (Kennelly et al., 2013; Karl et al., 2022). For instance, the research demonstrates how the removal of staff support could simultaneously lead to structural constraints (reduced access to assistance) and intrapersonal constraints (increased anxiety or lack of confidence in using technological alternatives) which could have negative outcomes for this user group. The synergy between constraints negotiation theory and cognitive work analysis offers a robust framework for understanding and addressing the constraints of travel for late adopters in the contemporary rail sector.

A key insight emerging from this combined approach is the significant role that human interaction continues to play for late adopters in the rail travel environment. Despite the increasing digitalisation of rail services with plans to expand the use of digital tickets and introduce further personalisation of travel through smartphone applications (Department for Transport, 2021), late adopters consistently express a strong preference for staff support, viewing it as more efficient, reassuring, and reliable than technological alternatives. This preference is not merely a matter of personal comfort but is deeply rooted in issues of trust, familiarity, and perceived effectiveness. The multifaceted role of staff support is evident throughout the passenger journey. From providing reassurance during ticket purchases to offering real-time assistance with wayfinding and journey alterations, staff serve as a vital link between late adopters and the increasingly complex rail travel environments. Participants frequently highlighted the value of face-to-face interactions, particularly in situations of uncertainty or when facing unexpected challenges. For instance, participants were observed seeking reassurance and support from rail staff during the travel-along journeys when technological solutions were insufficient or unreliable. This behaviour was consistently observed across all seven travel-along journeys, particularly in the moments just before boarding trains, highlighting the crucial role of human interaction

in providing reassurance and clarity when digital information alone proved inadequate or confusing for late adopter passengers.

The cognitive work analysis reveals a wide range of support mechanisms available throughout the passenger journey. However, the thematic analysis, employing constraints negotiation theory, found that late adopters of technology—who are also infrequent rail travellers—were frequently unaware of these support options, particularly those involving digital technologies. A notable distinction in technology engagement between everyday activities and rail travel was identified for this user group. While late adopters actively use digital technologies in their daily lives, especially within the familiar context of their homes, they demonstrate a marked reluctance to use similar technologies in rail travel settings. These differences primarily stem from issues of trust and familiarity with technology outside the home environment. In the context of rail travel, technology is constructed by late adopters as unnecessary and a distraction from the more efficient and traditional support services provided by staff. This finding challenges assumptions about the universality of technology adoption across different domains (Seebauer, 2015; Shin and Baek, 2023). It highlights the need for a nuanced understanding of how late adopters perceive and interact with technology in various contexts, particularly in environments where they have less frequent engagement, such as rail travel.

The analysis in this chapter also reveals concerns about the potential reduction of staff presence in favour of automated technological systems. Many participants expressed apprehension about this trend, fearing it could lead to a less accessible and more impersonal travel experience. These findings align with the arguments of Groth (2019), Zhang et al. (2020), and Durand et al. (2022), who posit that smart mobility trends and increased digitisation of transport could disadvantage many passengers, particularly those from marginalised groups such as individuals with low levels of education and reduced income. Late adopters of technology, as examined in this research, may face similar challenges. These concerns highlight the need for maintaining human-centred support that many passengers, especially late adopters, clearly value and rely upon. With a comprehensive understanding of constraints relating to rail travel for late adopters established, the next chapter focuses on future support and improving the passenger experience for these users.

CHAPTER 7: SUPPORTING AND IMPROVING THE PASSENGER EXPERIENCE

7.1 Introduction

The rapid digitalisation of rail services in Great Britain presents both opportunities and challenges, particularly for late adopters of technology. Following the previous chapter's examination of constraints to rail travel for this user group, this chapter explores potential improvements to enhance rail accessibility and passenger experience. The exploration is structured around three key areas of investigation, each providing unique insights into the challenges and opportunities for supporting late adopters in an increasingly digitalised rail environment.

Firstly, the chapter examines the provision of support for late adopters, analysing industry discussions and debates surrounding the extent and nature of assistance offered. This section highlights the tensions between digital advancement and the maintenance of traditional support mechanisms (Groth, 2019; Durand et al., 2023a), reflecting the broader challenges faced by the sector in ensuring services are accessible, efficient, and easy to use for all (RTS, 2021). This complexity is further highlighted through comparative examples from other sectors, consideration of the consequences of withdrawing traditional support formats, and discussion of the obligation public services have to ensure rail is accessible (ORR, 2019).

Secondly, the chapter explores improvement strategies from an industry perspective. Through thematic analysis of industry focus group data, key themes such as simplification of processes, enhanced support and training initiatives, and the often-overlooked role of organisational culture in shaping passenger experiences are identified. This section provides valuable insights into how industry representatives envision the future of rail travel and the steps they believe are necessary to make it more accessible to all users, particularly late adopters. It examines proposed solutions ranging from streamlining ticketing systems to implementing innovative training programmes for both staff and passengers. The discussion also delves into the potential of community engagement initiatives and the adaptation of successful models from other sectors. Moreover, this section highlights the industry's recognition of the need

for a cultural shift within organisations to better empower staff in supporting passengers, especially in challenging circumstances. These findings collectively illustrate an industry navigating the intricate balance between technological modernisation and the imperative to maintain inclusive services for all passengers (Groth, 2019).

Lastly, the chapter turns its attention to the passenger perspective, specifically focusing on late adopters of technology. It presents and analyses a range of solutions and improvements proposed by this user group, offering further insights into their needs, preferences, and concerns. This section is particularly valuable in highlighting potential misalignments between industry perceptions and user realities, underscoring the importance of user involvement in developing effective support mechanisms (Harvey et al., 2019).

By bringing together these diverse perspectives, this chapter aims to contribute to a more nuanced understanding of how the rail sector can offer services to effectively support late adopters of technology. It seeks to inform future policy and practice, encouraging the development of inclusive, accessible rail services that cater to the needs of all passengers, regardless of their technological proficiency. As the sector continues to evolve, the insights presented here will be crucial in ensuring that technological progress enhances, rather than hinders, the rail travel experience for everyone (Durand et al., 2022; Durand et al., 2023a).

7.2 Provision of Support for Late Adopters

The support of late adopters in the railway sector emerged as a key topic among industry focus group participants. The discussion yielded three main themes and six sub-themes related to this issue (see Table 7.1). As the sector continues to digitalise passenger support mechanisms, these findings suggest a growing tension surrounding the provision of support for this particular passenger group. The ‘inclusive approach’ theme represents the middle ground where most participants agreed that the rail industry should consider the needs of all passengers and provide appropriate support to ensure accessibility through a combination of traditional and technological means. Industry participants observed a growing focus on ensuring universal accessibility in rail sector documentation, suggesting this trend might mitigate the shift away from staff-based support towards fully digitalised systems:

> “From what I’ve seen of the new national rail contracts coming in, there is a far greater emphasis on accessibility, so that might counter that sort of charge towards online-only ticketing and access to information because we are going to be increasingly targeted and charged with accessibility, but you can’t have that if not everyone can access the information” (Participant 5)

Table 7.1 – Themes and Sub-Themes Identified in Relation to Support for Late Adopters Discussion Topic at Industry Focus Groups

Topic	**Theme**	**Sub-Theme**	**Description**
Supporting Late Adopters of Technology	Removing Support	Other Sectors Don’t Support Them	Comparisons to other sectors where support has ceased
		It’s Cheaper Not To	Financial benefits of ceasing support for late adopters
	Inclusive Approach	Accessibility Focus	Commitment to accessibility signifies support for all
		Variety of Options	A combination of modern and traditional support
	Excluding Users	Leaving People Behind	Unsupported users will be left behind
		Should Not Happen in Rail	Exclusion of passenger groups should not happen

From an accessibility perspective, participants emphasised the need for a variety of support options to effectively accommodate passengers with additional needs, a group that may include late technology adopters. They noted that the diversity within all passenger categories could render digital support inappropriate for some. This observation aligns with McKercher and Darcy's (2018) argument that disabled people may experience constraints both as shared experiences with others and as unique challenges specific to their own impairments. Moreover, one size does not fit all in a passenger group. Participant 7 highlighted the importance of ensuring a wide variety of support mechanisms to cater for individual needs:

> "I think there will always be someone who needs that [access support] so we just need to make sure we've kind of got options available for customers and just have a broad range of everything" (Participant 7)

The remaining two themes, concerning the removal of support and the exclusion of users, highlight the challenges of balancing the industry's economic needs while avoiding passenger exclusion and the potential negative impacts for both travellers and the rail sector. As more passengers purchase tickets online and adopt digital formats, it becomes less viable for the sector to maintain alternative options, such as staffed ticket offices. This shift towards digital ticketing is driven by multiple factors, including cost-effectiveness for companies, convenience for some users, and technological advancements. The COVID-19 pandemic significantly accelerated this trend, as contactless transactions became preferable for health and safety reasons. Participant 5 highlighted this rapid transformation:

> "Eighteen months ago, maybe 30% of people had a digital ticket on their phone. Now it's probably 80% of people… The world is going that way, it's cheaper for the company to do it, so you can see why it is attractive to them" (Participant 5)

The increase in digital ticket adoption has far-reaching implications for the transport sector. For train operators, the financial incentives are clear: digital ticketing reduces overhead costs associated with physical infrastructure, staff, and paper-based systems. Nevertheless, this shift towards digital solutions gives rise to concerns about fairness and inclusivity in public transport access (Durant et al., 2022; Shin and Baek, 2023). Whilst those comfortable with technology may find digital ticketing straightforward, late adopters of technology may struggle to adapt or be more resistant to these changes. The consequences of users being unable or unwilling to adapt to new travel processes could potentially lead to the inadvertent exclusion of significant portions of the community from easily accessing public transit systems, especially in areas where traditional alternatives have been phased out in favour of digital-only options (Durant et al., 2023).

Currently, the rail industry appears to be more accommodating of late technology adopters compared to other sectors, offering a variety of support mechanisms. Participants contrasted the availability of staff-based and non-digital support for rail

travel with that in car parking, aviation, and healthcare sectors in Great Britain. Participant 2 observed that the car parking sector has already undergone an "evolution from offline, to hybrid, to online", with an increasing number of car parks requiring customers to use smartphone applications or online payment systems. However, this shift has not been without challenges. In England, many local authority car parks have reintroduced physical payment machines, while in Wales, organisations like Mencap and Age UK have advised local authorities against moving to cashless facilities (Lenton, 2024). Some retailers are also considering reintroducing more staffed checkouts due to consumer demand (Moreau, 2024). The healthcare sector faces similar issues. Participant 10 pointed out that several National Health Service (NHS) services in England are now inaccessible "unless you have the ability to get online". In contrast to some other sectors, the rail industry in Britain is slow to adopt innovation (Nash et al., 2018). Several factors are suggested to contribute to the Great British rail industry being a late technology adopter including sector fragmentation, franchising of train operators, political factors, organisational culture, and funding (Ahmad, 2019). Participant 2 perceives this slowness to implement innovation to be more inclusive for late adopter passengers:

> "Actually, as an industry we are behind the curve... we are still supporting those people who haven't taken on technology more than other industries are" (Participant 2)

These comparisons suggest that while fast-paced digital transformation is widespread across various sectors, the rail industry's reduced pace adoption may inadvertently benefit late adopter passengers through maintenance of traditional support services.

Participants strongly emphasised the importance of inclusivity in the Great British rail network, ensuring no users or potential users are excluded. This concern is particularly relevant given the significant changes currently underway in the rail sector, including the development of Great British Railways (GBRTT, 2024b) and the introduction of the Passenger Railway Services (Public Ownership) Bill (2024-2025). Amidst this transformation, accessibility in publicly owned institutions has become a key focus. Participant 4 highlighted this issue in relation to Great British Railways' development:

> "As we go forward with Great British Railways the railways, or any organisation, shouldn't be allowed to exclude different groups of people because they don't have technology." (Participant 4)

Whilst major industry documents, such as the Accessible Travel Policy (ORR, 2019), Williams-Shapps Plan for Rail (Department for Transport, 2021), Rail Technical Strategy (2021) and the GBRTT (2022) long-term strategy for rail, frequently discuss accessibility, they fail to acknowledge how technological advancements might reduce access to rail services. This oversight is particularly significant for late technology adopters (Durant et al., 2023), a substantial demographic representing half of the population (Rogers, 2003). Participant 4's observation not only highlights this critical gap but also presents a timely opportunity for Britain's rail sector to broaden its accessibility assessments, specifically examining how digital advancements affect access across different passenger groups.

Financial considerations also support the case for inclusivity in the rail sector. Participant 3 stressed the need for the industry to prioritise people over technology: "It's not about running trains, it's giving people transport, that's what we are doing here." Participant 8 echoed this sentiment, highlighting that increasing passenger numbers is crucial for the industry's financial health and future development:

> "We need passengers... the more bums on seats we have, you know, the more money we've got coming into the system which allows more opportunity for further investment and development for the railway as a whole." (Participant 8)

Interestingly, the rail industry's current position of being ‘behind the curve’ in digital transformation, as noted by Participant 2, may present a unique opportunity. This lag could allow for a thoughtful and measured implementation of changes that maintain accessibility for all users while simultaneously modernising the system. However, Participant 3 cautions against making assumptions about future technological adoption:

> "We can't just assume that in ten years' time everyone is going to have the latest iPhone and be able to operate it." (Participant 3)

This insight highlights the importance of planning for a diverse user base with varying levels of technological proficiency and access. As the rail sector advances, it must achieve a balance between embracing new technologies and ensuring that these advancements do not inadvertently exclude late adopters and other segments of the population. This approach aligns with the broader goal of creating an inclusive and accessible rail network that serves all members of society, regardless of their technological capabilities. In conclusion, the Great British rail sector finds itself at a crucial juncture. While the push towards digitalisation offers undeniable benefits in terms of efficiency and cost-effectiveness, it is paramount that the industry does not lose sight of its fundamental purpose: providing accessible transport for all (Rail Technical Strategy, 2021). The current position of being "behind the curve" (Participant 2) in digital transformation may, paradoxically, offer a unique opportunity to implement changes thoughtfully and inclusively. The next section of this chapter explores the areas and ideas for improving the sector as discussed by industry representatives.

7.3 Passenger Support Improvements: An Industry Perspective

Industry representatives proposed several ways to enhance the passenger experience for late technology adopters, beyond merely discussing existing support provisions. Thematic analysis of the industry focus group data on ‘improvements’ revealed three key themes and seven sub-themes (see Table 7.2). One sub-theme, providing well-trained staff, aligns with consistent findings in accessible tourism literature (Darcy, 2006; Patterson et al., 2012; Zaluska et al., 2022). Interestingly, industry participants suggested extending support and training to passengers themselves, helping to "keep everyone up to date with technology" (Participant 2) both now and in future. This idea is supported by some passenger participants discussed later in this chapter. Drawing inspiration from the banking sector, industry Participant 8 proposed that rail staff could offer hands-on support:

> "A lot of banks do that now where they take you to the machine and show you how to use it. So, whilst people are waiting to be assisted, we could ask them 'did you book your tickets in person?' If they did, we could ask if they would like us to show them how to use the online facility, sort of thing." (Participant 8)

This approach would provide practical training and demonstrations on using digital support mechanisms, specifically targeting late adopters of technology. These individuals are traditionally more sceptical and resistant to using unfamiliar digital devices (Rogers, 2003; Kim et al., 2010; Guttentag and Smith, 2022). Similarly, utilising community user groups, such as community rail partnerships, could support rail staff with the training and development of late adopter passengers, enhancing their capability and willingness to adopt technology for rail travel. Participants also highlighted that existing user groups and customer panels are already consulted when rail operators introduce new processes:

> "One of the good things about having our customer panel is that we could always check things with them and see what they think to make sure we're doing everything as well as we can be" (Participant 7)

This feedback mechanism ensures that new initiatives are vetted by a representative group of users before widespread implementation. User panels are made up of a wide range of travellers who are selected based on their travel habits, demographic details, disability or long-term illness, and travel routes used (London Northwestern Railway, 2024). Currently, applicants for user panels are not asked about their engagement with digital technology. Creating a new group to represent passengers who could be categorised as late adopters of technology could help with increasing adoption of technology for rail travel and reduce associated constraints.

While enhancing human-centred support through staff training and community engagement is crucial, industry representatives also highlighted the potential role of technological infrastructure in supporting late adopters. Increased investment in station- and train-based technology was suggested as a way to better serve late adopters, reducing the need for passengers to use their own devices for travel-related activities. Participant 7 proposed installing more interactive digital screens in unstaffed stations, meaning passengers "don't need a smartphone or anything like that" to use them. However, this suggestion may not align with the preferences of some late adopters. Findings from Chapter 6 of this thesis indicate that some people in this user group prefer using their own devices due to issues of trust and usability associated with station-based technology. Moreover, those that do not have their own devices or would not use this outside of the home environment prefer to seek more traditional

support from staff in-person. However, where in-person staff support is unavailable, especially during out-of-hours, interactive digital screens could be beneficial.

Table 7.2 - Themes and Sub-Themes Identified in Relation to the 'Improvements' Discussion Topic at Industry Focus Groups

Topic	**Theme**	**Sub-Theme**	**Description**
Improvements	Simplification	Simplification of fares and booking processes	Simplify online ticket sales process and make ticket sales equitable (online and offline).
		Clear and simple guidance	Reduction and simplification of physical signage at the station.
		Update, simplify and improve industry standards	Improve consistency across operating companies through updated industry standards.
	Support and Training	Well-trained staff	Ensure all staff are available and well-trained to support all passengers.
		Training passengers to use technology	Support passengers to use technology for their journey through digital coaches or training days.
		Utilise community user groups	Involve the community rail groups or create a user group to engage with.
		Increase infrastructure-based technology offer	Increase the availability and accessibility of station-based and/or train-based technologies to support the passenger journey.
	Culture		The need for culture change in the rail sector to empower staff to speak up and be better positioned to support passengers, especially in challenging circumstances.

While addressing the preferences of late adopters regarding device usage is important, industry representatives also emphasised a more fundamental need: simplifying the entire ticketing and fare system. In 2019, the Rail Delivery Group proposed a new, modernised ticketing and fares system. Similarly, the Department for Transport (2021) put forward a ‘new deal for passengers’, incorporating some of the Rail Delivery Group’s proposals for fares reform. Despite industry and government awareness and proposed changes to simplify processes for passengers, findings revealed through the constraints analysis framework in Chapter 6 demonstrate that these constraints remain prominent for late adopters of technology. There are intrapersonal, interpersonal, and structural constraints throughout the passenger journey in relation to purchasing tickets. Industry participants highlighted how simplifying the fares and booking process would reduce some of these constraints for passengers. It was also noted that improvements to booking and ticketing processes would benefit staff. Drawing on their own experience supporting customers, Participant 6 explained the lengthy process of helping passengers understand fare variations for the same journey:

> "If ticket prices were simplified it would help staff a lot more because sometimes passengers will see something advertised online and say they've seen this price, but then you've got to delve into how they found that price and unravel it for them because it will turn out it's only a single journey, not a return, or there's restrictions in place. So yeah, simplify tickets for staff and passengers, that would help a lot" (Participant 6)

Nevertheless, industry participants appear optimistic that progress towards developing Great British Railways signifies a move towards simplifying ticketing:

> "With the changes to Great British Railways I expect there will only be one ticketing and retail operations, so online sales will go through one portal and hopefully everyone will get access to the same tickets" (Participant 3)

Whilst addressing the constraints of the fare system and its simplification tackles tangible aspects of the passenger experience, the data also unveiled a more subtle impediment to progress: the pervasive organisational culture within the rail sector. Industry participants highlighted the restrictive influence of the rail sector's prevailing culture. They suggested that the mindset within railway organisations tends to discourage proactive behaviour from staff and hinders their ability to provide the best

possible support to passengers. Interestingly, this finding emerged unexpectedly from the thematic analysis of the data, as most other themes relate to staff-based and physical support mechanisms. This intangible factor influences staff attitude, and the quality of customer service delivered. Participant 10 emphasised the need for cultural change, particularly in handling customer feedback and complaints:

> "Our passengers do understand the challenges of our industry… but what they're not comfortable with is the attitudes and behaviours of staff when things go wrong… we can look at digital, online, and offline, but what we really need to do is change the culture" (Participant 10)

In agreement, Participant 9 echoed this sentiment, suggesting that staff in the rail sector are effectively 'being set up to fail'. Both participants implied that a shift in organisational culture would empower staff to offer more effective support to customers.

The significance of this cultural challenge is further evidenced at the highest levels of rail governance. Secretary of State for Transport, Louise Haigh, directly referenced the need to deliver culture change in the Great British rail sector during a speech at the Derby Rail Skills event in October (Department for Transport, 2024b). Additionally, during parliamentary scrutiny of the rail transformation programme, Public Accounts Committee members raised concerns about organisational culture with Network Rail's Chief Executive. In the oral evidence session, both Network Rail's Chief Executive and the Department for Transport's Interim Director General of Rail Infrastructure acknowledged that their current organisational focus prioritised engineering and asset management over passenger outcomes - a mindset they aim to transform as Great British Railways is developed (Haines, 2024).

This section has explored industry-proposed improvements to enhance the rail passenger experience, with a particular focus on late technology adopters. Through thematic analysis of focus group data, three key themes emerged: simplification, support and training, and organisational culture. The simplification of fares, booking processes, and station signage was identified as crucial. Despite ongoing efforts by the Rail Delivery Group (2019) and the Department for Transport (2021), the current system's complexity continues to pose challenges, particularly for late adopters. The

development of Great British Railways suggests a positive trajectory towards a more user-friendly rail network.

Support and training initiatives emerged as vital components in improving the passenger experience. Innovative approaches, such as extending training to passengers and utilising community user groups, demonstrate a commitment to user-centred design principles (Maguire, 2001). However, a potential misalignment between industry perceptions and user preferences was noted regarding infrastructure-based technology improvements, highlighting the importance of continual user research and engagement with late adopters (Vines and Thompson, 2007; Essen and Ostlund, 2011). These insights collectively point towards a holistic approach to improving the rail passenger experience, balancing technological and process-oriented solutions with human-centred approaches and cultural shifts. However, it is important to note that these findings are based on industry perspectives and may not fully capture the preferences of late adopter passengers. While this section has focused on the industry perspective, it is crucial to consider how these proposed improvements align with passenger needs and expectations. The subsequent section will examine the passenger perspective on improvements for the rail sector, providing a complementary view to the industry insights presented here. This multistakeholder approach will offer a more comprehensive understanding of the challenges and opportunities in enhancing the rail travel experience for late technology adopters.

7.4 Passenger Support Improvements: The Passenger Perspective

During this research, several late adopters of technology offered suggestions for improving support and service. The semi-structured interview schedule (see Appendix 3) included several prompts to encourage participants to consider ways the constraints of rail travel could be negotiated, particularly constraints with negative consequences for accessibility and passenger experience. For instance, participants were asked to consider how the rail service could make it easier to find information pre-journey. Additionally, some participants offered suggestions through their answers to other questions without being specifically prompted by the researcher to think about improvements. In total, interview participants proposed 18 solutions and improvements (see Table 7.3). These ideas were then presented to late adopters in Ketso focus group sessions for feedback and development. The sessions were designed

to explore what a positive rail experience might entail, what would be necessary to achieve it, and any potential challenges. The sessions began with five pre-established themes, identified from analysis of earlier studies (staff focus groups and passenger interviews): support, ease of use, simplicity, comfort and efficiency. Participants were invited to map their ideas against these themes using the Ketso activity board, with the freedom to suggest additional themes if needed. The first focus group added 'social atmosphere' and 'value', whilst the second group contributed three new themes: 'navigation', 'options' and 'communication'. At the end of each session, the ideas proposed during the one-to-one interviews were presented to the group. Participants were asked to discuss these proposed solutions in relation to the factors they had identified throughout the session as contributing to an ideal rail experience.

Table 7.3 – Solutions and Improvements Proposed by Late Adopter Interview Participants Categorised by Associated Theme

Theme	Proposed Solution
Ease of Use	Basic version of ticket vending machine to be available onboard trains (i.e. iPad style)
	Provision to purchase tickets and get advice from other locations – i.e. Post Offices
	Basic version of ticket vending machine at the station pre-programmed for popular journeys
	More ticket machines
	Contactless phone charging points at stations and on trains
	One central helpline, WhatsApp number, or website for help when something goes wrong
	Smartphone application with location tracking and push notifications for in-journey support
Support	Digital help points at station with video call feature during out-of-hours
	Provision of a dedicated helpline for lone or vulnerable passengers for 'emergency' use
	Staff to show people how to use ticket machines or download applications at train stations
	Unique journey code that can be entered into application or website for journey-specific help, information, and advice
	Option to declare if you are a lone traveller or vulnerable person at the time of booking train tickets

Information and Communications	Leaflet with information about all available technology to support journey (i.e. applications)
	Poster adverts for available services at the station
	Audio adverts to be played at the station and on the train informing people about available support services
	Posters and/or billboards with QR code to FAQs and web chat facilities
	'How to' video available via YouTube
	Online webpage with information about all available technology to support journey (i.e. applications, help, tickets)

Figure 7.1 illustrates the distribution of ideas across various themes discussed during focus group sessions. The five pre-proposed themes were most prominent, with support and comfort receiving the most mentions with a diverse spread across all discussion topics. The additional topics added by focus groups one and two were less prominent in the data as they were only discussed at one session. For instance, social atmosphere and value received fewer mentions than the pre-proposed themes, however they still contributed to the overall discourse for improving the passenger journey. Some themes have more solutions aligned with them than others. For example, the 'support' theme attracted a substantial number of proposed solutions, whilst 'comfort' garnered notably fewer suggestions from participants. Analysing the Ketso data in this way highlights the areas participants find most critical to their experience, while also indicating where the most actionable ideas for improvement were generated.

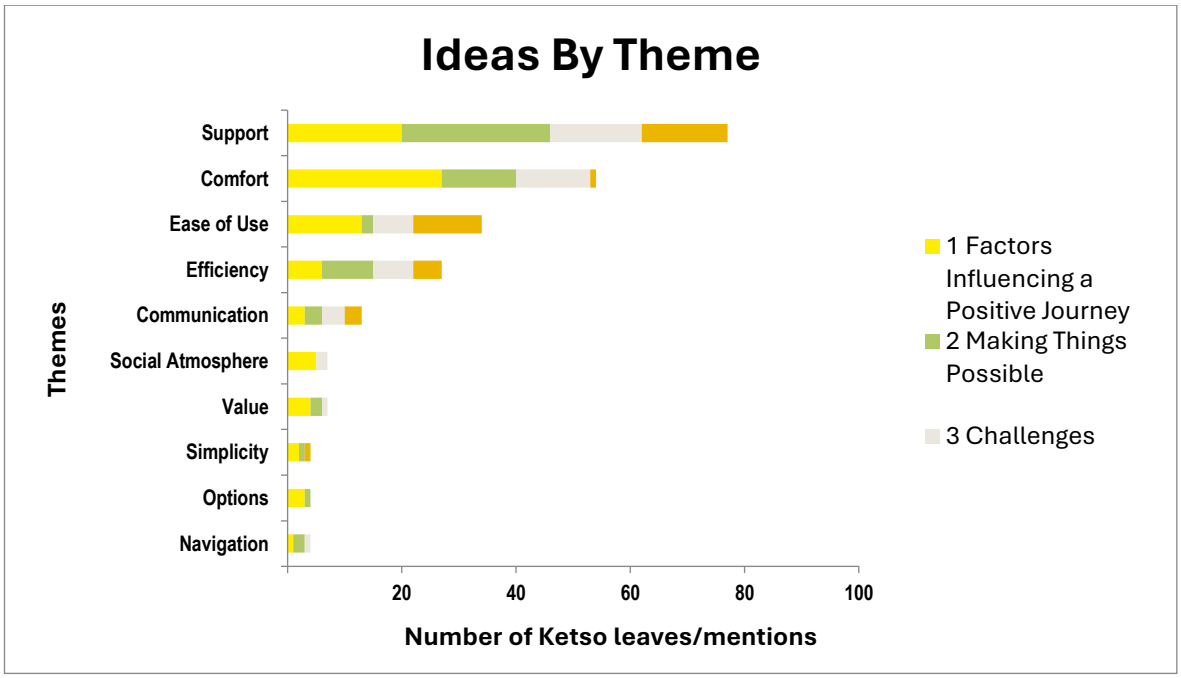


Figure 7.1 – Bar Chart Indicating the Distribution of Ideas and Discussion of an Ideal Rail Journey Across Different Themes

An interesting observation emerged during the second focus group session. Participant 9 noted that while several solutions were accepted by the group for themes related to support and communication, gaps remained on their Ketso activity board for acceptable solutions in relation to navigation, efficiency, options, and comfort (see Figure 7.2). Unlike the other groups, this group dismissed two solutions related to efficiency that had been favourably received elsewhere. These were the installation of contactless charging points at stations and the ability to purchase tickets and seek advice from alternative locations. The disparity in solution generation across the different themes presents an area for further exploration and potentially indicates a need for more focused ideation in these underrepresented yet crucial aspects of the journey experience.



Figure 7.2 – Focus Group Two: Complete Ketso Workspace with Blue Circles Indicating Areas Where Solutions to Constraints with Potentially Negative Impacts have not been Identified or Agreed and Green Circles Highlighting Solutions Accepted by the Group

The focus group sessions with late adopters produced mixed results for the 18 proposed solutions. Seven ideas received unanimous support: Ticket machine on the train, central helpline, smartphone application with location tracking feature, digital help points, dedicated helpline for vulnerable travellers, staff to show passengers how to use digital mechanisms, and audio notices. However, five proposals—including the distribution of posters and leaflets, unique journey codes, and more ticket machines at stations —were rejected by two or more groups. Notably, the dismissal of printed materials intended to boost passenger confidence and awareness of support services is unexpected, given that the discourse analysis in Chapter 6 emphasised the importance of tangible items in enhancing traveller assurance. Regarding the provision of leaflets to inform passengers about available technological support, participants from focus group two remarked that "leaflets are not the answer, but the information is required", while group three deemed it a "waste of paper". This feedback suggests a multifaceted perspective: whilst physical items such as printed tickets, journey plans, and booking confirmations may provide these passengers with an enhanced sense of confidence and security, this preference does not extend to physical items serving purely informational purposes. This distinction highlights a key insight: late adopters value tangible materials that directly relate to their specific journey but are less receptive to general informational materials in physical form. This finding could inform more targeted and effective communication strategies for this demographic.

The analysis of constraints to rail travel for this user group in Chapter 6 highlighted a disconnect between the availability of technological support mechanisms and passenger awareness of these services. Interview participants had suggested placing posters at train stations to raise awareness and provide information on how to access and use these services. However, this proposal met with rejection from participants in focus groups one and three. Their comments indicated that such posters would be "lost amongst other posters". This feedback aligns with insights from industry participants, who emphasised the need for simplification and reduction of informational posters in railway stations. They noted that an overabundance of posters leads to people ignoring them altogether, rendering this form of communication ineffective:

> “We’ve got so many posters giving them [passengers] information, but people get overwhelmed with the amount of information they’re getting, they don’t

always know what they're looking at, why they're looking at it, or why we are trying to draw attention to it" (Industry Participant 8)

These combined findings reveal important insights into information dissemination preferences, particularly for late adopters. While there's a recognised need for better awareness of technological support services, the effectiveness of visual displays in busy station environments is questioned. This highlights the importance of considering not just the content of information, but also the medium through which it is delivered, especially when targeting late adopters of technology in transport settings. It also suggests a potential conflict between the desire to provide comprehensive information and the risk of overwhelming passengers with too much visual input.

Having explored some of the proposals that faced opposition, attention now turns to solutions favoured by late adopter participants, examining which ideas garnered unanimous support and why they appealed to this demographic. Chapter 6 emphasises the crucial role of staff support in making rail services accessible to late technology adopters. A widely endorsed solution for enhancing these passengers' journeys involves providing personnel to demonstrate technological aids, such as ticket machines, smartphone applications and interactive help points. All focus groups unanimously backed this idea, though one group suggested using volunteers instead of staff for more efficient implementation. Table 7.4 offers an overview of unanimously supported solutions across all focus groups, along with their associated feedback. Industry representatives also advocated for digital coaches—be they staff, community rail groups or volunteers—as an effective means to increase late adopters' engagement with and awareness of journey-supporting technology. Familiarity with customer engagement and adoption programmes in other sectors has grown, particularly during the COVID-19 pandemic, when reliance on technology for everyday activities increased (Kerigan, 2020). Several industry and late adopter participants cited the Barclays Bank Digital Eagles programme (Barclays, 2014) as an established and well-known model that the rail industry could adopt to help customers engage with technology:

"For example, Barclays Bank have these Digital Eagles I think they're called, helping people adopt technology. I think, let's be honest, everything is going online, so I think if we are going down that route, we [the industry] have a

responsibility to try reach out to those people that can't access that or find it difficult and offer them extra help" (Industry Participant 5)

The widespread acceptance and positive feedback from this typically sceptical user group might be attributed to the programme's longevity and extensive publicity. Having existed for over a decade and been widely advertised through a partnership with one of the UK's largest commercial television stations (Thomas, 2017), the Digital Eagles programme has likely gained credibility and familiarity among late adopters. These findings suggest that an adapted version of this scheme, tailored to encourage technology adoption for rail journeys, could be successfully implemented and widely embraced.

Table 7.4 – Solutions Favoured by All Focus Groups with Comments Captured from the Discussions

Theme	Solution	Focus Group Comments
Ease of Use	Basic version of ticket vending machine to be available onboard trains (i.e. iPad style)	Group One: Very efficient, genius idea
		Group Two: Good idea but could have some complications and usability issues
		Group Three: Helpful if you are running late
	One central helpline, WhatsApp number, or website for help when something goes wrong	Group One: Good idea
		Group Two: Good idea, centralised and simple
		Group Three: Accessible for people who may not want to ring or know who to ring.
	Smartphone application with location tracking and push notifications for in-journey support	Group One: Helpful when it's dark and you cannot see outside location. No need to be alert all the time – can relax more.
		Group Two: Good idea encompassing many areas of the journey. Can reduce anxiety, provide information, and more relaxing journey
		Group Three: Helpful, peace of mind.

Support	Digital help points at station with video call feature during out-of-hours	Group One: The current 'help button' offers no privacy. A digital help point could make you feel safer and be more personal – some old people don't like talking to a speaker.
		Group Two: Good idea, nice to have the choice and feel more secure.
		Group Three: More personal and offers reassurance.
	Provision of a dedicated helpline for lone or vulnerable passengers for 'emergency' use	Group One: Offers security and more private than pushing the help button.
		Group Two: Inclusive and a good idea but possibly open to abuse.
		Group Three: Offer reassurance and support – Could be misused.
	Staff to show people how to use ticket machines or download applications at train stations	Group One: Helpful
		Group Two: Good idea, but should not be necessary for staff to do this, could use volunteers
		Group Three: Good to develop confidence to use the technology
Information and Communications	Audio adverts to be played at the station and on the train informing people about available support services	Group One: No comment captured but received one vote as the most preferable solution from group members
		Group Two: Information in an accessible format and could be incorporated to other forms.
		Group Three: Tells everyone the information so they don't need to read it.

Late adopters, whilst favouring staff-based support, also showed unexpected enthusiasm for certain technological solutions (see Table 7.4). Surprisingly, given this group's privacy concerns and data-sharing hesitations (as discussed in Chapter 5), their most preferred technical innovation was a smartphone application with location tracking and in-journey support notifications. This application would provide passengers with real-time journey information, including expected platform numbers, onboard services, and prompts to prepare for disembarking based on their location

data. Feedback from late adopters highlighted two key benefits of this technology: an increased ability to relax during journeys and reduced anxiety about missing stops. These benefits align with the 'comfort' factor that all three focus groups identified as key to a positive rail journey experience. The positive reception of this solution is especially noteworthy when contrasted with the thematic analysis of interview data, which revealed three sub-themes in late adopters' 'attitudes and beliefs': lack of trust, security concerns, and perceived technological intrusiveness (see Chapter 5 for further discussion).

In conclusion, these findings highlight the complex and sometimes contradictory preferences of late technology adopters in the context of rail travel. While they value personal support and tangible materials, they also show openness to certain technological solutions that address specific needs like reducing anxiety and enhancing comfort during journeys. This suggests that the rail sector could benefit from involving late adopters in the early stages of technological development to create solutions that are both usable and desirable for this demographic (Harvey et al., 2019), potentially improving adoption rates among traditionally resistant users (Rogers, 2003).

7.5 Chapter Summary

This chapter has explored the complex landscape of support and improvements for late adopters of technology in the Great British rail sector, drawing insights from both industry representatives and passengers. The findings reveal a nuanced interplay between technological advancements and the need for human-centred support, highlighting the importance of considering both factors to ensure inclusivity and accessibility for all rail users.

The industry perspective emphasised three key themes: simplification, support and training, and organisational culture. There is a clear recognition of the need to simplify fare structures and booking processes, which aligns with ongoing efforts by the Rail Delivery Group (2019), the Department for Transport (2021), and most recently in the Labour Government rail strategy (Labour, 2024). The development of Great British Railways (GBRTT, 2024b) presents an opportunity to address these longstanding issues. Support and training initiatives, including the innovative concept of extending training to passengers themselves, demonstrate a commitment to user-centred design

principles. However, the unexpected emergence of organisational culture as a theme highlights the need for a holistic approach to improvement that goes beyond technological solutions.

From the passenger perspective, late adopters of technology demonstrated complex and sometimes contradictory preferences. While they value personal support and tangible materials directly related to their journeys, they also showed surprising enthusiasm for certain technological solutions, particularly those that address specific needs such as reducing anxiety and enhancing comfort during travel. The positive reception of a smartphone application with location tracking capabilities, despite previous privacy concerns, illustrates the potential for well-designed technology to overcome initial resistance.

Interestingly, both industry representatives and passengers identified similar areas for improvement, such as the need for better staff training and the potential benefits of community engagement through programmes like digital coaches. The widespread support for initiatives similar to the Barclays Bank Digital Eagles programme suggests a promising avenue for increasing technology adoption among traditionally resistant users. However, the research also revealed some misalignments between industry perceptions and user preferences, particularly regarding infrastructure-based technology improvements and the effectiveness of visual information displays in stations. These findings highlight the critical importance of continual user research and engagement with late adopters throughout the development and implementation of new initiatives (Rogers, 2003; Harvey et al., 2019).

In conclusion, this chapter highlights the need for a multifaceted approach to supporting late adopters of technology in the rail sector. By combining targeted technological solutions with enhanced human support, simplified processes, and a shift in organisational culture, the industry can work towards a more inclusive and accessible rail network. Early and continuous engagement with late adopter passengers is essential to ensure that innovations are both technically viable and meet the specific needs of this user group. The following chapter summarises the constraints of rail travel for late adopters as a unique and diverse user group. The discussion examines the research questions and findings, whilst highlighting contributions to

academic knowledge, implications for rail management, and recommendations for policy makers.

CHAPTER 8: CONCLUSION

8.1 Introduction

Digitalisation has transformed public services, particularly in transport (Durand et al., 2020), prompting significant changes in how passengers access and engage with rail travel. This transformation has raised concerns about digital exclusion, particularly among late adopters who comprise approximately half of potential users yet remain understudied in both academic literature and industry practice. While technological innovation promises enhanced service delivery and passenger experience, questions persist about its implications for passengers less familiar with, hesitant, or unable to use digital systems.

This thesis examines the constraints of rail travel for late adopter leisure passengers in Great Britain, challenging oversimplified representations of this diverse user group. Through developing and applying a novel constraints analysis framework, the research bridges human factors and leisure studies approaches to provide comprehensive insights into how late adopters engage with technology in rail environments. The research specifically investigates the complex factors influencing late adopters' technology adoption decisions, their preferences for different support mechanisms, and the implications for inclusive service delivery as rail transport becomes increasingly digitalised.

The following sections review the research objective and questions that guided this investigation. The chapter first examines theoretical contributions regarding late adopter representation in innovation literature and the effectiveness of current constraints analysis approaches. It then explores managerial and policy implications, discussing identified constraints of rail travel for late adopters and potential improvements to built and digital environments. The chapter concludes by highlighting opportunities for future research and offering final reflections on the significance of the thesis for understanding and supporting late adopters in increasingly digitalised transport environments.

8.2 Review of the objective and research questions

The overarching objective driving this research was to identify, analyse, and understand the constraints of travel for leisure passengers who could be considered late adopters of technology. This intended to provide a comprehensive understanding of this user group that challenges stereotypical representations, while contributing to more inclusive design and policy decisions in the rail sector. This objective was addressed through four research questions: two focused on theoretical contributions, while two tackled industry and policy challenges. These will be discussed in the following sections under the relevant sub-headings.

8.2.1 Contribution to knowledge

This section sets out the key contributions to knowledge and theory in relation to the first two research questions. The first question focuses on developing a better understanding of late adopters of technology as a diverse user, and non-user, group. This broader understanding of late adopter behaviours, needs, and preferences breaks away from the stereotypical representation often found in academic literature. This is followed by a discussion of how the combined use of cognitive work analysis and constraints negotiation theory, through development of a novel methodological framework, can lead to a more effective and in-depth analysis of constraints for late adopters in the rail sector.

8.2.1.1 *Question 1: To what extent does the diffusion of innovation literature accurately represent late adopters?*

Rogers' (2003) diffusion of innovation model reveals a gap in research regarding late adopters, who comprise roughly half of all users and non-users of technology. Whilst numerous studies employ this model to examine technology adoption, they predominantly focus on early adopters, who are typically viewed as more accessible research participants. Even research purporting to examine the full spectrum of adopter categories inadvertently prioritises early adopter groups (Escobar-Rodregues and Romero-Alonso, 2014; Guttentag and Smith, 2022). The limited research specifically examining late adopters' behaviours and needs tends to concentrate on older adults, perpetuating an oversimplified stereotype of this adopter group as elderly people who lack interest in technology (Harvey et al., 2019).

This research challenged stereotypical representations and extended the application of the constraints negotiation theory model beyond its original leisure context (Godbey et al., 2010), demonstrating its effectiveness in examining technology adoption. The model's categorisation of intrapersonal, interpersonal, and structural constraints provides valuable insights into late adopters' technology engagement (as detailed in Chapter 5). At the intrapersonal level, late adopters demonstrate thoughtful consideration of privacy and security features rather than simple fear or resistance (Jahanmir and Lages, 2016; Harvey et al., 2019). When users perceive technology as potentially intrusive or insecure, their cautious approach reflects not disinterest or lack of understanding, but rather a deliberate evaluation of security features. At the same time, by exploring both the positive and negative outcomes of intrapersonal constraints, such as security concerns, it is suggested that technologies with enhanced security features can also motivate adoption when perceived as more secure than traditional options.

Interpersonally, this research reveals the complex social dynamics influencing late adopters' technology engagement. When introduced and encouraged by trusted social connections, late adopters often exhibit adaptability and openness to new technologies - characteristics typically associated with early adopters (Rogers, 2003; Lu et al., 2015). This positive reception is particularly evident in social contexts, where participants actively embraced specific applications and platforms to maintain connections with friendship groups, demonstrating considerable flexibility in their adoption patterns. Notably, this receptiveness and willingness to experiment is specifically tied to the influence of trusted individuals rather than businesses, highlighting how personal relationships can drive technological engagement. However, an interesting paradox emerges in the learning process: despite this initial enthusiasm and openness to new technologies when introduced by trusted connections, well-meaning individuals often inadvertently hinder progress by completing tasks for late adopters instead of supporting their learning journey. This intervention, though well-intentioned, ultimately discourages late adopters from developing their technological skills and independence, despite their demonstrated willingness to engage with new technologies when properly supported. This oversight in academic literature fails to acknowledge a critical finding: late adopters often

possess genuine interest in learning and using technology, yet their progress can be constrained by the interventions of others.

Previous research oversimplifies the reasons for late adoption among this user group predominantly focusing on disinterest as a key factor (Essen and Ostlund, 2011; Harvey et al., 2019). However, this research has found a broader set of factors and constraints can influence adoption and engagement with technology for this user group. Structural constraints extend beyond basic factors of cost and time, encompassing factors like a misalignment between technology design and late adopters' specific needs and preferences. For example, transparency of customer data use through technology design is important to late adopters which also links back to intrapersonal constraints relating to privacy concerns. Through this use of the constraints negotiation theory framework, the research reveals how intrapersonal factors, social influences, and broader systemic constraints collectively shape late adopters' technology experiences. This novel application marks the first time the model has been used to examine late adopters' engagement with everyday technology, offering structured analysis of the complex factors influencing their adoption decisions.

This thesis demonstrates that the diffusion of innovation literature inadequately represents late adopters, often reducing them to stereotypes of disinterested or technologically resistant individuals (Rogers, 2003; Jahanmir and Lages, 2016). As demonstrated primarily in Chapter 5, this research reveals a more nuanced reality: late adopters often show genuine interest in technology, particularly when introduced through trusted social connections, and display thoughtful evaluation of device or software features rather than simple resistance. Their adoption patterns are influenced by a complex combination of intrapersonal factors, interpersonal dynamics and structural constraints, rather than mere disinterest. This analysis has addressed a significant gap created by the literature's focus on early adopters and stereotypical representation of late adopters, revealing the diverse motivations and behaviours of late adopters who comprise approximately half of all potential users.

8.2.1.2 *Question 2: How effectively do current approaches to constraints analysis understand, examine, and represent constraints of travel?*

The analysis in this thesis has been guided by cognitive work analysis (human factors) and constraints negotiation theory (leisure studies). It has been argued that while these approaches offer valuable insights into the constraints of travel, their effectiveness in understanding, examining, and representing travel constraints varies significantly when applied independently. Cognitive work analysis, whilst providing robust frameworks for analysing system efficiency and safety (Vicente, 1999; Naikar et al., 2006; Stanton et al., 2013), demonstrates limitations in capturing complex personal and social factors that shape travel decisions. Its technical-operational focus potentially overlooks the subjective experiences and perceptions that influence passenger behaviour. Conversely, constraints negotiation theory, though offering structured approaches for identifying constraints within leisure and tourism contexts, proves partially misaligned with rail travel realities. Its tendency to frame constraints negatively (Samdahl 2005; Godbey et al., 2010; McKercher and Darcy, 2018), often conflating them with barriers, combined with its lack of tools for analysing hierarchical system relationships, restricts its effectiveness in comprehensively understanding how different elements of the rail network interact to shape passenger experiences.

In response to these limitations, this research developed a constraints analysis framework that bridges these distinct approaches. A key factor of this framework is its neutral conceptualisation of constraints. This marks a significant departure from the predominantly negative framing found in constraints negotiation theory, recognising instead that while constraints themselves are neutral, their outcomes can be either positive or negative (exceptions include Godbey et al., 2010 and Halpern et al., 2021). By moving beyond seeing constraints purely as barriers, this neutral approach reveals opportunities for innovative solutions. Through examining both positive and negative outcomes of each constraint, the framework facilitates a deeper understanding of their functional role in the system and provides a more complete picture of how constraints shape travel behaviour and system performance. For example, the provision of information in the station environment is a neutral constraint of rail travel. While accessible information can positively influence passenger behaviour, the same constraint might negatively impact passengers when they must process large amounts

of information under time pressure. Halpern et al. (2021) suggest constraints offer an opportunity to reimagine how people engage with an activity. In this scenario, limiting the amount of information provided at the station could lead to a constraint with positive outcomes for passengers who are overwhelmed with information. This understanding enables more considered decision-making about which constraints to modify, maintain, or remove based on their actual outcomes rather than initial assumptions.

Similarly, this research considers constraint negotiation strategies to be neutral factors with positive or negative outcomes. Although Kono and Ito (2021) suggest that negotiating a negative factor should lead to positive outcomes, the reality is more complex. For instance, examples demonstrated through this research include when an individual accepts their perceived inability to use digital systems (a cognitive negotiation of an intrapersonal constraint), initially producing a negative outcome. However, their subsequent behavioural negotiation of seeking assistance from a friend leads to a positive outcome, enabling task completion. This example demonstrates how negotiation strategies themselves are neutral, with outcomes varying from positive to negative depending on the individual's circumstances and choices.

The constraints analysis framework integrates cognitive work analysis and constraints negotiation theory to identify, analyse, and understand constraints, providing a comprehensive methodology that addresses the limitations of using either approach in isolation. The framework's effectiveness stems from its three-phase structure. The initial phase combines development of an abstraction hierarchy with the hierarchical categorisation of constraints from constraints negotiation theory, revealing both systemic relationships, potential constraints, and the nature of the constraints. This enables identification of critical support mechanisms and their interconnections within the rail network. The second phase integrates phases two and four of cognitive work analysis, involving the development of a contextual activity template, with the constraints negotiation theory approach, providing visual representations of where activities occur and who performs them. This reveals the frequency and nature of constraints across different locations, helping understand their cumulative impact on passenger experiences. The final phase examines negotiation strategies through thematic and discourse analysis, identifying both cognitive and behavioural

approaches used by passengers to overcome constraints. Figure 8.1 illustrates each of these phases in a flow diagram.

This multilayered approach provides unique insights by visualising often-intangible travel constraints, making them more comprehensible. Through its integrated methodology, the framework reveals the nature of constraints, showing how their impact varies based on context. It effectively identifies interconnected constraints across different levels (intrapersonal, interpersonal, and structural) whilst demonstrating how support mechanisms can simultaneously address multiple constraints. Importantly, it challenges traditional negative framing of constraints by considering both positive and negative outcomes. The framework thereby provides a more nuanced understanding of constraints and their negotiation, enabling better-informed service design and policy recommendations for more inclusive rail travel.

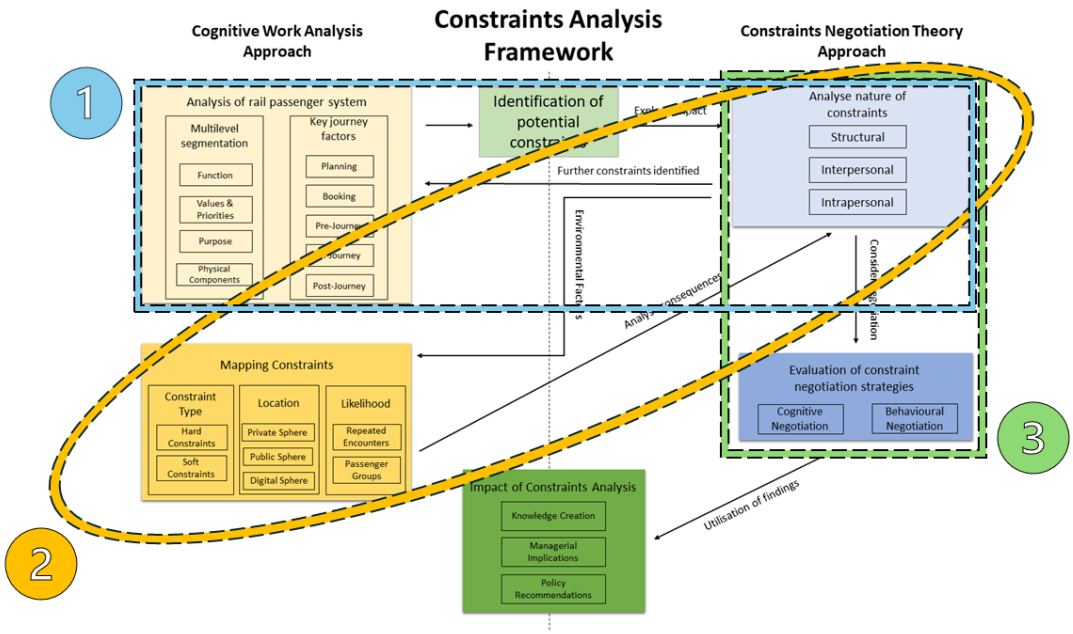


Figure 8.1 – Flow Diagram of the Constraints Analysis Framework with Each Phase Segmented

8.2.2 Managerial and policy implications

The third and fourth research questions discussed in this section take a more practical direction, examining how this thesis generates insights and implications for industry management and policymakers. This section examines the key practical contributions regarding rail travel constraints for late technology-adopting leisure passengers. The

findings emphasise the critical role of staff assistance in digital travel environments and the impact of trusted confidants on late adopters' use of digital services. These insights can inform industry strategies to enhance adoption and engagement within this passenger segment. The section then discusses the practical contributions arising from the final research question on service delivery improvements. It highlights a critical gap in rail sector accessibility policy, which fails to address how limited or non-existent engagement with digital services affects passenger experience and access to rail services.

8.2.2.1 *Question 3: What are the constraints of rail travel in Great Britain for late adopters of technology as leisure passengers?*

This research presented a novel constraints analysis framework examining rail travel constraints for late technology adopters as leisure passengers in Great Britain. Understanding these constraints as neutral factors that influence passenger behaviour and decision-making—leading to both positive and negative outcomes—was central to this analysis and offers valuable insights for industry implementation. The findings demonstrated that constraints are present throughout the journey for these passengers, each with distinct implications that transport operators can address through targeted interventions and service improvements. The following sections outline four key findings that provide a practical foundation for enhancing service delivery and passenger experience for this important user group.

Firstly, this research demonstrates the critical importance of staff support for late adopter leisure rail travellers who strongly prefer human assistance over technological alternatives. This preference stems from passengers finding staff interactions more efficient, reliable and reassuring. Recent research by Durand et al. (2023a) warns that increasing service digitalisation risks disadvantaging those less familiar with or hesitant to use technology. Industry stakeholders interviewed for this study shared similar concerns about digital advancement occurring at the expense of staffing levels. Through hypothetical testing using the abstraction hierarchy within the constraints analysis framework, this research confirmed staff's integral role in maintaining rail accessibility, efficiency, and convenience—key strategic priorities identified by the Rail Technical Strategy (RTS, 2021)—for this important passenger group potentially representing up to half of all rail leisure travellers.

The analysis also revealed a comprehensive network and variety of support mechanisms available across all stages of the passenger journey. However, a notable limitation emerged through thematic analysis of interview data, particularly concerning digital services. Despite the rail industry providing various support tools, including smartphone applications and websites, many late adopter leisure passengers were unaware these resources existed. This knowledge gap was strikingly illustrated when several study participants suggested developing smartphone applications for journey information and disruption updates, not realising such tools were already available. This highlights that the challenge lies not in the absence of digital support mechanisms, but rather in effectively communicating their existence and benefits to passengers. Through enhanced communication with passengers about these digitalised services, the sector could play a more direct role in supporting late adopters during their initial engagement with these systems.

The third insight for industry is understanding how to influence late adopter leisure passengers in adopting new practices and technologies. The findings presented here challenge traditional stereotypes that portray these users as resistant to change and technologically disinterested (Essen and Ostlund, 2011; Jahanmir and Lages, 2016). Instead, it is suggested these users are more adaptable than previously thought, with their willingness to change largely dependent on who encourages adoption and how it is communicated. Notably, late adopters showed greater openness to adopting new messaging platforms when encouraged by their social circle, while displaying resistance when businesses promoted similar platforms for getting in contact, particularly when traditional alternatives remained available. For industry, the key challenge lies in effectively communicating the benefits of innovative support mechanisms to passengers and potential passengers in a way that encourages similar engagement and adoption behaviours observed when influenced by trusted individuals. Additionally, facilitating a smooth transition from traditional to digital support requires careful consideration of both technology provision and service design. Utilising staff or volunteers to gain passenger trust and support them with adopting digital support options could be an effective way of easing this transition to digitalised passenger rail services.

The fourth practical contribution associated with this question stems from examining late adopters' technology engagement across multiple domains, extending beyond

previous single-context studies (Mattila et al., 2003; Min et al., 2019). By comparing technology interaction in both home and rail travel environments, this research revealed that while users actively engage with digital technologies at home, they display marked reluctance in rail travel contexts. Similarly, the social dynamics of rail environments influence the behaviour of these passengers. Late adopters typically prefer staff assistance over digital services when it's readily available at stations. However, in home settings where human support is sometimes less accessible, these same passengers are more inclined to attempt to use digital services to complete their tasks. This finding has significant implications for industry stakeholders and policymakers, highlighting the need for domain-specific approaches to technology implementation and adoption. Rather than assuming universal technology acceptance across different environments (Seebauer, 2015; Shin and Baek, 2023), this research suggests that successful approaches to technology adoption in one setting may not translate effectively to others.

Together, these findings demonstrate the complex relationship between late adopter leisure passengers and technology in rail travel. While digital transformation offers opportunities for enhanced service delivery, successful implementation requires maintaining staff presence, improving awareness of existing digital tools, leveraging social networks for technology adoption, and recognising domain-specific constraints to digital engagement. This detailed understanding provides a foundation for developing inclusive rail services that effectively serve all passenger groups, including those hesitant, reluctant, or unable to engage with technology, while advancing technological innovation in the sector.

8.2.2.2 *Question 4: How can the built and digital environments of the rail sector be improved to better support this passenger group?*

This research engaged directly with industry and passenger representatives to identify the constraints of rail travel for late adopter leisure travellers and discuss potential ways journeys could be improved. Through focus groups with both stakeholders, several key areas for improvement emerged. These centred primarily on enhancing staff training and support, alongside developing community programmes to help passengers transition to digital services. The findings suggested that looking beyond the railway sector could prove valuable, particularly observing the banking industry,

which has successfully implemented digital coaching schemes. This approach was widely supported as a means to boost technological engagement among hesitant users. As discussed earlier in this chapter, research evidence indicated that late adopters are more likely to embrace technology when encouraged by trusted individuals. Therefore, utilising community rail volunteers and railway staff to build trust and provide support through digital coaching schemes could prove more effective than traditional marketing methods. Such personalised approaches would likely achieve better results than conventional engagement campaigns relying on advertising, posters and announcements.

While late adopters demonstrate a preference for personal support and tangible materials, the findings also showed they are receptive to technological solutions that address specific concerns, particularly those reducing journey anxiety and enhancing travel comfort. Building on recent research into late adopter user engagement (Harvey et al., 2019), the rail sector could benefit from involving late adopters in the early stages of technological development. This collaborative approach could help create solutions that are both usable and desirable for this demographic, potentially improving adoption rates among traditionally resistant users. Additionally, by working with late adopters it is possible to identify the digital services they already use, are familiar with, and trust. With this understanding the rail sector could leverage these familiar platforms to promote and connect to additional digital resources as new systems are implemented.

This emphasis on understanding and incorporating late adopters' perspectives aligns with current industry practice, as several industry participants advised that rail sector organisations across Great Britain regularly engage with customer panels. These panels' members are selected to represent diverse travel patterns, demographics, health conditions and routes travelled. However, when recruiting new panel members, their levels of technological engagement and adoption behaviours are not currently considered as selection criteria. As railway services become increasingly digitalised (Durand et al., 2023a), understanding panel members' technology adoption preferences and tendencies would enable rail organisations to better assess the impact of digital transformation on different user groups. This insight could prove valuable in developing more inclusive services that consider the needs of all passengers.

This gap in considering technological engagement extends beyond customer panels to key industry policies. Notable sector-wide frameworks, including the Accessible Travel Policy (ORR, 2019), Rail Technical Strategy (2021), and GBRTT long-term strategy (2022), do not currently address technology engagement and adoption as accessibility concerns for rail services. Including technological engagement within these policies could help ensure digital accessibility is considered alongside physical and sensory accessibility needs when developing new services. This broader approach to accessibility could be particularly crucial as rail services continue to digitalise, helping to address varying levels of technological engagement among passengers. Furthermore, embedding digital accessibility considerations into policy frameworks could encourage rail organisations to maintain appropriate non-digital support mechanisms that are valued by this important passenger segment, ensuring services remain accessible to all passengers regardless of their technological capabilities.

The evidence presented in this section reveals the multifaceted requirements for supporting late adopter leisure passengers through rail sector digitalisation. Success factors extend beyond traditional marketing strategies, emphasising the importance of building trust through personalised support - particularly from railway staff and community volunteers. By expanding accessibility policies to include technological engagement factors, rail organisations could be better equipped and motivated to consider the wider implications of service digitisation. This broader approach to accessible travel would strengthen the sector's commitment to inclusive service delivery across all passenger groups. These insights provide a foundation for inclusive digitalisation of rail services in Great Britain that acknowledges varying levels of technological engagement across passenger demographics.

8.3 Limitations

This research has several limitations relating to its sample, geographical context and scope. As a qualitative study, the relatively small sample size means the findings cannot be considered generalisable, though valuable in-depth insights were produced. The recruitment of late adopters presented particular challenges, as these individuals tend to be more hesitant and sceptical users of technology (Rogers, 2003). Although the research successfully engaged participants from diverse demographic backgrounds, there were few participants who completely avoided technology use.

This may reflect the contemporary reality that total non-use of technology has become increasingly rare, as even reluctant users often need to engage with basic digital services for essential activities like banking, healthcare and communications which was highlighted by several participants of this research. This limitation highlights how the concept of ‘late adoption’ may be more relevant than ‘non-adoption’ in modern contexts. However, it may also be the case that those at the extremity of the late adopter spectrum are particularly difficult to engage and recruit.

Whilst this research provides valuable insights into rail travel experiences, the majority of the participant interviews and travel along journeys focused on the East Midlands region of England. This presents another limitation of the thesis as the rail network in Great Britain is complex with differing services and operators across the country. The East Midlands region has a combination of rural and urban routes with service availability differing between small, medium, and large stations. This could create experiences that differ markedly from those in other regions such as the West Midlands, Wales, or London. Therefore, the findings presented here about late adopter leisure travellers experiences may not fully reflect the experience of passengers in other parts of Britain.

A final limitation relates to the study's focused scope on rail travel experiences. Whilst the travel along methodology involved accompanying participants for their complete journey, observations and analysis concentrated specifically on rail-related activities rather than capturing the broader context of participants' day trips. Although time was spent with participants between their outbound and return rail journeys, these periods were not systematically analysed unless directly related to rail travel. While this focus enabled an in-depth examination of rail experiences, exploring how rail travel integrates with participants' wider leisure activities and onward journeys could offer valuable insights about how digital technologies are used or avoided across different stages of their complete day trips and holidays.

8.4 Recommendations for future research

This research opens up several directions for future investigation. The findings provide groundwork for more comprehensive studies of late adopters as a diverse user group, particularly their behaviours, preferences and experiences across different contexts. This research advocates examining these factors from a neutral stance, while applying

constraints negotiation theory would provide a structured framework for analysing the constraints of technology adoption for this user group – for instance, helping categorise and understand how different types of adoption constraint (intrapersonal, interpersonal, and structural) intersect and how these are negotiated. This theoretical lens could yield valuable insights into how to better support late adopters' negotiation processes and ultimately improve services and innovation adoption rates in the travel sector and beyond.

Moreover, within transport research, late adopters as leisure travellers remain understudied. Unlike regular commuters following familiar daily routes with specific transport modes, leisure travellers typically exercise more flexibility in their transport choices (Grobe et al., 2018). While this thesis explored late adopters' behaviours and preferences in rail travel, future research could expand understandings of late adopter leisure travel contexts in several ways. At an organisational level, studies could examine how transport providers' processes and practices shape the leisure travel experience, particularly considering how physical infrastructure and digital services might better accommodate the varied nature of leisure journeys for this passenger group. At an individual level, investigation into leisure passengers' specific needs and expectations could reveal how support mechanisms might be better tailored to late adopters who may be navigating unfamiliar routes, services and systems. This could include exploring how different forms of assistance - whether through staff interaction, physical signage, or digital interfaces - might be optimised for occasional use and leisure travel scenarios. Additionally, future studies could investigate behaviour-influencing constraints for late adopter leisure travellers in broader travel and tourism contexts, such as air travel and destination management.

Beyond examining late adopter experiences specifically, this research highlights opportunities for broader theoretical applications in accessible tourism research. While accessible tourism research continues to grow, the application of interdisciplinary frameworks to analyse complex tourism environments remains underexplored. Human factors approaches offer valuable insights for understanding accessibility constraints, yet their potential in tourism research is largely untapped. Future research could employ human factors methodologies, particularly cognitive work analysis, to examine constraints across diverse tourism contexts. There is potential for cognitive work analysis to be used in tourism experience design as it aligns with the three

fundamentals proposed by Tussyadiah (2013) being human-centred, following an iterative process, and being able to provide a holistic experience through design.

The novel methodology developed in this thesis, which combines human factors and leisure studies approaches, could be extended to analyse other bounded tourist spaces such as theme parks, airports, or even entire destinations. Through industry collaboration, focus groups, and engagement with visitors, researchers could develop detailed environmental models and identify constraints of tourist spaces. Such research would advance both theory and practice, informing how tourism operators can exceed accessibility standards and develop competitive advantage, while bridging the gap between human factors approaches and accessible tourism research.

Additionally, the combined approach using cognitive work analysis and constraints negotiation theory revealed important insights challenging the applicability of universal design in tourism contexts. Universal design in tourism, defined by the United Nations (2022) as "the design of products, environments, programmes and services to be useable by all people, to the greatest extent possible, without the need for adaptation or specialised design" is often proposed as a solution for accessibility. This research reveals the limitations of universal design as a comprehensive solution for accessible tourism, given the demonstrated diversity in user behaviours, influences and preferences. While digital services may aim for universal accessibility, late adopters often prefer traditional support methods and will find ways to navigate around digital systems to access services in ways that better suit their comfort levels. Further research is necessary to explore how universal design principles can better integrate both digital and traditional service approaches, reflecting the diverse ways users engage with and access tourism services.

8.5 Concluding remarks

This thesis reveals critical gaps in our understanding of late adopters as a diverse and significant user group, an issue gaining urgency as public services, including rail transport, become increasingly digitalised (Durand et al., 2022; Durand et al., 2023a). While digital transformation promises enhanced service delivery and efficiency, this research demonstrates that successful implementation depends on deeper understanding of late adopters' complex relationship with technology. Through applying a systematic approach in novel ways, this research challenges oversimplified

narratives about late adopters, revealing thoughtful technology users whose adoption patterns reflect careful evaluation rather than simple resistance.

The constraints analysis framework developed here bridges disciplinary boundaries between human factors and leisure studies, providing new methodological tools for examining complex travel environments. By conceptualising constraints as neutral factors with both positive and negative outcomes (Naikar, 2017; Mei and Lantai, 2018), this approach reveals nuanced insights into how late adopters engage with technology and the constraints of rail travel for this user group. The framework's integration of cognitive work analysis with constraints negotiation theory enables comprehensive examination of systemic relationships, potential constraints, and critical support mechanisms within the rail network. Through this lens, the research reveals how late adopters' engagement with technology varies significantly across different contexts, challenging assumptions about universal technology acceptance. The findings highlight that effective digitalisation involves maintaining accessible support mechanisms, particularly human assistance that late adopters find more reliable and reassuring, recognising that successful approaches to technology adoption in one setting may not translate effectively to others.

As the rail sector continues its digital transformation, understanding and addressing late adopters' needs becomes increasingly critical for ensuring inclusive service delivery. This research provides evidence that late adopters, representing potentially half of all leisure rail passengers, warrant specific consideration in service design and policy development (Rogers, 2003; Harvey et al., 2019). Currently, key industry frameworks overlook technological engagement as an accessibility concern, potentially disadvantaging passengers less familiar with, hesitant, or unable to use technology. These insights highlight opportunities for developing inclusive digital services that serve all passengers, regardless of their technological engagement levels.

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APPENDICES

Appendix 1: Example of Participant Information Sheets and Consent Forms

PROJECT INFORMATION



Date: [30/06/2021]

Project: [Mapping the online and offline passenger facing support/booking/information mechanisms in the rail sector.]

Faculty of Engineering Ethics Reference: [Number]

Purpose of the research: This study aims to map the online and offline booking, information, and support mechanisms that are currently available for passengers to use.

Nature of participation: Participation in this research is voluntary and will involve participating in an online workshop via MS Teams which should last no longer than 60 minutes. You will be asked to discuss the online and offline mechanisms that are currently available for passengers to use during their journey. You will also be asked to note down the systems/mechanisms you think of on paper or a Word document throughout the workshop. We are looking to compile a comprehensive list of all the available ways that passengers can book their journey, get information about their journey and access support during their journey. A PowerPoint presentation will be displayed during the workshop to prompt discussion around each of the different phases of the passenger journey.

Benefits and risks of the research: Your participation in this research will help us to map out the online and offline mechanisms that are currently available for passengers to use on the UK railway. This will help us to understand where later adopters and non-users of certain technologies might face additional barriers to travel. There are no risks associated with your participation in this workshop above and beyond those normally associated with undertaking an online workshop. Where all participants of the workshop agree, the session will be recorded to assist the researcher with compiling a comprehensive list of the different mechanisms discussed in the session. The recordings will be encrypted, stored in a secure password protected repository and only be accessed by the research team. The recordings will also be transcribed and anonymised. Transcriptions will also be encrypted, stored in a password protected repository and only accessed by the research team. Participant details will be retained by the research team in case a follow up conversation is required. In the reporting of results, the research team will anonymise the data you provide, however job title and rail organisation name may be stated in the reporting of results – for example, Station Manager – Network Rail.

Use of your data: As mentioned above, the data you provide will be anonymised and then used in supervision meetings and reports for the purpose of the research. The results may be disseminated via educational and industry seminars, conferences, and journal publications.

Future use of your data: Your data may be archived and reused in future for purposes that are in the public interest, or for historical, scientific, or statistical purposes. Your data will be stored on password protected University of Nottingham servers.

Procedure for withdrawal from the research: You may withdraw from the study at any point in the time leading up to and during the workshop. You do not have to give reasons for why you no longer want to take part. If you wish to withdraw, please contact the researcher. If you receive no response from the researcher, please contact the Faculty of Engineering Ethics Committee.

Contact details of the ethics committee. If you wish to file a complaint or exercise your rights, you can contact the Ethics Committee at the following address: ez-eng-ethics@nottingham.ac.uk

Consent Form

Date: 30/06/2021

Project: Mapping the digital and analogue passenger facing support mechanisms in the rail sector

Faculty of Engineering Ethics Reference:

Funded by: Horizon Centre for Doctoral Training at the University of Nottingham and the Rail Safety and Standards Board (RSSB).

Section 1

Section One: Taking part in the study

1.I have read and understood the project information sheet dated 30/09/2021, or it has been read to me. I have been able to ask questions about the study, and my questions have been answered satisfactorily.

- (•) Yes
- ( ) No

2.I give my voluntary consent to be a participant in this study and understand that I can refuse to answer any questions. I also understand that I can withdraw from the study at any time up until the end of the workshop, without having to give a reason.

- ( ) Yes
- ( ) No

3.I understand that taking part in the study requires me to provide data. This will involve taking part in an online workshop, and allow the researcher of this study to collect the following: Video recordings of the workshops hosted via Microsoft Teams (optional) Handwritten/typed I make during the workshop Handwritten/typed notes by the researcher about comments I make.

- ( ) Yes
- ( ) No

Section 2

Section Two: Use of my data in the study

4.I understand that data which can identify me will not be shared beyond the project team.

- ( ) Yes
- ( ) No

5.I agree that the data provided by me may be used for the following purposes: - Presentations and discussion of the project and its results in research activities (e.g., in supervision sessions, project meetings, conferences) - Publications and reports describing the project and its results - Dissemination of the project and its results, including publication of data on webpages and databases.

- Yes
- No

6.I give permission for my words to be quoted for the purposes described above and these will be quoted anonymously.

- Yes
- No

Section 3

Reuse of my data

7.I give permission for the data that I provide to be reused for the sole purposes of future research and learning.

- Yes
- No

8.I understand and agree that this may involve depositing my data in a data repository, which may be accessed by other researchers.

- Yes
- No

Section 4

Security of my data

9.I understand that safeguards will be put in place to protect my identity and my data during the research, and if my data is kept for future use. Safeguards include: Storing the raw (unprocessed) data in a password protected computer in a secure digital repository provided by the University of Nottingham. Only the research team will have access to any raw data.

- Yes
- No

10.I confirm that a written copy of these safeguards has been given to me in the University's privacy policy, and that they have been described to me and are acceptable to me.

- Yes
- No

11.I understand that no computer system is completely secure and that there is a risk that a third party could obtain a copy of my data.

- Yes
- No

Section 5

Copyright

12.I give permission for data gathered during this project to be used, copied, excerpted, annotated, displayed and distributed for the purposes to which I have consented.

- Yes
- No

Section 6

Signatures

13.Please type your full name below

14.Please type your initials to act as an electronic signature

15.Date

Recruitment Information (Stage One – Passenger Participant Interviews):

Are you someone that rarely uses the train? Are you a bit of a technophobe? Do you prefer printed tickets or person-person customer service over a smartphone app? If so, we are recruiting for a study that could interest you!

As part of a broader PhD project exploring the accessibility of rail services in the UK for people that are late adopters of technology, this study investigates the barriers and constraints to travelling by rail from the perspective of passengers that are later to use technology or prefer not to use modern technology. If this sounds like you, then we would invite you to get in touch to book a friendly chat (aka interview) about your experiences as an infrequent rail traveller.

We are looking for participants willing to volunteer for this study and who:

- Are over 18 years of age
- Could be considered a late adopter of technology (i.e., hesitant to use new technologies, prefer more traditional methods of communication, only upgrade to a new technology out of necessity, etc.)
- An infrequent/occasional or currently a non-user of the railway
- Willing to take part in an interview (face-to-face or virtually) lasting no longer than one hour

How do I sign up?

If you would like to participate, please read the details below and then get in touch with us via the email (Charlotte.lenton@nottingham.ac.uk).

What will I be asked to do?

If you agree to participate, you will be asked to complete a short questionnaire to assess your suitability to take part in this study. If suitable, you will be invited to attend a one-to-one interview (in-person or virtually) which will last no more than one hour. The interview will be focused on any previous rail travel experiences you have had, any problems you encountered (or anticipate you might encounter if you haven't travelled in a while) and talking through some hypothetical rail travel situations. The interview will be audio recorded, transcribed, and anonymised.

Will I be compensated for participating?

You will receive a £20 high street voucher as a thank you for your time.

Location:

Interview location is flexible (in-person or virtually).

1. University of Nottingham (room to be confirmed)
2. Virtually via MS Teams
3. The White Hart Hotel Restaurant, Boston
4. University of Lincoln (room to be confirmed)

Research data will be anonymised, and appropriate measures are in place to ensure confidentiality.

Who funds this work?

This study is funded by the EPSRC and Rail Safety and Standards Board (RSSB).

Information Sheet Ref: 07092022.1

Recruitment Information (Stage Two – Travel Along Primary Participant):

Thank you for taking part in the first stage of this study exploring the experiences of late adopters of technology as passengers of the railway. You have been identified as a suitable candidate to take part in the second stage of this research. Further to talking about your experiences and anticipated experiences of using the railway, we would like to invite you to take part in an accompanied journey with our researcher.

What will I be asked to do?

If you agree to participate in the second stage of this research, you will be asked to plan, book, and make a train journey whilst being accompanied by our researcher. This could be a train journey you are already planning on taking or a pre-designated journey as prescribed by our researcher which will take no longer than 90 minutes each way.

Within one week of completing the journey, you will also be invited to take part in a post-journey interview which will last no longer than one hour (this can be in-person or virtual).

We would like this experience to be as normal as possible for you, so if you usually travel with a companion (e.g. partner/spouse, relative, or friend) then you may wish to invite them to travel with you.

Will I be compensated for participating?

The train fare for the legs of the journey where the researcher was present will be reimbursed following participation in the study (after the accompanied journey has taken place).

You will also receive high street vouchers to thank you for your time. The value of this will depend on the length of your journey and time spent with the researcher (see table below).

Research Stage	Reward Voucher Amount
Stage Two – Accompanied Journey **Primary Participant** Up to 1hr Up to 2hrs More than 2hrs **Travel Companion** **(Secondary Participant)** Up to 1hr Up to 2hrs More than 2hrs	 £20 £35 £45 £10 £15 £20
Stage Two – After travel interview (30mins-1hr)	£15

Location:

The journey start location and final destination are highly flexible, and we will work around you if you already have some train travel plans. For example, if you were already considering taking the train for a day out shopping/going to the theatre I will accompany you on that journey if appropriate. (NB. You will only be reimbursed and receive reward vouchers for the legs of the journey where the researcher was present – i.e., times where you are participating in the study).

If you do not have any plans to travel via train, then we have several route options available to choose from:

Option One: Nottingham to Duffield (via Derby) – Approx. 2hr return journey

Option Two: Boston to Lincoln – Approx. 3hrs return journey

Option Three: Lincoln to Grantham (via Sleaford) – Approx. 3hrs return journey

Option Four: Lincoln to Gainsborough – Approx. 1hr return journey

Option Five: Boston to Sleaford – Approx. 1.5hrs return journey

Throughout the journey the researcher will be taking notes and photographs which will be anonymised, and appropriate measures are in place to ensure confidentiality.

Who funds this work?

This study is funded by the EPSRC and Rail Safety and Standards Board (RSSB).

Contact Information:

If you have any queries or concerns about taking part in this research, please get in touch with the lead researcher in the first instance:

Charlotte Lenton – Charlotte.lenton@nottingham.ac.uk

Information Sheet Reference: 07092022.2

Recruitment Information (Stage Two – Travel Along Travel Companion):

You have been identified as a travel companion to take an accompanied train journey with your friend/relative/partner and our researcher. This leaflet tells you a bit more about the study and what you will be asked to do.

As part of a broader PhD project exploring the accessibility of rail services in the UK for people that are late adopters of technology, this study investigates the barriers and constraints to travelling by rail from the perspective of passengers that are later to use technology or prefer not to use modern technology. Your friend/relative/partner has recently taken part in the first phase of this research which involved an interview talking about their experiences/anticipated experiences of travelling by train in the UK as a later adopter of technology. They have agreed to take part in the second phase of this research which now involves taking a train journey and they have requested that you join them as a travel companion.

What will I be asked to do?

If you agree to participate, you will be asked to travel by train with your friend/relative/partner as well as one of our researchers who will be observing the journey. This could be a journey you are already planning to take with them, or it could be an unmotivated journey that has been designed by our research team. Your friend/relative/partner will remain the primary participant in this study however, your presence and interactions with them will also be observed and recorded by our researcher as fieldnotes.

Will I be compensated for participating?

The train fare for the legs of the journey where the researcher was present will be reimbursed following participation in the study (after the accompanied journey has taken place).

You will also receive high street vouchers as a thank you for your time. The value of this will depend on the length of your journey and time spent with the researcher (see table below).

	Reward Voucher Amount
Stage Two – Accompanied Journey **Travel Companion** **(Secondary Participant)**	
Up to 1hr	£10
Up to 2hrs	£15
More than 2hrs	£20

Location:

The journey start and end location are highly flexible however, this will largely be determined by your friend/relative/partner as they are the primary participant. If you already have travel plans that our researcher could accompany you on we will work around this. For example, if you were already considering taking the train for a day out shopping/going to the theatre they will accompany you on that journey if appropriate. (NB. You will only be reimbursed and receive reward vouchers for the legs of the journey where the researcher was present – i.e., times where you are participating in the study).

If you do not have any plans to travel via train, then we have several route options available to choose from:

Option One: Nottingham to Duffield (via Derby) – Approx. 2hr return journey

Option Two: Boston to Lincoln – Approx. 3hrs return journey

Option Three: Lincoln to Grantham (via Sleaford) – Approx. 3hrs return journey

Option Four: Lincoln to Gainsborough – Approx. 1hr return journey

Option Five: Boston to Sleaford – Approx. 1.5hrs return journey

Throughout the journey the researcher will be taking notes and photographs which will be anonymised, and appropriate measures are in place to ensure confidentiality.

Who funds this work?

This study is funded by the EPSRC and Rail Safety and Standards Board (RSSB).

Contact Information:

If you have any queries or concerns about taking part in this research, please get in touch with the lead researcher in the first instance:

Charlotte Lenton – Charlotte.lenton@nottingham.ac.uk

Information Sheet Reference: 07092022.3

Project Title: Exploring Barriers to train travel in the UK for Late Adopters of Technology (Passenger Participant Interviews) **Consent Form:**
Funded by: EPSRC and RSSB

Section One: Taking Part in the Study

1. I have read and understood the project information sheet (Ref: 07092022.1) or it has been read to me. I have been able to ask questions about the study, and my questions have been answered to my satisfaction.
2. I give my voluntary consent to be a participant in this study and understand that I can refuse to answer any questions. I also understand that I can withdraw from the study at any time up until the end of the interview, without having to give a reason.
3. I understand that taking part in the study requires me to provide data. This will involve taking part in an interview and allow the researcher of this study to collect the following: Audio recording of the interview and handwritten/typed notes by the researcher about comments I make.

Section Two: Use of my Data in the Study

4. I understand that data which can identify me will not be shared beyond the project team.
5. I agree that the data provided by me may be used for the following purposes: - Presentations and discussion of the project and its results in research activities (e.g., in supervision sessions, project meetings, conferences) - Publications and reports describing the project and its results - Dissemination of the project and its results, including publication of data on webpages and databases.
6. I give permission for my words to be quoted for the purposes described above and these will be quoted anonymously.

Section Three: Reuse of my Data

7. I give permission for the data that I provide to be reused for the sole purposes of future research and learning.
8. I understand and agree that this may involve depositing my data in a data repository, which may be accessed by other researchers.

Section Four: Security of my Data

9. I understand that safeguards will be put in place to protect my identity and my data during the research, and if my data is kept for future use. Safeguards include: Storing the raw (unprocessed) data in a password protected computer in a secure digital repository provided by the University of Nottingham. Only the research team will have access to any raw data.
10. I confirm that a written copy of these safeguards has been given to me in the University's privacy policy, and that they have been described to me and are acceptable to me.
11. I understand that no computer system is completely secure and that there is a risk that a third party could obtain a copy of my data.

Section Five: Copyright

12. I give permission for data gathered during this project to be used, copied, excerpted, annotated, displayed and distributed for the purposes to which I have consented.

Section Six: Signatures

1. Name of participant:
2. Signature (participant):
3. Date:

Project Title: Exploring Barriers to train travel in the UK for Late Adopters of Technology (Accompanied Journeys) **Consent Form:**
Funded by: EPSRC and RSSB

Section One: Taking Part in the Study

1. I have read and understood the project information sheet (Ref: 07092022.2) or it has been read to me. I have been able to ask questions about the study, and my questions have been answered to my satisfaction.
2. I give my voluntary consent to be a participant in this study and understand that I can refuse to answer any questions. I also understand that I can withdraw from the study at any time up until the beginning of the accompanied journey, without having to give a reason.
3. I understand that taking part in the study requires me to provide data. This will involve taking part in an accompanied train journey and allow the researcher of this study to collect the following: handwritten/typed notes by the researcher about the journey, things that happen, and comments I make, and the taking of photographs by the researcher.

Section Two: Use of my Data in the Study

4. I understand that data which can identify me will not be shared beyond the project team.
5. I agree that the data provided by me may be used for the following purposes: - Presentations and discussion of the project and its results in research activities (e.g., in supervision sessions, project meetings, conferences) - Publications and reports describing the project and its results - Dissemination of the project and its results, including publication of data on webpages and databases.
6. I give permission for my words to be quoted for the purposes described above and these will be quoted anonymously.

Section Three: Reuse of my Data

7. I give permission for the data that I provide to be reused for the sole purposes of future research and learning.
8. I understand and agree that this may involve depositing my data in a data repository, which may be accessed by other researchers.

Section Four: Security of my Data

9. I understand that safeguards will be put in place to protect my identity and my data during the research, and if my data is kept for future use. Safeguards include: Storing the raw (unprocessed) data in a password protected computer in a secure digital repository provided by the University of Nottingham. Only the research team will have access to any raw data.
10. I confirm that a written copy of these safeguards has been given to me in the University's privacy policy, and that they have been described to me and are acceptable to me.
11. I understand that no computer system is completely secure and that there is a risk that a third party could obtain a copy of my data.

Section Five: Copyright

12. I give permission for data gathered during this project to be used, copied, excerpted, annotated, displayed and distributed for the purposes to which I have consented.

Section Six: Signatures

1. Name of participant: 2. Signature: 3. Date:

Project Title: Exploring Barriers to train travel in the UK for Late Adopters of Technology (Accompanied Journeys – Travel Companion) **Consent Form:**
Funded by: EPSRC and RSSB

Section One: Taking Part in the Study

1. I have read and understood the project information sheet (Ref: 07092022.3) or it has been read to me. I have been able to ask questions about the study, and my questions have been answered to my satisfaction.
2. I give my voluntary consent to be a participant in this study and understand that I can refuse to answer any questions. I also understand that I can withdraw from the study at any time up until the beginning of the accompanied journey, without having to give a reason.
3. I understand that taking part in the study requires me to provide data. This will involve taking part in an accompanied train journey and allow the researcher of this study to collect the following: handwritten/typed notes by the researcher about the journey, things that happen, and comments I make, and the taking of photographs by the researcher.

Section Two: Use of my Data in the Study

4. I understand that data which can identify me will not be shared beyond the project team.
5. I agree that the data provided by me may be used for the following purposes: - Presentations and discussion of the project and its results in research activities (e.g., in supervision sessions, project meetings, conferences) - Publications and reports describing the project and its results - Dissemination of the project and its results, including publication of data on webpages and databases.
6. I give permission for my words to be quoted for the purposes described above and these will be quoted anonymously.

Section Three: Reuse of my Data

7. I give permission for the data that I provide to be reused for the sole purposes of future research and learning.
8. I understand and agree that this may involve depositing my data in a data repository, which may be accessed by other researchers.

Section Four: Security of my Data

9. I understand that safeguards will be put in place to protect my identity and my data during the research, and if my data is kept for future use. Safeguards include: Storing the raw (unprocessed) data in a password protected computer in a secure digital repository provided by the University of Nottingham. Only the research team will have access to any raw data.
10. I confirm that a written copy of these safeguards has been given to me in the University's privacy policy, and that they have been described to me and are acceptable to me.
11. I understand that no computer system is completely secure and that there is a risk that a third party could obtain a copy of my data.

Section Five: Copyright

12. I give permission for data gathered during this project to be used, copied, excerpted, annotated, displayed and distributed for the purposes to which I have consented.

Section Six: Signatures

1. Name of participant: 2. Signature: 3. Date:

Ketso Focus Group Participant Recruitment Information (Existing Participants)

As part of a broader PhD project exploring the accessibility of rail services in the UK for people that are late adopters of technology, this study investigates the barriers and constraints to travelling by rail from the perspective of passengers that are later to use technology or prefer not to use modern technology. Following on from the previous study which you were involved in, we would like to invite you to take part in a focus group session with up to seven other participants. The focus group session will involve taking part in a practical activity and discussing your ideas with the others in the group. The main objective of the session is to start to develop some ideas and solutions to the barriers and challenges to travel for people who are less familiar with technology to enable better access to rail services.

How do I sign up?

If you would like to participate, please read the details below and then get in touch with us via the email (Charlotte.lenton@nottingham.ac.uk).

What will I be asked to do?

If you agree to participate, you will be invited to attend a group workshop session which will last no longer than three hours in total. The workshop will focus on developing some ideas and potential solutions to the challenges to accessing and using rail services for people that are less familiar with using technology. There will be up to seven other participants taking part in the workshop with you. The researcher will be taking handwritten notes throughout the workshop and photographs will be taken of the final workshop worksheet.

Will I be compensated for participating?

Pizza will be provided during the workshop – *Face-to-face workshops only*. You will also receive a £15 high street or Amazon voucher as a thank you for your time (both face-to-face and virtual workshops).

Location:

Workshop location is flexible, but it is likely that the sessions will take place at the Len Medlock Voluntary Centre in Boston. The full address is: The Len Medlock Voluntary Centre, St Georges Rd, Boston PE21 8YB.

Research data will be anonymised, and appropriate measures are in place to ensure confidentiality.

Who funds this work?

This study is funded by the EPSRC and Rail Safety and Standards Board (RSSB).

Information Sheet Ref: 27062023/1.

Ketso Focus Group Participant Recruitment Information (New Participants)

As part of a broader PhD project exploring the accessibility of rail services in the UK for people that are late adopters of technology, this study investigates the barriers and constraints to travelling by rail from the perspective of passengers that are later to use technology or prefer not to use modern technology. If this sounds like you, we would like to invite you to take part in a focus group session with up to seven other participants. The focus group session will involve taking part in a practical activity and discussing your ideas with the others in the group. The main objective of the session is to start to develop some ideas and solutions to the barriers and challenges to travel for people who are less familiar with technology to enable better access to rail services.

We are looking for participants willing to volunteer for this study and who:

- Are over 18 years of age
- Could be considered a late adopter of technology (i.e., hesitant to use new technologies, prefer more traditional methods of communication, only upgrade to a new technology out of necessity, etc.)
- An infrequent/occasional or currently a non-user of the railway

How do I sign up?

If you would like to participate, please read the details below and then get in touch with us via the email (Charlotte.lenton@nottingham.ac.uk).

What will I be asked to do?

If you agree to participate, you will be invited to attend a group workshop session which will last no longer than three hours in total. The workshop will focus on developing some ideas and potential solutions to the challenges to accessing and using rail services for people that are less familiar with using technology. There will be up to seven other participants taking part in the workshop with you. The researcher will be taking handwritten notes throughout the workshop and photographs will be taken of the final workshop worksheet.

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Pizza will be provided during the workshop – *Face-to-face workshops only*.

You will also receive a £15 high street or Amazon voucher as a thank you for your time.

Location:

Interview location is flexible, but it is likely that the sessions will take place at the Len Medlock Voluntary Centre in Boston. The full address is: The Len Medlock Voluntary Centre, St Georges Rd, Boston PE21 8YB.

Research data will be anonymised, and appropriate measures are in place to ensure confidentiality.

Who funds this work?

This study is funded by the EPSRC and Rail Safety and Standards Board (RSSB).

Information Sheet Ref: 27062023/2.

Project Title: Exploring Barriers to train travel in the UK for Late Adopters of Technology (Ketso Focus Group Sessions) **Consent Form:**
Funded by: EPSRC and RSSB
Section One: Taking Part in the Study

1. I have read and understood the project information sheet (Ref: 27062023/1 or 27062023/2) or it has been read to me. I have been able to ask questions about the study, and my questions have been answered to my satisfaction.
2. I give my voluntary consent to be a participant in this study and understand that I can refuse to answer any questions. I also understand that I can withdraw from the study at any time up until the end of the interview, without having to give a reason.
3. I understand that taking part in the study requires me to provide data. This will involve taking part in a workshop and allow the researcher of this study to collect the following: Handwritten/typed notes by the researcher about comments I make and photographs of the workshop activity sheet.

Section Two: Use of my Data in the Study

4. I understand that data which can identify me will not be shared beyond the project team.
5. I agree that the data provided by me may be used for the following purposes: - Presentations and discussion of the project and its results in research activities (e.g., in supervision sessions, project meetings, conferences) - Publications and reports describing the project and its results - Dissemination of the project and its results, including publication of data on webpages and databases.
6. I give permission for my words to be quoted for the purposes described above and these will be quoted anonymously.

Section Three: Reuse of my Data

7. I give permission for the data that I provide to be reused for the sole purposes of future research and learning.
8. I understand and agree that this may involve depositing my data in a data repository, which may be accessed by other researchers.

Section Four: Security of my Data

9. I understand that safeguards will be put in place to protect my identity and my data during the research, and if my data is kept for future use. Safeguards include: Storing the raw (unprocessed) data in a password protected computer in a secure digital repository provided by the University of Nottingham. Only the research team will have access to any raw data.
10. I confirm that a written copy of these safeguards has been given to me in the University's privacy policy, and that they have been described to me and are acceptable to me.
11. I understand that no computer system is completely secure and that there is a risk that a third party could obtain a copy of my data.

Section Five: Copyright

12. I give permission for data gathered during this project to be used, copied, excerpted, annotated, displayed and distributed for the purposes to which I have consented.

Section Six: Signatures

13. Name of participant:
14. Signature (participant):
15. Date:

Passenger Information & Support Workshops

Please (1) add any other mechanisms you can think of in blue, (2) highlight the most and least effective mechanism for each phase for passengers that might have difficulties using technology.

Journey Phase	Offline	Online	Hybrid
1. Information & planning *Fact finding, journey planning, accessibility information etc*	• Ticket office (at manned stations) • Timetable leaflets • Timetable posters • Accessibility information leaflets • TOC Contact Centre	• National Rail Enquiries App • Timetable on TOC website • Online enquiries form on TOC website • Alert Me in Messenger/WhatsApp • Tweet the TOC • Message the TOC (Facebook) • National Rail Enquiries website	
2. Booking *Pre-booking tickets, purchasing tickets for an imminent journey, purchasing season tickets etc*	• Ticket office (at manned stations) • Telesales (depending on TOC) • Purchase on train (depending on TOC) • Bus Company (combined bus/rail ticket)	• TOC website/mobile app • Third party website/mobile app	• Ticket machine (at station)
3. Pre-journey *Arrival at the station, disruption information, station navigation, station facilities, assistance requests etc*	• Information posters (at station) • Station map • Station staff (at manned stations) • Wayfinding Signage	• National Rail Enquiries website/app • TOC/Network Rail website/app • Alert Me via Messenger/WhatsApp • Google Maps • Navigation app/technology	• Digital display boards (at station) • Help Points
4. In-journey *Boarding, finding a seat/reserved seat, locating on-board facilities, knowing when to prepare to alight etc*	• Train guard • Catering Crew • Revenue staff	• National Rail Enquiries website/app • Alert Me via Messenger/WhatsApp	• Digital display boards (onboard) ○ Coach information ○ Stopping Pattern ○ Seat Reservation • Onboard Announcements
5. Post-journey *Station navigation, connecting train information, onward travel information, assistance requests, complaints etc*	• Station staff (at manned stations) • Signage at the station • Information posters • Station map • Leaflets	• National Rail Enquiries website/app • Third party mobile app (e.g. Trainline) • Alert Me via Messenger/WhatsApp • Google Maps	• Digital display boards (at station) • Announcements

Appendix 3: Semi-Structured Interview Schedule

Section One: About You

Age Group: 18-30 31-40 41-50 51-60 61-70 Over 70
Employment status
Highest level of education
Do you have any disabilities or impairments?
Do you live alone or with others?
Do you have any family members close by?
Do you meet up with friends?

Section Two: Technology in Daily Life

Do you use any digital technologies on a day-to-day basis? (e.g., smartphone, tablet/iPad, TV, computer/laptop)
What do you use these things to do? (e.g., social media, games, news?)
If you don't use technology very much, how do you: Communicate with your friends or family? Receive news?
What is it that would put you off using new technology? *Not knowing how to use it?* *Not seeing a need for it?*

Section Three: Train Journeys

Imagine that you need to use the train to get to a different town or city in a few days' time from now.

How would you find out if there would be a suitable train for you to go on? *Would you use any technology to help you?* *Would you ask other people to help you?* *Do you think the rail service could do anything to make this easier for you?* *Can you imagine making this journey solo or would you make sure you had a travel companion? If so, who would that be?*
If you decided to go on the train, how would you go about getting a ticket? *Have you considered using any technology to help you?* *Would you get help from someone else?* *What are the reasons for you not using technology to get tickets for your journey?* *How do you think the rail service could make getting tickets for travelling easier?*
On the day that you are due to travel, is there anything you would want to do before leaving the house to prepare for your journey by train? *If you wanted to check for any travel disruption, how might you do this?* *Would you need to print any tickets at home?* *Would you need to organise transport to get you to the station? – How would you organise this?* *Would you leave early in anticipation of problems? If so, how early?*
Imagine that you've arrived at the train station. What sort of things do you think you would need to do now? *If you're collecting tickets, how would you do this?* *How would you find the platform you need to be waiting at for your train?* *If you need help, what would you do?*
Do you think you would need to look for any information whilst you're waiting at the station?

How would you get this information?
How about when you're on the train, do you think you'll need to find out anything new then? *Would you want to know if there's any spare/unreserved seats on any carriages if you hadn't got a seat booked?* *How would you find out which station the train is calling at next?* *How would you know when you should be preparing to alight the train?*
If you were to be experiencing a problem at some stage in your journey, for example there could be disruption or your train might be delayed/cancelled, how do you think technology could help you to resolve the issues you were experiencing? *What would you do if the station you were at was 'unstaffed' or it was outside of the office hours of station staff?*
You said earlier that you sometimes use a smartphone, tablet/iPad, or computer in your day-to-day life for things like browsing online, would you consider using this to help you travel by train? *If so, how do you think it could help?* *If not, why wouldn't you want to use this to support your journey?* *What do you think the rail services could do to help you to use technology to support your journey by train?*
Are you planning on taking any journeys by train? *If so, where are you planning on going?* *Why are/aren't you thinking of using the train for that journey?*

Appendix 4: Travel Along Thematic Analysis with Theme Descriptions

Theme	Sub-Theme	Description
Avoidance of staff support		Passenger spends extended periods of time trying to work out what they have to do themselves and appears to be actively avoiding engaging with staff to help with their travel
Insider information	Information understandable to those with prior experience	The information provided by the rail network is difficult to understand for people with limited prior experience of rail travel
	Uncertainty associated with being an outsider	Passengers express feelings of anxiety and worry as a result of being unable to easily understand the information provided and the processes associated with travelling by train
Searching for confirmatory signs	Looking for audio/visual confirmation	Physical activity undertaken to be frequently looking around the environment for audio and/or visual indication they are in the right place or doing the right thing
	When something 'looks' or 'feels' right	Undertaking an activity with confidence because the situation looks right or feels right to them
	Observing and/or copying others	Watching and/or copying other passengers who may appear to know what they are doing
Being given permission	Permission to do something through engagement with staff	When the passenger is unsure if they are allowed to do something, they engage with a member of staff to check they are permitted
	Visual signage indicating permission to do something	Checking the environment for visual signage indicating permission to do something – i.e. waiting area open
	Having a sense of being unentitled to do something	When the permission is not explicitly granted the passenger feels unentitled to do something – i.e. other passenger had leg out covering space where passenger wanted to sit
Preparations	Use of technology to prepare	Using technology to prepare for travel in the home, travelling to the station, in the station, and on the train environments

	Anticipation of something not going how they expected	Engaging in preparation activities to reduce the risk of something not going to plan
	Time factors	Time constraints influence the amount of preparation work carried out prior to a journey
	Cost factors	Engaging in research and preparatory activities in an attempt to save money or find out travel costs
Impact of crowds and busy trains		Environmental factors affecting passenger experience due to varying levels of activity and crowdedness
Device type matters		Undertaking activities for rail travel on the preferred device matters
Making mistakes		Worrying about making mistakes and mistakes actually happening during travel
Staff support		Engagement with staff to support with the journey
Familiarity	Familiarity with systems	Being familiar with rail processes
	Familiarity with places	Being familiar with rail travel environments and/or the destination