Heritage User Experience Design: A Journey Driven Simulation Approach

A thesis submitted for the degree of Doctor of Philosophy

By

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ABSTRACT

Museum visitor expectations continually evolve as new forms of technology mediate ever more personalised interactions, not only within the museum, but also virtually around the physical environment. Designing visitor journey experiences that support visitor heterogeneity are complex. Consequently, it is difficult for museum management and collection managers to respond effectively in their design of heritage experiences. Understanding human behaviour at scale is challenging, often explored in other disciplines by simulating generic process models and scenarios. Creating experiences for cultural heritage persona remains a challenge because no systematic methodology currently exists.

Design science research methodology is employed with design, build and evaluate cycles undertaken over three interlinked iterations. The first iteration constructs the necessary scaffolding for heritage experience design. Interviews with heritage stakeholders are analysed using grounded theory techniques - resulting in a heritage user experience taxonomy. The second iteration constructs a Heritage User Experience (HUX) framework synthesising service design practice with practical application within two focus groups in a UK museum. Heritage stakeholders and visitors designed and built journey based experiences with a focus on both the museum and surrounding physical landscape. The framework was then evaluated in the museum through design instantiations of Visitor Journey Map (VJM) models for several scenarios. The third iteration extends the HUX framework, adding dynamic elements to the already-designed journeys. Simulation models are used to explore visitor experience and behaviour using system thinking tools to better understand the effectiveness and quality of the experience journey.

A Heritage User Experience and Simulation (HUXSIM) methodological framework results from the three iterations. The research contributes new design methods that are able to effectively help experience designers and museum workers investigate the dynamic use of digital services and technology in a heritage setting. The framework includes design thinking tools (Persona and Customer Journey Mapping) as modelling foundations for collaborative design. Heritage experience designers can then transform a Visitor Journey Map (VJM) model into a system dynamic simulation. The HUXSIM approach allows designers to understand persona behaviour when interacting with new digital services using these novel simulations.

DEDICATION

I dedicate this work to God almighty, to which all glory shall always be, for giving me the health and motivation to finish my thesis

{ رَبِّ أَوْزِعْنِي أَنْ أَشْكُرَ نِعْمَتَكَ الَّتِي أَنْعَمْتَ عَلَيَّ وَعَلَىٰ وَالِدَيَّ وَأَنْ أَعْمَلَ صَالِحًا تَرْضَاهُ وَأَدْخِلْنِي بِرَحْمَتِكَ فِي عِبَادِكَ الصَّالِحِين}

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DECLARATION

The following papers have been published (or submitted for publication) as a direct result of the research discussed in this thesis:

- Al Subhi, N.N., Bell, D. and Lashmar, P. (2015) “Location Based Modelling for Heritage Mobile Applications”. In *UKAIS Conference* (p. 30).

- Al Subhi, N.N., Bell, D. and Lashmar, P. (2016) “User Experience (UX) of Heritage Journeys: Design Taxonomy for Quality Measurement”. In *International Conference on Human-Computer Interaction* (pp. 247-256). Springer, Cham.

- Zamri, K.Y. and Al Subhi, N.N. (2015) “10 user interface elements for mobile learning application development”. In *Interactive Mobile Communication Technologies and Learning (IMCL), 2015 International Conference* (pp. 44-50). IEEE.

- Al Subhi, N.N. and Bell, D. (2018) “Hybrid User Experience (UX) Modelling in a Heritage Setting”. In *Proceedings of the 2018 Winter Simulation Conference* (pp. 1298-1309). IEEE.

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LIST OF ABBREVIATIONS

CJM	Customer Journey Map
CLD	Causal Loop Diagram
DSR	Design Science Research
GT	Grounded Theory
HUX	Heritage User Experience
HUXSIM	Heritage User Experience and Simulation
HCI	Human Computer Interaction
IS	Information Systems
iSEE	Interactive Social Experience Engine for History and Heritage
PC#	Participant Code Number
QoE	Quality of Experience
QoS	Quality of Service
SD	System Dynamics
SFM	Stock-and-Flow Models
UCD	User Centred Design
UK	United Kingdom
UX	User Experience
VJM	Visitor Journey Map

CHAPTER 1 Introduction

1.1 Overview

This chapter presents an overview of the thesis, investigating design in the heritage sector using collaborative tools and techniques. After providing a contextual background to digital experiences in museums, the aims and objectives will be presented. The research methodology used to achieve the aims and objectives will be described, followed by an outline of the thesis' chapters. A diagrammatic representation of the thesis is also presented (Figure 1.1).

This chapter is structured as follows: Section 1.2 presents the research problem and the motivation for carrying out this study; Section 1.3 outlines the research aims and objectives; Section 1.4 presents a description of the research methodology; and Section 1.5 provides a structure for the thesis and a summary diagram.

1.2 Research Background and Motivation

Digital user experience (UX) is a recent introduction to the field of Human Computer Interactions (Garrett et al., 2010). Interactions between users and products are central: "this includes the degree to which all our senses are gratified (aesthetic experience), the meanings we attach to the product (experience of meaning), and the feelings and emotions that are elicited (emotional experience)" (Hekkert, 2006, p.160). UX is significant because users must easily interact with web sites, products and services to understand how to use them. Developing an interaction-rich experience will drive users back for further interaction.

There is a growing need in business to focus on creating outstanding customer experiences (Razzouk and Shute, 2012; Pine II and Gilmore, 1998). This paradigm change, known as the experience economy, represents a move from offering services to offering experiences (Alves and Nunes, 2013). This authorises a designer to think of a design problem in terms of combined experiences, which are perceived holistically by individuals (Bitner, 1992), instead of designing one or more specific artefacts. The design of digital experiences is usually expressed through brainstorming in a specific domain (Leung, 2008). The process of designing a digital experience, and how it is overseen,

constitutes a key issue for organisations that depend on multidisciplinary groups and teams.

The heritage sector is a complex environment. Like other human interaction systems, it is changing in terms of digital technology expansion. While digital heritage experiences are significant, a higher-quality experience design is expected to motivate and interact with visitors, enriching their heritage experience. The dynamic online life and digital heritage have changed the tools that bring experience to visitors. Despite there being extensive research in the field of museums and cultural heritage, focusing on visitor experiences, there is a lack of studies concentrating on the design process of heritage journeys and the quality of experience (QoE).

Scholars have studied specific systems to investigate interactions and UX from different perspectives. These have contributed to the field by offering different views on applying technology and digital experiences, in and around museums (Gentile et al., 2011; Kocsis et al., 2012, Andolina et al., 2012 and Boca et al., 2013). In addition, Wang et al. (2009) recommended that curators should adopt an immersive museum environment that combines the museum website with the physical museum space. By reviewing the literature, it is clear that many authors have focused on the motivation behind the digital interactive heritage experience. However, there is a lack of literature on considering visitor experience design as a tactic in the wider digital heritage environment. Exploring and understanding how museum workers and interested parties think about the digital interactive heritage environment may help to develop more common approaches to design processes of users/visitor experiences (Al Subhi et al., 2016).

Research on the design of digital user experiences in medical and educational domains is more mature than the heritage sector. Over the past decade, the heritage domain has been subjected to little research on user experiences and QoE. The significant increase in the internet of things and digital heritage has affected how experiences are presented to visitors. Digital heritage literature indicates that many organisations hold traditional views on heritage and do not fully recognise its impact on all areas of visitor experience. Many professionals do not understand the significance of visitor experiences and thus fail to articulate the real value of their contributions. Stakeholders and museum personnel should work together to build their own heritage experience.

Most papers which cover specific types of design thinking tools have focused on the medical and educational domains (Fors, 2013; Moore, 2015). Few published papers cover

design thinking for designing the digital heritage experience. Examples of research techniques include focus groups, customer journey map (CJM), persona and scenarios. It is evident that more research is required covering digital experience design across the heritage sector. Higher quality experience designs are expected to provide ways to motivate and interact with visitors, to enhance their heritage experience.

However, to overcome the limitations of traditional experience design techniques, there is an opportunity for this study to employ system thinking tools. Utilisation of System Dynamics (SD) simulations using Stock-and-Flow Models (SFM) should help to capture the complexity of visitor interactions in historical museums. System thinking provides a powerful language to communicate and investigate complex issues (Peters, 2014). Using system dynamics, researchers can simulate process scenarios which cannot be carried out on real populations, or for which historical data on natural experiments is not available (Bishai et al., 2014).

The potential of design and system thinking techniques to overcome the limitations of traditional experience designs will be emphasised in this study. The approach will overcome the limitations of the traditional experience designs for visitors, by providing a universal view for visitor behaviour, along with creating a unique position and brand in the heritage sector to explore dynamic visitor behaviour. Designing journey experiences that better support visitor heterogeneity is a complex task. Thus it is difficult for museum management and collection managers to respond effectively in the design of heritage experiences. Consequently, the research question starts by asking if process (or method) exists for the design of heritage user experience and explore dynamic visitor behaviours.

1.3 Research Aim and Objectives

The main aim of this research is:

To design more effective approaches for heritage stakeholders to motivate visitor engagement, focusing on a methodological framework for journey-based experience design.

In fulfilling this aim, the following objectives will be considered:

Objective 1: To investigate the state-of-the-art experience design techniques for visitors in the heritage domain, highlighting capabilities and limitations in the design of heritage experiences. **(Chapter 2)**

Objective 2: To investigate the need for innovative technologies to build structured frameworks to help categorise visitor experiences. **(Chapters 3 and 4)**

Objective 3: To design and develop a visitor experience model for different personas and to capture their behaviours and emotions during heritage experiences. **(Chapter 5)**

Objective 4: To develop a methodological framework that considers the findings of objective 3, in providing a novel approach to explore visitor dynamic behaviours. **(Chapter 6)**

Objective 5: To evaluate the utility and efficiency of the proposed framework by instantiating the framework for a number of scenarios and using simulation to generalise and confirm findings. **(Chapter 6)**

1.4 Research Approach

Design Science Research (DSR) was chosen as the research strategy for executing this research. A set of analytical techniques from the problem space are used to understand, explain and improve elements of an IT solution (or artefacts) (Hevner et al., 2004). DSR is considered both a product and a process. The process incorporates a set of designs and behavioural science activities: building, evaluating, justifying and theorising (March & Smith, 1995). The products of this approach can be classified according to four product classifications (March & Smith, 1995):

- Constructs are sets of concepts that define problems and solutions.
- Models describe real-world situations of the design problem and its solution space.
- Methods provide guidance on how to solve problems using constructs and models. They are in effect methodological tools.
- Instantiations are the implementation of constructs, models and methods, allowing actual evaluation of feasibility and effectiveness of the design research artefact.

DSR must be applied as a search process for effective solutions. To demonstrate effectiveness of the solution, rigorous DSR evaluation methods from the knowledge space

must be executed to evaluate the quality of the artefact (Hevner et al., 2004). DSR seeks to achieve an appropriate solution to the design problem in an iterative refinement manner, where each iteration builds and evaluates cycles, contributing new learning and knowledge that feeds into consequent iterations (Peffers et al., 2007).

Designing a heritage UX as a research area is a new concept; consequently DSR was used as the research methodology, as it allowed learning to evolve as the solution was developed for the problem space (Vaishnavi & Kuechler, 2004). DSR was employed as a problem-solving methodology with an iterative build and evaluate design cycle creating purposefully designed artefact. Five consecutive DSR phases were applied to the design and implementation processes. These phases are:

1. Problem awareness and motivation involves conducting an extensive review into the digital experience in museums and QoE. In addition, to investigate state-of-the-art design experience techniques and tools, identifying a problem and providing justification for addressing the selected solutions, thus confirming the lack of design experience tools in heritage experience design.
2. Solution selection and suggestions involves introducing ideas for solving problems using the approaches and frameworks. It involves design thinking and system dynamics to solve the problem. This phase is presented in Chapter 2 and 3. Further suggestions arise in later iterations; for example, new knowledge is gained during development and evaluation of the heritage taxonomy. Thus, suggestions from the build and evaluate cycles initiate subsequent iterations.
3. Development is accomplished by building research artefacts. This phase is carried out over three iterations. Different approaches address the objectives of each iteration. The knowledge derived from each iteration is fed into the next iteration, while attempting to solve the problem identified in phase one.
4. Evaluation is performed by validating the effectiveness of the frameworks adopted to address a research problem. DSR evaluation criteria examine the efficiency and generality of the framework. Applying the Heritage User Experience (HUX) framework to real life scenarios in the Dorset County Museum results in extending the framework to serve as an instantiation of the Heritage User Experience and Simulation methodological (HUXSIM) framework. This framework is used to validate scenario evaluations over different Visitor Journey Maps (VJM) in iteration 3. Reflections on the research outcomes is provided.

5. Conclusion is the final phase of the design research cycle and presents the research outputs. In addition, limitations of the research are presented and ideas for future work are suggested.

Applying March & Smith's (1995) design research product classification to illustrate research contributions leads to identifying the main design artefact as the development of the HUXSIM. To achieve the main artefact for this research, the following activities were conducted in an iterative DSR manner. The activities consisted of three iterations in building consequent sets of constructs, models, methods and instantiations. These iterations are:

Iteration One: This iteration was achieved by synthesising and analysing interview outcomes from heritage stakeholders. A taxonomy of heritage user experience was developed using Grounded Theory (GT) techniques to analyse interview data. The primary purpose was to guide experience designers on choices initiating high-quality user experiences in a heritage context (Al Subhi et al., 2016). Nonetheless, this iteration showed that the heritage domains lacked a common design process for heritage journeys, in relation to rapid changes seen in digital environments. Thus, greater improvements on Personas representing types of user and motivating visitors are vital. Therefore, the importance of developing other techniques and tools throughout the next iteration is clear, whilst utilising and building on the initial framework.

Iteration Two: The framework is extended by applying design thinking tools and techniques. Examples include personas and CJMs, which help designers develop journey experiences for visitors. A User Centred Design (UCD) technique involved users in designing HUX frameworks. This iteration contributed a secondary design structured process model for VJM design. This was done by conducting studies in the Dorset County Museum to identify and understand the design process from a visitor and stakeholder perspective. Moreover, it contributed to the literature by highlighting state-of-the-art techniques for heritage journey designs.

Iteration Three: To address the limitations highlighted in iteration two, this iteration sought to provide a novel approach for adding dynamic behaviour modelling to the experience design, utilising SD Modelling. This uncovered visitor dynamic behaviours in an experience journey and, importantly, it identified the transfer from journey maps to SD Modelling. The SFM was validated by conducting a simulation experiment using the Vensim software. This iteration contributes to DSR by providing HUXSIM

methodological frameworks which are discussed in chapter 6. Chapter 3 provides further explanation of the phases and iterations that were undertakes.

1.5 Thesis Structure

This thesis is structured as follows:

Chapter 2 presents a literature review focusing on key study areas: digital experiences in museums, design of digital experiences, challenges in heritage experience designs, design thinking tools and SD modelling. This chapter is organised into three sections. The first section investigates state-of-the-art digital experiences in museums, highlighting the challenges of heritage experience design to understand visitors. The second section critically reviews the design of digital experiences; it introduces the concept of QoE models, outlining their benefits and limitations in this study. This section critically reviews design thinking tools and techniques to design experiences, pointing to a gap in having a structured process to design visitor experiences. The third section highlights the potential of systems thinking techniques to explore visitor behaviours, thereby highlighting the need for this research.

Chapter 3 proposes a DSR approach to address the research problem. The chapter presents a background summary of design research. DSR is used to effectively conduct a valid information systems search. Justification for adopting specific methods and techniques are also presented. Research iterations are identified and research outputs are categorised based on the design research products classification. The chapter concludes by explaining the steps carried out to meet the aims and objectives.

Chapter 4 presents the first DSR iteration of the study, which focuses on developing a heritage taxonomy. Semi-structured interviews gather in-depth information. The Grounded Theory technique is adopted to extract and analyse data from stakeholders, to uncover elements of designing visitors' experiences, thus developing the taxonomy. The steps involved in building the taxonomy are explained and its implementation detailed. The output of the iteration is presented as a set of design research products. During the execution of this cycle, additional knowledge is gained about the problem domain. This knowledge was fed into subsequent iterations.

Chapter 5 presents the implementation of the second DSR iteration, which builds on the heritage taxonomy developed in Chapter 4 by introducing design thinking tools and

techniques to a design process called the HUX framework. To build the HUX framework, a UCD technique is followed by use of a focus group with visitors and stakeholders. The developed artefact is instantiated in the Dorset County Museum to validate the design process of a static VJM. The VJM model outcomes are evaluated by comparing them with the components of a CJM (Chapter 2).

Chapter 6 presents the execution of the third DSR iteration. This chapter expands on Chapter 5 by extending the methodological framework HUX, to incorporate SD modelling (HUXSIM). A detailed explanation and demonstration of the extension process, that includes Causal Loop Diagram (CLD) and SFM, is presented. Moreover, an SFM is established to explore the dynamic behaviours of visitors, by extracting elements from VJM models. A validation of the HUXSIM framework is also presented. The validation is carried out using the Vensim software as simulation software. Details about the Vensim software are presented in Chapter 3.

Chapter 7 concludes the thesis and presents key contributions and findings. It summarises how the research achieved its aims and objectives. In addition, research contributions made by the study are presented. Research limitations are also explained, along with ideas for future research.

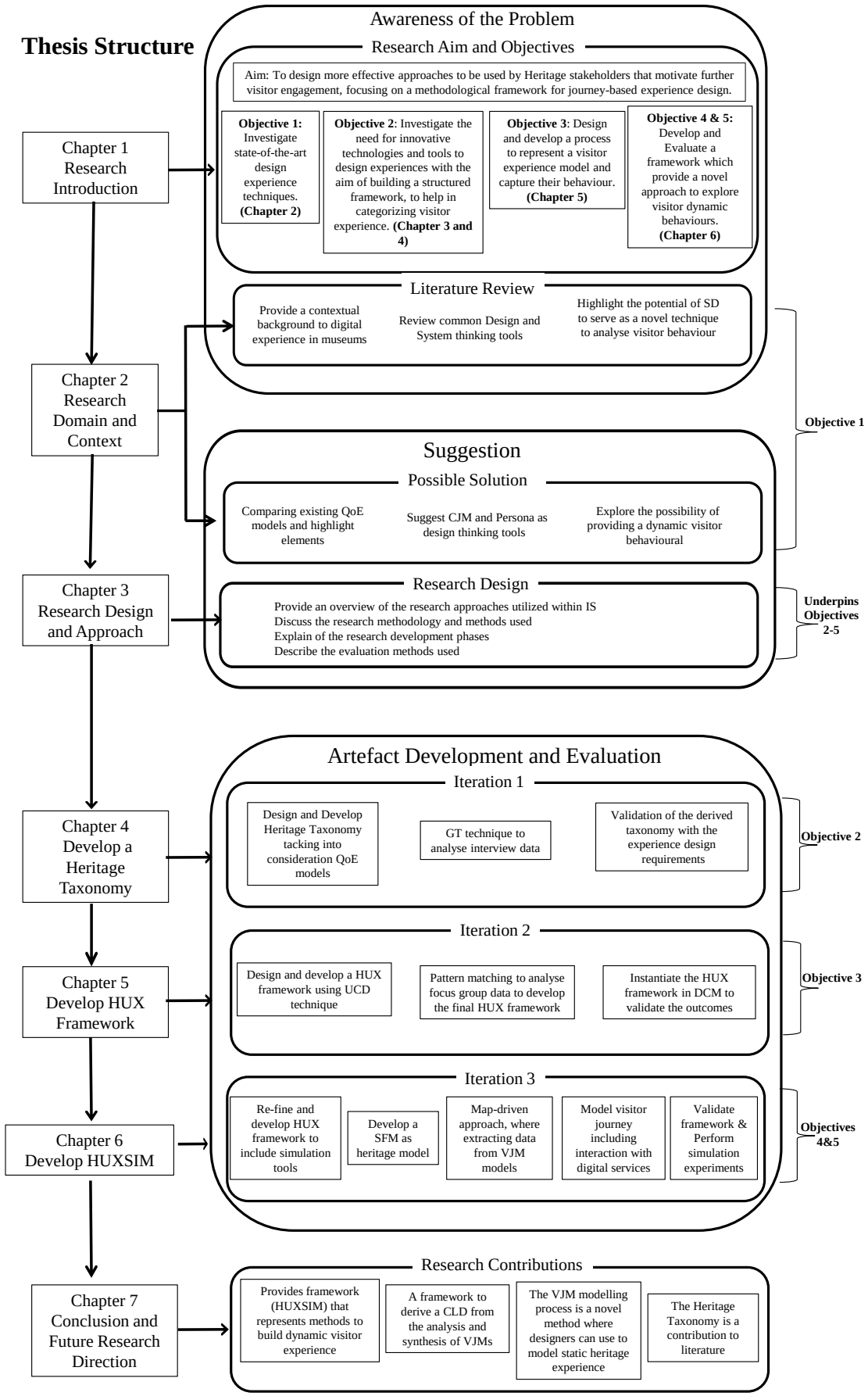


Figure 1.1: Overview of the thesis

CHAPTER 2 Literature Review

2.1 Introduction

This chapter explores state-of-the-art experience design for visitors in the heritage domain. The aims of this chapter are to: (1) provide contextual background to digital experience in museums; (2) critically review the design of digital experiences; (3) present customer journey mapping (CJM) and persona use as a method to understand visitor journey experiences; and (4) highlight the potential of design thinking and system dynamic models to serve as a novel tool to design visitor journeys.

Section 2.2 presents the background information on digital experiences in museums and narrows the focus to the challenges of heritage experience design in order to understand visitor journeys. Section 2.3 reviews the existing literature on the design of digital experiences and also introduces CJM within experience design, exploring methods that engage visitors in the design heritage experience. It also presents a critical review of their benefits and the limitations to this study, highlighting a gap in the structured process to design visitor experiences. Section 2.4 explores the potential for utilising systems thinking techniques to overcome the limitations of previous studies by discussing its application in different domains, thereby supporting the need for this research. Finally, a summary of the chapter is provided in Section 2.5.

2.2 Digital Experience in Museums

Understanding the elements of UX is necessary before undertaking a full UX design. Taking into consideration the interaction between the user, the system, devices, and content, UX is results in the satisfaction a user gets from interacting with a product or digital tool. In addition, it can encompass all experiences (physical, sensory, emotional and mental) a person has when interacting with a digital tool (Stokes, 2015). According to Hassenzahl (2008, p.12), "UX is a momentary, primarily evaluative feeling (good/bad) while interacting with a product or service"; whereas Hekkert (2006, p.160) holds the view that UX is the whole set of affects that are caused by an interaction between a user and a product, and "this include the degree to which all our senses are gratified (aesthetic experience), the meanings we attach to the product (experience of meaning), and the feelings and emotions that are elicited (emotional experience)." There are a number of similarities between the definitions of UX in the work of Hassenzahl (2008), Hekkert

(2006), Stokes (2015) and Kuniavsky (2010). All believe that is it the perceptions of the users while interacting with a product or service. Leung (2008) recommends a need to turn to and learn from the terminologies, methodologies and models of other disciplines that are already well-versed in experience design. Thus, the inspiration for the digital experience is taken from Leung's (2008) philosophy, which believes that the design of a digital experience is expressed through brainstorming and ideas of practitioners in a specific domain. Therefore, for the purpose of this study, Heritage User Experience (HUX) is defined as the perceptions and emotions experienced by a visitor whilst interacting with a product or service within a heritage context. Table 2.1 presents some more general definitions of UX.

Table 2.1: Definitions of user experience

Author	Definition of User Experience
Forlizzi and Battarbeee, 2004	The art of experience design considers the holistic factors of a UX that go beyond or extend the science of usability.
Hekkert, 2006	The entire set of affects that is elicited by the interaction between a user and a product, including the degree to which all our senses are gratified (aesthetic experience), the meanings we attach to the product (experience of meaning), and the feelings and emotions that are elicited (emotional experience).
Leung, 2008	Adds to Forlizzi and Battarbeee, 2004 definition: it also encompasses the more abstract, emotional and atmospheric elements of users' digital interactions such as attraction, seduction and engagement.
Hassenzahl, 2008	UX is a momentary, primarily evaluative feeling (good-bad) while interacting with a product or service.
Kuniavsky, 2010	UX is the totality of end-users' perceptions as they interact with a product or service. These perceptions include effectiveness (how good is the result?), efficiency (how fast or cheap is it?), emotional satisfaction (how good does it feel?), and the quality of the relationship with the entity that created the product or service (what expectations does it create for subsequent interactions?).
Garrett, 2010	UX is not about the inner workings of a product or service, rather it is about how it works on the outside, where a person comes into contact with it.
Stokes, 2015	The satisfaction a user gets from interacting with a product or digital tool. It can also encompass all experiences (physical, sensory, emotional and mental) a person has when interacting with a digital tool.

While user heritage experiences are significant, it is important to have interactive tools with all museum objects, stories, and their interlinked locations. Consequently, the user can interact directly with objects. Nevertheless, this could result in minor changes in the experience quality, which may then have a major impact on the overall heritage experience. In order to mitigate these effects, higher-quality experience design is recommended (Ives and Olson, 1984). This provides a way to motivate and interact with visitors in order to enhance their experience in a museum.

The heritage sector is a complex environment and is changing dramatically in terms of rapid technological developments (McKercher et al., 2005; Macdonald, 2011; Mortara et al., 2014; Della Spina, 2018). A significant increase in the internet of things, big data and digital heritage has affected how experiences are designed and presented to visitors (Schaffers et al., 2011; Falk and Dierking, 2016; Ambrose and Paine, 2018). From the related literature, it is clear that much research has focused on the motivation of interactive experience in museums, while there is a lack of literature which considers UX design as a tool for journeys experienced in a wider digitally interlinked heritage environment. Exploring and understanding how museum workers and interested parties think about the digital interactive heritage environment may provide a basis upon which to develop more common approaches to UX design processes. Therefore, the research question in this study is: 'What are the elements of UX design in the heritage sector?' The nature of this study is not to confirm and test an established theory; rather, it proposes to identify and categorise the environment of the digital interactive heritage experience, and in chapter 4 an initial set of constructs and a taxonomy model are created.

2.2.1 Challenges in Heritage Experience Design

There is a growing emphasis in business on creating memorable and noteworthy customer experiences (Pine II and Gilmore, 1998). This has come to represent a paradigm change, known as the experience economy, and is a move from offering services to offering experiences (Alves and Nunes, 2013; Willcock, 2017). This includes permitting a designer to think of the design problem in terms of designing an integrated/incorporated experience which is perceived holistically by individuals (Bitner, 1992), instead of designing one or more specific artefacts.

The dynamic nature of life and digital heritage have changed the techniques for conveying an experience to visitors. Despite there being extensive research in the field of museums and cultural heritage, it has focused on the visitor experience, behaviour and educational

goals, and there is a lack of studies focusing on the design process of heritage journeys and the Quality of Experience (QoE). However, some studies have highlighted the design process of interactive exhibits and present some of the challenges encountered, such as funding and external expertise with recent technology (Parry, 2010; McDermott et al., 2013). Another challenge is that of audience expectations and the QoE (Parry, 2010; McDermott et al., 2013). Rapid changes in technology and the need to keep up to date with user expectations is another challenge confronted by museums and cultural heritage (Thomas and Mintz, 1998; McDermott et al., 2013). Limited availability of skilled designers also limits a museums ability to respond and there is a need for suitable training to be developed to support the continued expansion of experience design (Willcock, 2017).

The following section presents and explains relevant studies related to user experience in a digital environment, cultural heritage and museums. Hinrichs et al. (2008) studied UX based on the design of an interactive information presentation using visual representations and interaction techniques - revealing the different ways visitors approached and interacted with the product and how they perceived the new form of information. Unsurprisingly, the authors concluded by recommending that information needs to be presented in an attractive manner. Meanwhile Wang et al. (2009) recommend that curators should adopt an immersive museum environment that combines the museum web site with the physical museum space. Wang et al. (2009) developed software (CHIP) which offers tools to users to be their own curators, for instance to plan a personalised tour, browse online collections, and find their way in a museum. Furthermore, this also builds an online user model to support a 'virtuous circle', linking personalised experiences both online and on-site. Dragoni et al. (2017) offers a solution for managing digital collections which proposes a description of an abstract architecture to address several challenges directly related to the creation, management, preservation, and visualisation of digital collections. For example, support for the collaborative management of curated information, making collections available to different stakeholders, exposing pre-organised forms of data both to users and machines.

Stoica and Avouris (2010), Gentile et al. (2011), Kocsis et al. (2012), Andolina et al. (2012) and Boca et al. (2013) have all studied specific systems in order to investigate interaction and UX from different perspectives, adding to the field by offering different views on utilising technology and digital experiences in and around museums. They did not, however, consider quality of experience or employ a design framework. Fors (2013)

describes how to design museum learning environments that will attract young people through the sensory learning qualities that emerge through everyday use of digital media, a common theme in the design for learning and education (Moore, 2015; Price et al., 2016; Hauan et al., 2017; Gronemann, 2017).

Other studies support the view that the design and development of a technological or digital environment is significant, and a variety of tools, frameworks and platforms to support the visitor experience have been suggested (Varvin et al., 2014; Derby Museums, 2014; Chan and Cope, 2015; Rubino et al., 2015; Vosinakis and Tsakonas, 2016; Mason, 2016;Willcock, 2017; Hughes and Moscardo, 2017; Smolentsev et al., 2017; Pedersen et al., 2017). However, these studies were not concerned with the design process of the heritage journey taking into consideration QoE. As summarised in Table 2.2, most studies in the field of digital experiences in museums have only focussed on UX in a general manner, and there is a gap relating to introducing a design methodology process to develop a journey experience for visitors, including the QoE.

Table 2.2: Literature review of key studies on digital experiences in museums

Author	User Experience	Indoor environments	Outdoor environments	Interaction Process	Context/Application
Hinrichs et al, 2008	✓	✓	None	✓	An interactive information presentation (visual representations and interaction techniques).
Wang et al., 2009	✓	✓	None	✓	A dynamic user model. Online, the user model stores a user's personal background, ratings of artworks and art concepts, recommended or created museum tours. On-site, it is a conversion of the online user model stored in RDF into XML format which the mobile guide can parse.
Stoica and Avouris, 2010	✓	✓	None	✓	Abstract architecture is presented, supporting interaction with mobile context aware applications in public digitally augmented spaces.
Gentile et al., 2011	✓	✓	None	✓	Multichannel information system.
Kocsis, Barnes, and Kenderdine, 2012	✓	✓	None	✓	Digital container exhibits.
Andolina et al., 2012	✓	✓	✓	✓	Exploring with several case studies how personal mobile devices (smartphones, PDAs, tablets), may become part of a memorable experience during a visit that one may want to share with friends and relatives. Specifically, the paper focuses on the definition of UX, on integration issues, and on context detection within augmented environments in cultural heritage sites.

Author	User Experience	Indoor environments	Outdoor environments	Interaction Process	Context/Application
Fors, 2013	✓	✓	None	✓	To learn more about the sensory learning qualities that emerge through the everyday use of digital media. The proposal is for a research agenda that takes perception as a skill acquired through participation in social and cultural practices as a starting point for understanding how to design museum learning environments that will attract young people.
Boca et al., 2013	✓	None	✓	✓	Evaluate and compare two different versions of an information provision system deployed in two editions of a large fair. In particular, it focuses on the human-computer interaction (HCI) and computer-mediated-communication (CMC) points of view. The analysis of such case studies is essential to understand the social dynamics of groups of people remotely interacting.
Derby Museums, 2014	✓	✓	✓	✓	The Derby Museum Human Centred-Design (DMHCD) approach includes workflow guides with different stages, questions, templates and tools for experience design.
Varvin et al., 2014	✓	✓	None	✓	A journey as a metaphor for design and development of the app Kunstporten (Art gate) for mobile and iPod.
Chan and Cope, 2015	✓	✓	None	✓	A pen along with interactive media, associated hardware, and the integration of a new ticketing system and relevant front-of-house staff.
Rubino et al., 2015	✓	✓	None	✓	Evaluating visitors' behaviour and learning/a location-based mobile game.
Moore, 2015	✓	✓	✓	✓	Maximise the potential of online and blended learning (a combination of onsite and online) programming in their portfolio to deepen work with existing audiences and/or reach new ones.
Rubino et al., 2015	✓	✓	None	✓	Mobile digital tool - a location-based mobile game integrating a storytelling approach.

Author	User Experience	Indoor environments	Outdoor environments	Interaction Process	Context/Application
Vosinakis and Tsakonas, 2016	✓	✓	None	✓	A platform for presenting museum exhibits and archaeological sites, which can support most of the functionality and features found in existing implementations. Museums hosted in generic Virtual worlds such as Second Life and the Google Art Project are two possible such platforms.
Mason, 2016	✓	✓	None	✓	To explore the use of smart glasses in the museum setting, we designed and implemented a functional Glassware prototype and tested it through field experiments.
Price et al., 2016	✓	✓	None	✓	Physically mediated installations for young children through natural user interfaces.
Hughes and Moscardo, 2017	✓	✓	None	None	Analysis of the use of mobile communication devices.
Hauan et al., 2017	✓	✓	None	✓	An educational intervention based on field investigations, theories of conceptual development, and previous empirical research.
Gronemann, 2017	✓	✓	None	✓	The assessment of the implications for museums' integration of portable tablets showed that they effectively enhanced young people's media and information literacy (MIL) practices but in so doing risked the support of practices beyond the museums' intentions. Moreover, the museums' aspirations to innovate learning through new technologies and supporting pedagogies often conflicted in paradoxical ways with young use. By applying (MIL) components as analytical dimensions, a pattern of discrepancies between young people's expectations, their actual learning and the museums' approaches to framing such learning was identified.
Smolentsev et al., 2017	✓	✓	None	✓	Digital virtual environment.

Author	User Experience	Indoor environments	Outdoor environments	Interaction Process	Context/Application
Pedersen et al., 2017	✓	✓	None	✓	TombSeer is a digital cultural heritage (DCH) application that uses holographic augmented reality (AR) to enhance the Egyptian Tomb of Kitines replica exhibit at the Royal Ontario Museum (ROM). TombSeer aims to immerse the wearer in a museum space, engaging two senses (visual and gestural interaction) in combination with a 3D holographic, artificial reality interface that brings virtual, historical artefacts 'back to life' in a gallery setting.
Dragoni et al., 2017	✓	✓	None	✓	Architecture for managing digital collections - architecture of the knowledge management platform for digital collections.
Hughes and Moscardo, 2017	✓	✓	None	✓	Using mobile communication devices to experience exhibitions. For learning purposes for young teenagers.

Although technology mediation has advanced rapidly in all aspects of human life, there is a missing element when producing tailored designs for a mobile device that is based on user needs and interests (Garrett et al., 2010). Importantly, how do we know if an experience is of high quality? Clearly, there is a need for high-quality design experiences, specifically between the heritage landscape and interlinked museums. Thus, the use of QoE is significant in this study; which relates to the perception of the user about the quality of a particular service or network (Soldani and Cuny 2006; Agboma and Liotta, 2012). According to D'Ambra, Amenta, and Lucadamo (2018), QoE is related to the users' expectations about a service or product. However, what are the triggers of so-called 'good' and 'amazing' experiences to a visitor, and how is an enjoyable experience defined when visitors differ? A critical review of the available UX design is required in order to uncover appropriate theory. This then needs to be encapsulated within a framework that can be used to guide designers of heritage experience and make use of advancing technology.

Challenges of heritage experience design motivate this research problem, specifically reducing these challenges and obstacles. In the next section, appropriate techniques and tools are proposed and discussed. An inclusive range of factors must focus on the interaction design process, including the user of the product, how these products will be used, and where they will be used, and, crucially, creating an engaging UX by understanding how emotions work and what is meant by aesthetics and desirability (Ardito et al., 2009).

2.3 Design of a Digital Experience

UX is the foundational step of an effective digital asset and is comprised of six qualities which together represent a good UX, as shown in Table 2.3 (Stokes, 2015).

Table 2.3: User experience qualities

Findability	Can I find it easily? Does it appear high up in the search results?
Accessibility	Can I use it when I need it? Does it work on my mobile phone, or on a slow Internet connection? Can I use it as a disabled person?
Desirability	Do I want to use it? Is it a pleasant experience, or do I dread logging in?
Usability	Is it easy to use? Are the tools I need intuitive and easy to find?
Credibility	Do I trust it? Is this website legitimate?
Usefulness	Does it add value to me? Will I get something out of the time I spend interacting with it?

However, these UX qualities are more of a technical UX design, which is generally embedded as part of QoE models. Hence, a more detailed discussion of QoE is presented in the following section.

2.3.1 Quality of Experience Models

Several authors, including Marcus and Baradit (2015) and Parry (2010), have identified the key components of all human-computer-interactions, or user-interfaces as: Metaphors, mental models, navigation, interaction and appearance, as well as information visualisation. This takes into consideration user-centred design which links the process of developing software, hardware, the user-interface and the total user-experience, to those who will use a product or service (Marcus, 2006; Hartson and Pyla, 2012). The UX as defined by Hartson and Pyla (2012, p.19) is:

> "The totality of the [….] effects felt by a user as a result of interaction with, and the usage context of, a system, device, or product, including the influence of usability, usefulness, and emotional impact during interaction, and savouring the memory after interaction".

In order to design a high-quality UX, it is important to uncover state-of-the-art quality models (specifically QoE). Uncovering appropriate quality models directs the identification of key elements for a high quality experience. There are many models of QoE which introduce different elements that affect the QoE; examples of these models include Möller et al. (2009), Laghari, and Connelly (2012), and Perkis (2013). The main elements are human, system, context, business, and interaction, but only three of the models introduce interaction as a factor for QoE. However, another study introduced a new layered model for QoE via four main layers; components, combination, control and context. The model presented in this section combines all the factors included in state-of-the-art QoE models; however, human influence is assumed to contribute to each layer according to the subjectively perceived quality of the end-users (Floris et al., 2014).

Taking into consideration the elements introduced by Floris and colleagues (2014), the basis of this study's framework will be created. In order to achieve an effective QoE, an evaluation should include different domains, namely human, system, context, interaction, and business, which are all considered in this model (Figure 2.1). The structure (from base to top) is as follows: layer one is the media quality, layer two the multimedia quality, layer three interactivity and action, and layer four device, environment, business and community evaluation.

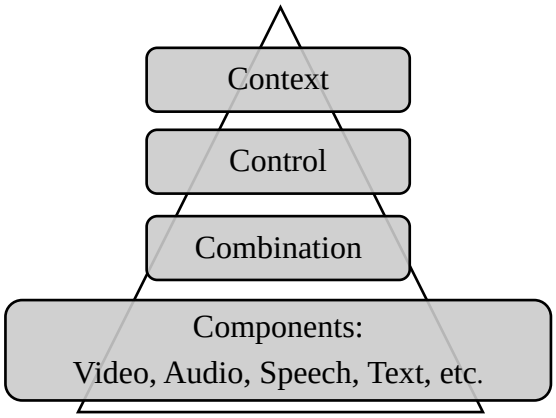


Figure 2.1: Quality of experience model
(Floris et al., 2014)

The lowest layer is concerned with media quality, which is also related to quality of service (QoS) and system parameters for every single media utilised, while the combination layer is focused on how a single medium's qualities are combined to provide the multimedia quality, and this layer is also related to QoS. The interaction features and user actions for multimedia content are considered in the control layer, while the highest layer is dedicated to the context of the use of multimedia services. Elements that influence the context are device, environment, business and community. As mentioned earlier, human influence elements are affected by all layers. This early work is important and relevant, in that it categorises QoE elements and evolution activities in the networking field. In this section, a complementary view of the heritage domain will be taken by focusing more on the design of heritage experiences, specifically the how, when, what and where, of the design process. The gap will be addressed by proposing characteristics, or elements, of heritage experience design and what types of element will influence these experience designs. A taxonomy can be used as a system for naming and organising experience design into groups which share similar journeys. Experience designs in this research refer to the techniques and tools used to achieve a high-quality experience. There is a need for a taxonomy in order to: (1) identify relevant design tactics given a specific experience context; (2) allow an evaluation of an experience design or techniques for a particular experience; and (3) provide an overview of the heritage domain of experience quality.

Design thinking has attracted the attention of both scholars and practitioners because of the applicability of design methods for endorsing innovation and applicability of design thinking across many areas. Design thinking is viewed as a system of three covering spaces, in which viability refers to the business point of view of design thinking,

desirability mirrors the user's viewpoint, and feasibility incorporates the technology point of view. Thus, innovation is increased when each of the three perspectives are addressed. Many design methods and tools encourage the design thinking procedure and cultivate innovation in teams comprising both designers and non-designers. Seeing how innovation inside groups can be bolstered by design thinking methods and tools has attracted the attention of business groups. There are a number of important reviews on this issue, for example Garcia Mata et al. (2013), Alves and Nunes (2013) and Bae et al. (2014); however, there is an absence of design rules/guidelines on the best way to support innovation through design thinking strategies and methods, which could be utilised by groups of non-designers, for example in a heritage domain (Chasanidou et al., 2015).

The process of designing a digital experience and how it is overseen constitutes a key issue for organisations that depend on multidisciplinary groups and teams. Thus, the adoption of unique design perspectives is expected to increase performance in terms of the quality of decision-making and/or the innovativeness of problem solving (West et al., 2003). Among the design processes supported by design thinking, a team needs to expand their reasoning by making it divergent and permitting various contributions to their issue territory. This imaginative aspect of the design process usually brings about the correct meaning of the real problem (Brown, 2009; Gurteen, 1998). In this research and from a design perspective, it is possible to address design thinking as the production of significance, the creation of meaning, and making sense of things (Krippendorff, 2006; Chasanidou et al., 2015; Cross, 2007). Choosing the correct tools is without doubt important for powerful decision-making and communication within a multidisciplinary team. The tools employed can be physical, for example pen, paper, and whiteboard, or programming devices, such as software tools with rich representations that support the design thinking procedure/process. These tools can likewise be utilised to help a team adopt a new perspective on design tasks, to visualise a system's complexity and, depending upon the design stage, mirror a united or different design perspective.

Countless design methods and tools encourage design thinking during the digital experience process. Alves and Nunes (2013) reviewed various sources from both industry and the scholarly world and identified more than 164 methods and tools associated with service design. The recommended scientific classification of the chosen 25 service design methods and tools gives direction to novice participants and applies team coherence, while also being strongly applicable to practitioners (Alves and Nunes, 2013). Utilising a four-quadrant outline, Alves and Nunes (2013) grouped the most applicable methods as

indicated by different dimensions, for example the inspiration to utilise it, the audience, the representations utilised, and exercises in the design process. These methods and tools are presented in Figure 2.2. This research uses some of these tools and methods based on the study by Alves and Nunes (2013) which provide guidance to newcomers and enforce team coherence. Methods are chosen and utilized is in order to comprehend an issue, and in this manner choosing the correct methods is essential, particularly during the early stage of the design thinking process.

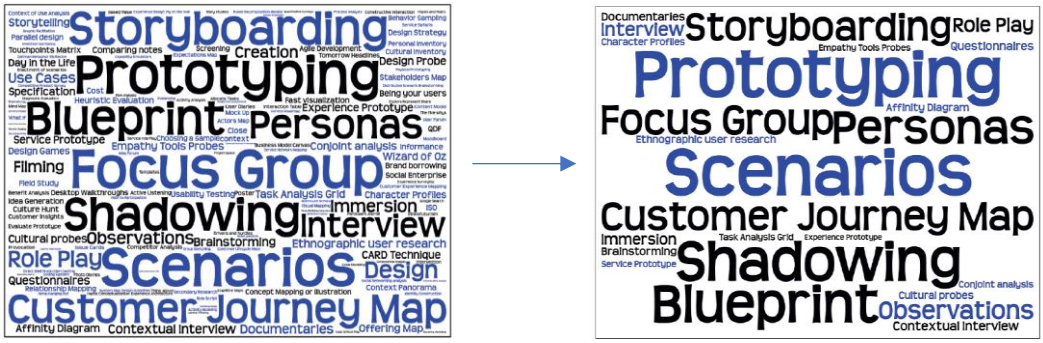


Figure 2.2: Word cloud of selected and analysed methods and tools
Adapted from (Alves and Nunes, 2013)

Chasanidou et al. (2015) suggest that three features should be considered when including design thinking methods and tools: (1) multidisciplinarity of participants; (2) applying two kinds of thinking; and (3) a training session in the design thinking method or tool. Therefore, using Persona and CJM could lead to better decision making and visualising complex system problems. However, some limitations to the research by Chasanidou et al. (2015) prevent an unambiguous interpretation of their findings, as they noted that the generalisability of their outcomes is narrow, and additional research in the field is required to explore this ambiguity.

In this research, personas and CJM are selected as design thinking methods. The criteria for picking these methods lies in their visualisation techniques and capacity to enhance communication inside multidisciplinary teams, together with their straightforwardness when used by non-specialists (Chasanidou et al., 2015). The mapping process provides valuable insight into the user's experience, thus it is critical to understand users over time (Marquez et al., 2015). That is through recognizing 'touch points' in multiple channels and media. This helps in delivering positive experiences in this era of increasingly complex user behaviour (Lemon et al., 2016).

2.3.2 Use of Personas

A persona represents a 'character' with which client and design teams can engage and which can be used efficiently in the design process (Stickdorn and Schneider, 2010). Put simply, it is a fictional character which represent a customer type. It is a model built after a comprehensive perception of the potential users has been undertaken. In determining personas, there ought to be an appropriate balance between contextual and all-encompassing knowledge, with regards to emotional, subjective and lifestyle issues (Dubberly, 2008), although the narrative can become convoluted by possibly distracting points of interest/details (Pruitt and Adlin, 2006). Other studies have defined personas as detailed caricatures used to represent user needs, and the benefit is to highlight users' issues when users cannot participate in the design process. This approach requires the development of a detailed profile of the motivations and tasks of a typical representative of each key user group (Cooper, 1999).

Junior and Filgueiras (2005) describe a persona as "a user representation intending to simplify communication and project decision-making by selecting project rules that suit the real propositions." This method is used for the development of marketing products, and is also utilised for communication and service design determinations to reflect the human perspective of design thinking (Stickdorn and Schneider, 2010). Importanly, it can help classify user requirements and desires.

2.3.3 Customer Journey Mapping

Customer Journey Mapping (CJM) is a digital design method originating within the marketing discipline (Meroni and Sangiorgi, 2016). CJM is a story- based interaction with visualisation of UX that takes into consideration personalisation through pictures and photos (Stickdorn and Schneider, 2013). CJM includes formal and informal touchpoints, which are factors affecting experience from a user perspective. In addition, CJM is a structured visual representation that allows the identification of levels of satisfaction at each stage of a customer journey, enabling problems and opportunities to be uncovered. CJM is a visualization of customer experiences over time and space as they accomplish a certain goal (Hegeman, 2012; Alves and Nunes, 2013). It originated from the technique of service blueprinting and CJM describes a collection of touch points from the beginning to the end of the service delivery from the customer point of view (Shostack, 1984; Chasanidou et al., 2014). It is also able to provide insight into the processes and user experiences in the work environment (Nenonen et al., 2008).

CJM has been introduced because it plays a vital role in understanding users' requirements in general, and more specifically in experience design. Journey mapping helps prioritise service development by providing evidence and persuasive arguments for where investment is most needed (Fichter and Wisniewski, 2015). An analysis of articles in this field (Ortbal et al., 2016; Alves and Nunes, 2013; Nenonen et al., 2008; Crosier and Handford, 2012; Marquez et al., 2015; Sandler, 2015; Temkin et al., 2010; and Andrews and Eleanor, 2013), is captured as a summary of the components required in every CJM in Table 2.4., In this research the following components will be considered: 1) represent your customer's perspective, 2) use research, 3) represent customer segments, 4) include customer goals, 5) focus on emotions, 6) represent touch points, 7) highlight moments of truth, 8) include time, 9) ditch PowerPoint, 10) understand channels, and 11) include stages. These will be used later (Table 5.12) to validate the artefact and examine the reliability of instantiating the framework.

A key concept behind using CJM is working with visitors to understand their experiences of using a range of museum services. Mapping a customer's journey can help in identifying barriers to physical experience, and these could be addressed with a view to enhancing the visitor experience. Thus, mapping the customer journey helps in understanding the needs and preferences of visitors, and the information gathered can support changes to experience design and ensure a match between visitors' experience and their requirements. Thus, in this study it will be helpful to use CJM as one of the design approaches.

Table 2.4: Analysis of CJM articles summarising the main components

Authors	Represent your Customer's perspective	Use research	Represent Customer segments	Include Customer goals	Focus on emotions	Represent touch points	Highlight moments of truth	Measure your brand promise	Include time	Ditch the Power Point	Channel	Include Stages
Ortbal et al., 2016	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
Alves and Nunes, 2013	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Nenonen et al., 2008	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Crosier and Handford, 2012	✓	✓	✓	✓	✓	✓			✓	✓		✓
Marquez et al., 2015	✓	✓	✓	✓		✓	✓		✓		✓	✓
Sandler, 2015	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Temkin et al., 2010	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
a PeopleMetrics ebook	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Andrews and Eleanor, 2013	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Oxford Strategic Marketing	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓

It is evident that while there has been substantial amount of research on design tools for experience, this has typically focused on education or health (Ardito et al., 2012; Pallud and Straub, 2014; Buisine et al., 2016; Pallud, 2017; Kemp, 2017; Shin, 2017). To date, few research has looked at the use of such methods in encouraging visits to historical locations (Table 2.5). Because there has been no research to encourage visitors to participate more widely, then opportunities exist to employ such a novel approach. Furthermore, an approach provided by design thinking will no longer be limited only to designers (Brown, 2009; Derby Museums, 2014).

While more in-depth research is required to fully address the viability and benefits of creating different experiential values for cultural visitors from a visitor and stakeholder perspective, this research contributes to the literature on independent museums and an interlinked landscape by investigating technological approaches to motivate more visitors to visit. In addition, it highlights the implications of visitor experience by using design thinking in a historical landscape, together with creating a unique position in the heritage domain to persuade visitors to visit interlinked locations. For example, a museum in a town or city displays objects that were found in the physical landscape (sometimes nearby). In this case it is worth visiting both locations, but some visitors do not know about these links. Opportunities exist to motivate and encourage visitors to visit these landscapes.

Table 2.5: Lack of design thinking methods in heritage research

Author	User Experience	Cultural Heritage	Education	Other fields	Mobile application	PAD	Other devices	Persona	CJM	Scenario	Other methods	Indoor environments	Outdoor environments	Design Process
Ardito et al., 2012	✓	✓	✓	None	✓	None	None	None	None	None	✓	✓	✓	None
Pallud and Straub, 2014	✓	✓	None	None	None	None	✓	None	None	✓	✓	✓	None	None
Derby Museums, 2014	✓	✓	✓	None	✓	✓	✓	✓	✓	✓	✓	✓	None	✓
Buisine et al., 2016	✓	None	None	✓	✓	✓	✓	✓	None	None	✓	✓	None	None
Pallud, 2017	✓	✓	✓	None	✓	✓	✓	None	None	✓	✓	✓	None	None
Kemp, 2017.	✓	✓	✓	None	None	None	✓	None	None	None	✓	✓	None	None
Shin, 2017.	✓	None	None	✓	✓	None	✓	✓	None	✓	✓	✓	✓	None

Investigating strategies to generate more visitors with the intention of increasing income is a continuing concern for museums in the UK (Evans, 2013). One approach to address this is the utilisation of new digital and mobile technologies. The use of such technology needs to improve visitor experiences in a natural manner. The UK's museums are lagging behind in the digital revolution, which is impacting on their revenue generation and audience development (Steel, 2013); consequently, opportunities exist for those wishing to innovate and invest in this sector. Interestingly, art and culture organisations in England have benefited from digital technologies to a greater extent than museums (Bakhshi, 2013). Examples of these technologies include standalone digital exhibits, the use of cloud computing to run heritage software, hosting and the storage of data or content and digital experiences (Steel, 2013).

To conclude, from the critical review of user experience in heritage literature, there is a need for an effective framework that can be used by designers which could eventually enable the creation of a digital interactive experience for heritage museums. The framework would have to encapsulate the right design tools based on the critical review conducted on the related theories. Accordingly, a visitor experience would be built based on many factors related to design thinking methods. The following sections detail the proposed digital interactive heritage experience framework.

2.3.4 Digital Interactive Heritage Experience Framework

Although technology has advanced rapidly in all aspect of human life, a specific design approach that combines the experience of the visitor with the strategies of the museum is missing. From the conceptual analysis of the literature review, an initial conceptual framework has been created which shows the interaction between museum workers and visitors in a digital heritage environment, and contains five main elements (Figure 2.3). The ambiguity of design thinking is supplemented by system thinking in order to synthesise theory and support collaborative design.

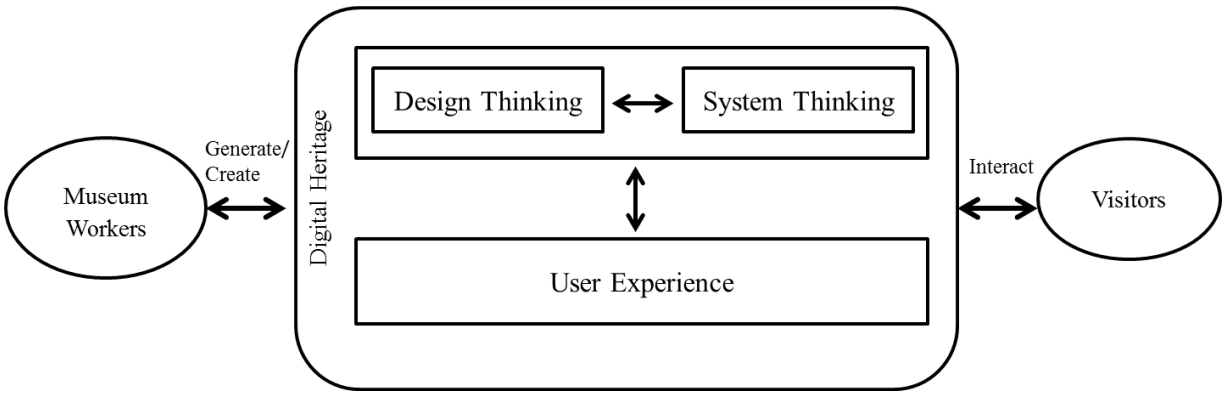


Figure 2.3: Digital heritage experience framework

While digital heritage experience is significant, it is also important to have an interactive experience with all museum objects, stories and interlinked locations. However, this could result in slight changes in the interactive process, which may then have a major impact on the quality of experience. To mitigate these effects, design and system thinking methods are expected to provide a way to motivate and interact with a visitor in order to enhance their heritage experience.

From the literature it is apparent that many authors have focused on motivation in the heritage experience, while there is a lack of literature which considers design thinking methods as a tactic in the digital heritage environment or how these methods can be achieved in this context. The significant increase in the internet of things and digital heritage has affected the way an experience is presented to visitors. Thus, this research argues that there is a need for a design process for heritage experiences which can motivate users to visit independent museums when users are in a nearby historical landscape. The heritage domain is a complex environment and is changing dramatically in terms of rapid technological developments. CJM and Persona are subjective in nature when compared to SD tools, which makes it difficult to derive an outcome that can reflect dynamic visitor journey. Hence, studying the possibility of utilising complex adaptive systems and systems thinking is crucial. The following section will explore this in more detail.

2.4 Simulation of Digital Experience

Systems thinking aims to determine how things are connected to each other within some notion of a whole entity. Its methods use explicit models with identifying assumptions, and importantly, contribute to an understanding of how things stand together (Peters, 2014). In addition, the approach can be repeated by other scholars and has several types

of theory, method and tool. Complex adaptive systems are a complex type of system which has emergent behaviours, such as adaptation, learning and self-organisation; it is divergent and convergent by nature. Divergence means unintended consequences and different outcomes resulting from the same inputs, whereas convergence refers to many routes leading to the same outcome. Most biological, social, economic, and physical systems that have many interacting agents in a changing environment are complex, adaptive systems. This study will use systems thinking approaches to show how to persuade in complex conditions, thus to grow or scale-up visitors to a specific heritage location.

Systems thinking can include an extensive variety of theories, which are rational sets of concepts or philosophies proposed to explain something. The theories and methods in systems thinking are each designed to address complex problems; complex means they involve multiple interacting agents and the environment is dynamic and does not conform to linear or simple patterns. That is because elements in a system can learn new things and create new patterns as they interact over time. Many of the challenges in heritage are now known as complex problems, as simple approaches have not completely addressed these issues. Systems thinking tools have a wide variety of applications, and systems archetypes are an example of a tool which facilitate groups of people and help to understand a common issue and build a story (Kim, 1993). Another example is Causal Loop Diagrams (CLD), which involve identifying people's understanding of how elements of a problem are related to each other (Williams and Hummelbrunner, 2010). This usually begins with qualitative descriptions outlining how one thing causes another in either a positive or negative direction. The elements of a CLD can also be converted into a quantitative systems dynamic model by classifying the elements as 'stocks', 'flows' or 'auxiliary' variables, and using equations to describe the relationships between individual variables in one of many available system dynamics software environments (Rwashana Semwanga et al., 2014; Bishai et al., 2014). Thus, using system dynamics researchers can simulate process scenarios which cannot be carried out using real populations or for which adequate historical data on natural experiments are not available.

Models which help in understanding these phenomena need to comprehend the unintentional consequences of complex adaptive systems. Many studies have explored the role of complexity in heritage systems (Stoica and Avouris, 2010; Gentile et al., 2011; Kocsis et al., 2012; Andolina et al., 2012; Boca et al., 2013). Systems thinking approaches can also provide guidance on where to collect more data or raise new

questions and hypotheses. For this reason, the principles of system dynamics modelling are used to develop sympathetic, non-linear interactions within defined systems (Forrester, 1961). Consequently, the proposed framework consists of four phenomena, as described in Table 2.6. Although extensive research has been carried out on UX in museums, no single study exists on developing a methodology to design UX using simulations, indicating a gap in the research which warrants investigation.

Table 2.6: Phenomena considered in the research model

Component	Description	Gap in the Research
Quality of Experience	Is a measure of the overall level of customer satisfaction with a vendor. quality of experience is related to but differs from quality of service, which embodies the notion that hardware and software characteristics can be measured, improved and perhaps guaranteed. Is often used in information technology and consumer electronics domain as an indication of the overall satisfaction with the service users receive.	Gap in designing the main elements of quality of experience in heritage
Design Thinking	Is a methodology used by designers to solve complex problems, and find desirable solutions for users. It draws upon logic, imagination, intuition, and systemic reasoning, to explore possibilities of what could be, and to create desired outcomes that benefit the end user.	Gap in combing design thinking with systems thinking to build a simulation model.
Design Experience Journey	Is the practice of designing products, processes, services, events, channel journeys, and environments with a focus placed on the quality of the user experience and culturally relevant solutions.	Gap in having a structured methodology to design experience journey for heritage.
System Dynamics	Is an approach to understanding the nonlinear behaviour of complex systems over time using stocks, flows, internal feedback loop, table functions and time delays.	Gap in using system dynamics approaches in heritage context.

2.5 Summary

This chapter provides a foundation for this thesis, with literature illustrating the need for a structured process to design heritage experiences. Understanding the variety of QoE elements and identifying digital heritage challenges has provided a deeper understanding of the need to apply innovative tools and technologies in the design of high quality experiences. Diverse types of design thinking tools and approaches are identified – including their applicability in the heritage domain. Experience development is a time-consuming process requiring designers to follow a structured methodology. Realising and validating high-quality experience can be very difficult as the heritage domain is a complex.

This research synthesises design thinking and systems thinking techniques and tools to enable the production of a structured design process aimed at motivating more visitors to visit heritage locations. QoE artefacts and design thinking form a vital source of domain knowledge (Floris et al., 2014; Alves and Nunes, 2013, Sandler, 2015). Recent research has tended to either: 1) Focus on the abstract modelling of heritage artefacts (Dragoni et al., 2017), 2) Encourage participation in the modelling and simulation (Tako and Kotiadis, 2015) or 3) Provided the designer with a palette of practical UX elements (Vermeeren et al., 2016). Consequently, a gap exists requiring exploration into how the creativity of design thinking can be utilised alongside system thinking early in the design process.

CHAPTER 3 Research Methodology

3.1 Introduction

This chapter explains the research approach followed to investigate design experience elements and methods that enable heritage workers to design heritage experiences. In addition, the chapter provides an explanation of the research development phases, together with the input and output of these phases. In this study the design research paradigm is employed as a general methodological framework.

Section 3.2 introduces some background to Design Science Research (DSR), and justifies its use as a research method, while section 3.3 describes design research as a methodology for Information Systems (IS) research by providing a broad review of the major design research frameworks in IS and their main strategies. Section 3.4 presents the design research evaluation criteria which are associated with design research artefacts, and typical evaluation methods are presented. Section 3.5 illustrates this study's design plan, and explains how DSR is applied in this research, while section 3.6 presents the three design research iterations of this study. Finally, section 3.7 summarises the chapter.

3.2 Design Science Research Methodology Background

IS is a multidisciplinary research field, involving a range of specialities, such as engineering, computer science, mathematics, and management science amongst others (Baskerville and Myers, 2002). IS research can be conducted using a variety of research approaches, techniques, methods, methodologies and paradigms, although DSR is a popular approach for conducting IS research as it provides a way for creating or improving existing artefacts (Hevner and Chatterjee, 2010).

DSR provides significant frameworks for IS studies (Hevner et al., 2004; Nunamaker et al., 1990; March and Smith, 1995). This is through a problem solving process which consists of an iterative design cycle, whereby valid IS research is achieved through the building and evaluation of purposefully-designed artefacts that address business needs. The term 'purposefully' means that the produced artefacts should offer a 'utility' that addresses unsolved problems or offers a better solution that can enhance existing practices (Vaishnavi and Kuechler, 2004). IS research is a multidisciplinary research field consisting of social and natural sciences, which are bound by an overlap in methods of research, and where continued improvement is necessary to meet the complicated dual

nature of the IS field (Nunamaker et al., 1990; Purao, 2002). There is no specific general research methodology within IS; however, research in this field is no different to any other research as, according to Blake's (1978) definition of research, it is a "systematic, intensive study directed toward fuller scientific knowledge of the subject studied."

A clear distinction between natural science and design science (science of the artificial) was made by Simon (1996). Natural science focuses on naturally-occurring phenomenon, whereas design science relates to human-made artefacts, and this distinction has led the IS community to realise and justify the need for design as a research discipline that combines the two (Hevner et al., 2004; Edelson, 2002; Winter, 2008; Nunamaker et al., 1990; March & Smith, 1995). Utility and truth are considered to be the vital aims of design science and behavioural science, respectively, and DSR is proposed by March and Smith (1995) and Hevner et al. (2004) as a research framework whereby IS research can occur through the integration of these two complementary disciplines: behavioural science where research is concentrated on theorising and justifying (truth); and design science, where research is focused on the process of building and evaluating (utility) (Hevner et al., 2004).

Design research as a valid research methodology for IS is formulated by integrating two complementary disciplines (design and behavioural science), which enables an IS researcher to engage in designing an artefact (design science), while at the same time learning is highlighted during the development process by the consequence of utility on people and organisations (behavioural science) (Hevner et al., 2004). The design cycle is performed in an iterative process that can be initiated by simple conceptualisation that provides the necessary learning to feed into subsequent iterations, so that the final iteration results are an improved product that satisfies the problem requirements and constraints.

Hevner et al. (2004) proposed a descriptive design research framework (Figure 3.1) that combines natural science and design science. Research rigour can be achieved by effectively applying knowledge (theories) from the knowledge base to develop and build an IS artefact, while relevance can be accomplished by assessing whether an artefact satisfies business needs. The build and evaluate cycle is the heart of any DSR (Hevner, 2007), and this cycle of research moves rapidly between the construction of an artefact and its evaluation to refine the design further, before applying a justify-evaluate process to assess an artefact's applicability in a suitable environment. It is a way of producing

design alternatives and evaluating them against requirements until a satisfactory design is reached (Simon, 1996).

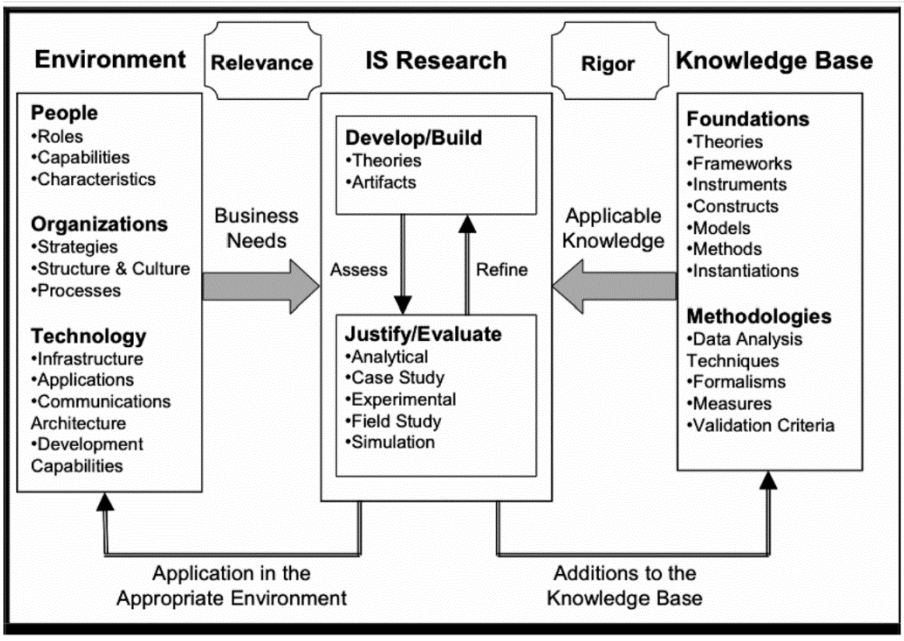


Figure 3.1: IS research framework
(Hevner et al., 2004)

Knowledge can be generated and accumulated through an iterative process via knowledge-using and knowledge-building activities (Owen, 1998; Takeda, Veerkamp & Yoshikawa, 1990). Therefore, design is considered as a process, and Vaishnavi and Kuechler (2004) have identified clear steps that are involved in the design process, which can also be employed as a research activity that generates knowledge. Linking theories and design to justify design as a research approach has led to the proposal of various theories (Brown, 1992; Kelly & Lesh, 2000). In contrast, others have placed an emphasis on the learning aspect of design research and identified types of learning that can evolve when engaged in the design process (Edelson, 2002).

This framework presents methodological guidelines to identify, execute and evaluate IS research. Build and evaluate are considered iterative processes through which both method and product are carefully assessed and then used to refine the developed product. This evaluative process usually applies measures from the knowledge base in order to assess the utility, efficacy and quality of the designed artefact. Hevner et al. (2004) also proposed a set of evaluation methods that can be used to evaluate a designed artefact.

An effective and rigorous evaluation process should be conducted to demonstrate the utility of a DSR artefact, and the evaluation process is a substantial aspect of DSR as it

creates validity and reliability in the resulting artefacts. The evaluation of design artefacts and design theories is a central and critical part of DSR (March and Smith, 1995; Hevner et al., 2004; Vaishnavi and Kuechler, 2004; Venable, Pries-Heje, and Baskerville, 2012; Venable et al., 2016). Moreover, it can generate knowledge which leads to a deeper understanding of the problem domain and to improvements to the quality of the artefacts themselves. Hevner et al. (2004) identified a set of evaluation methods for evaluating the quality and effectiveness of artefacts (Table 3.1).

Table 3.1: Design research evaluation methods
(Hevner et al., 2004)

Design Research Evaluation Method Types and their Description	
1. Observational	**Case Study**: Study an artefact in depth in a business environment.
	Field Study: Monitor use of an artefact in multiple projects.
2. Analytical	**Static Analysis**: Examine structure of an artefact for static qualities (e.g. complexity).
	Architecture Analysis: Study fit of an artefact into a technical IS architecture.
	Optimisation: Demonstrate inherent optimal properties of an artefact or provide optimality bounds on artefact behaviour.
	Dynamic Analysis: Study an artefact in use for dynamic qualities (e.g. performance).
3. Experimental	**Controlled Experiment**: Study an artefact in a controlled environment for qualities (e.g. usability).
	Simulation: Execute an artefact with artificial data.
4. Testing	**Functional** (Black Box) Testing: Execute artefact interfaces to discover failures and identify defects.
	Structural (White Box) Testing: Perform coverage testing of some metric (e.g. execution paths) in the artefact implementation.
5. Descriptive	**Informed Argument**: Use information from the knowledge base (e.g. relevant research) to build a convincing argument for the artefact's utility.
	Scenarios: Construct detailed scenarios around the artefact to demonstrate its utility.

Thus, evaluating the progress made in the problem domain when an artefact is built to perform a specific task demonstrates its utility, and therefore validates the research. Therefore it is critical to develop appropriate evaluation metrics to assess the performance of an artefact and prove the suitability/validity of the evaluation criteria (March and Smith, 1995). March and Smith (1995) identified quality attributes based on artefact type which are summarised in Table 3.2. Hevner et al. (2004) emphasised that the selection of an evaluation method should be carefully considered and should be appropriate for an artefact and the evaluation metrics; methodologies are typically drawn from the

knowledge base. The classifications shown in Table 3.2 represent the most common evaluation criteria for which a suitable method can be applied based on the type of artefact and the evaluation metrics used.

Table 3.2: Summarised evaluation criteria with artefact type
(March and Smith, 1995; Hevner et al., 2004a; Vaishnavi and Kuechler, 2004)

Artefact Type	Evaluation Criteria
Constructs	Completeness, simplicity, elegance, understand ability and ease of use.
Model	Fidelity with real world phenomena, completeness, level of detail, robustness and internal consistency.
Method	Operationally (ability of others to efficiently use the method), efficiency, generality and ease of use.
Instantiations	Efficiency, effectiveness and impact on an environment and its users.

3.3 The Design Science Research Process

A general design research methodology that includes five phases of design and encourages an iterative design cycle in which learning is a key attribute has been proposed by Vaishnavi and Kuechler 2004, adapted from Takeda et al., 1990. The initial step in DSR is problem awareness, followed by suggestion, which involves producing a proposal and a tentative design. Artefact development is the third step, when learning and improvement is fed back through restrictions into the first step. Evaluating an artefact is a significant step, and in this fourth step, performance measures from the knowledge base can be applied to test the utility of an artefact in the problem domain. The fifth step is the conclusion, which involves emphasising the results of the design research in adding knowledge to the solution space or feeding back into subsequent cycles. Nunamaker et al. (1990) note that system development (artefact construction) is considered to be a research methodology that can lead to improved and effective design when applied in conjunction with other research methodologies. They also note that artefact construction makes a rigorous contribution to knowledge. The DSR process follows a systematic approach which is structured into five phases (Vaishnavi and Kuechler, 2004), and Figure 3.2 presents these phases and their outputs.

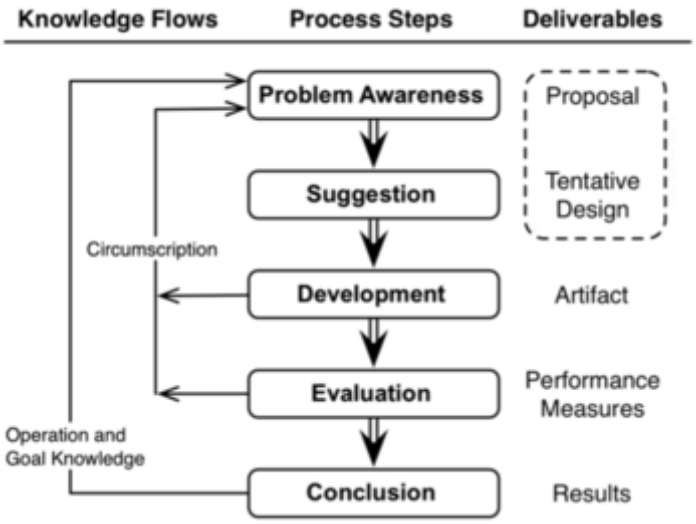


Figure 3.2: Phases of DSR methodology
(Adapted from Vaishnavi and Kuechler, 2004)

Awareness of problem: The process begins by identifying the problem under study, which may arise from multiple sources. Examples of sources are literature or current problems in an industry. The research problem needs to be clearly defined and articulated, and the output of this phase is a formal or informal proposal for new research.

Suggestion: This phase is explored when a research proposal has been presented. Possible solutions for the research problem are explored and evaluated, leading to the acquisition of further insights into the domain under study. The specifications of the appropriate solutions to the research problem are defined, and the output of this phase is a conditional design or representation of the proposed solutions.

Development: In this phase the DSR artefacts are developed based on the suggestions from the previous phases. The outputs of this phase are the artefacts, which are core elements of the DSR process. March and Smith (1995) classified DSR artefacts into four categories: constructs, models, methods and instantiations (see Table 3.2 for definitions).

Evaluation: The developed artefacts are analysed and evaluated according to the criteria set in phase 1 (awareness of problem phase), and deviations and expectations should be noted and explained in this phase. If the outcomes derived from the development or evaluation phase do not meet the objectives of the problem, then the design cycle returns to the first phase, together with the knowledge gained from the process of the first round of work. These phases may be iterated until the evaluation of the artefacts meets the solution requirements. The outputs of this phase are performance measures that should improve the efficiency and effectiveness of the artefact.

Conclusion: This is the final phase of the DSR cycle, when the results of the research are written-up and communicated to a wider audience in the form of professional publications and scholarly publications (Peffers et al., 2007). Kuechler and Vaishnavi (2008) categorise the knowledge gained in this phase as either 'firm' or 'loose ends'. Firm knowledge is facts that have been learned and can be repeatedly applied or behaviour that can be repeatedly invoked, while loose ends are anomalous behaviours that defy explanation and may well serve as the subject of further research (Kuechler and Vaishnavi, 2008).

3.4 Design Science Research Outputs

It is significant to represent how design can be incorporated as a research method. Hevner et al. (2004) categorise research as an innovative way of solving a problem; however, Edelson (2002) and Winter (2008) characterise design research by the generality of the proposed solution in the sense that it can be applied to a wider class of situations therefore leading to design science. The DSR paradigm is inspired by Simon's view of the 'Science of the Artificial' (1996, p.123), where 'artificial' means a hand-made product or an artefact. By unfolding the science of the artificial, a valid differentiation between behavioural science and design science was made, and Simon (1996) introduced the notion of an artefact, which is viewed as a link between the inner and outer environment in the search for a solution that fulfils the desired goal in seeking a satisfactory design rather than an optimal one. Design is a learning process through which the underlying artefact development process is observed differently and learned from.

DSR, as presented by March and Smith (1995), indicated the beginning of a new research era. It has enabled research to achieve both relevance and effectiveness by combining the research output (product) and research processing (activities) from behavioural and design science within a two-dimensional framework, as presented in Table 3.3. The four research activities drawn from design science and natural science are build, evaluate, justify and theorise, and these four processes are applied in IS research to produce different types of artefact, namely constructs, models, methods and instantiations, which are employed to ensure the utility and efficiency of the produced IS. DSR achieves an optimal solution to the design problem in an iterative knowledge refinement manner (Hevner and Chatterjee, 2010).

Table 3.3: DSR framework
(March and Smith 1995)

Research Activities					
		Design Science (Utility)		Natural Science (Truth)	
Research Outputs		Build	Evaluate	Theorize	Justify
	Constructs				
	Model				
	Methods				
	Instantiation				

Categorising design artefacts using March and Smith's (1995) research outputs classification can help in identifying an appropriate procedure to build, evaluate, theorise and justify DSR. The four types of research artefact are:

- **Constructs:** sets of concepts or vocabulary form specialized knowledge within a domain; they are used to define problems and solutions (Hevner et al., 2004).
- **Models:** use constructs to describe a real world situation of the design problem and its solution space (Hevner et al., 2004); models can be used to express relationships between constructs (March and Smith, 1995).
- **Methods:** a set of steps that define the solution space, and provide guidance on how to solve problems using the constructs and the models; methods can be thought of as methodological tools that are created by design science and applied by a natural scientist (March and Smith, 1995).
- **Instantiation:** the implementation of constructs, models or methods within a working system, which prove their feasibility and effectiveness and allow an evaluation (March and Smith, 1995). Instantiation plays an important role in enabling researchers to learn about the working artefact in a real-world scenario, and thus the significance of instantiations is in providing a better understanding of the problem domain and consequently to offer better solutions (Newell & Simon, 1976).

Evidence must be presented to address the following two fundamental DSR questions: 'What utility does the new artefact provide?' and 'What demonstrates that utility?' (Hevner et al., 2004). These questions are at the core of design science, and if a new artefact does not map effectively to the real world (rigor), then it cannot provide utility. Thus research contributions to the knowledge base are key to selling the research to the academic audience, just as useful contributions to the environment are the key to selling points to the practitioner audience (Hevner, 2007).

At the end of iteration three, the DSR methodology presented in this research is evaluated according to the seven guidelines presented in Table 3.4, in order to understand the effectiveness of the approach followed in this study (Hevner et al., 2004).

Table 3.4: DSR guidelines
(Adopted from Hevner et al., 2004)

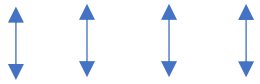
Guideline	Description
1: Design an Artefact	DSR must produce a viable artefact in the form of constructs, models, methods and instantiations.
2: Problem Relevance	The objective of DSR is to develop technology-based solutions to important and relevant business problems.
3: Design Evaluation	The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods.
4: Research Contributions	Effective DSR must provide clear and verifiable contributions in the areas of the design artefact, design foundations, and/or design methodologies.
5: Research Rigor	DSR relies upon the application of rigorous methods in both the construction and evaluation of the design artefact.
6: Design as a Search Process	The search for an effective artefact requires the utilisation of available means to reach the desired end while satisfying laws in the problem environment.
7: Communication of Research	DSR must be presented effectively both to technology-oriented as well as management-oriented audiences.

3.5 Contribution Types in Design Science Research

DSR involves the formation of new knowledge through the design of innovative artefacts, as well as an investigation into the use and/or performance of such artefacts, along with replication and generalisation to increase and recognise the behaviour of aspects of IS (Kuechler and Vaishnavi, 2008). Gregor and Hevner (2013) argued that the development of strong theory is only one form of DSR contribution, and thus they consider the nature of different forms of knowledge. It is vital to differentiate between the relationships among the nature of the artefact/object/problem studied in DSR, as isolated from the contributions made by a DSR study. To be true DSR there is a need to address diverse types of research contribution: the construct, model, method and/or instantiation (Hevner et al., 2004; Gregor and Hevner, 2013). These encapsulate both the contributions of practical artefacts and also the contributions at more abstract levels. Thus, through the accumulated knowledge contribution, actual DSR should create strong contributions to the real-world application environment from which the research problem or opportunity is drawn (Hevner et al., 2004).

Table 3.5 depicts different DSR outputs with three maturity levels of DSR artefact types and examples for each level. Research based on DSR methodology can produce artefacts on one or more levels; a level 1 artefact could be a specific instantiation in the form of products and processes; level 2 artefacts are more general (abstract) contributions in the form of nascent design theory (e.g., constructs, design principles, model, methods, technological rules); and level 3 artefacts are well-developed design theories about the phenomena under study (Gregor and Hevner, 2013). This research is considered to provide a level 2 contribution, as it produces all four types of artefact.

Table 3.5: DSR contribution types
(Adopted from Gregor and Hevner, 2013)

	Contribution Types	**Example Artefacts**
More abstract, complete, and mature knowledge  More specific, limited, and less mature knowledge.	Level 3. Well-developed design theory about embedded phenomena	Design theories (mid-range and grand theories)
	Level 2. Nascent design theory-knowledge as operational principles/architecture	Constructs, methods, models, design principles, technological rules.
	Level 1. Situated implementation of artefact	Instantiations (software products or implemented processes)

3.6 Design Science Research Approach for Improved Heritage Design

The research contribution of this study is the development of a methodological heritage framework for user experience and a tool resulting from instantiating this framework. To meet the research aim, DSR is adopted from Vaishnavi and Kuechler (2004) as an overall research methodology. March and Smith's (1995) research product (artefact) classification is adopted to illustrate the research output, which are identified in the form of constructs, models, methods and instantiations. The DSR methodology employed for developing the research artefacts is an iterative design cycle (build and evaluate). Build is concerned with the development of an artefact, and evaluation is concerned with the development of an assessment method or metric to assess the quality and effectiveness of that artefact in its context (March and Smith, 1995). The main design artefact is a methodological heritage experience framework, and the iterative process involving the five design process phases (awareness, suggestion, development, evaluation and conclusion) are elaborated upon in Figure 3.3. This methodology has been selected as it allows knowledge gained from an iteration to be applied to the subsequent iterations.

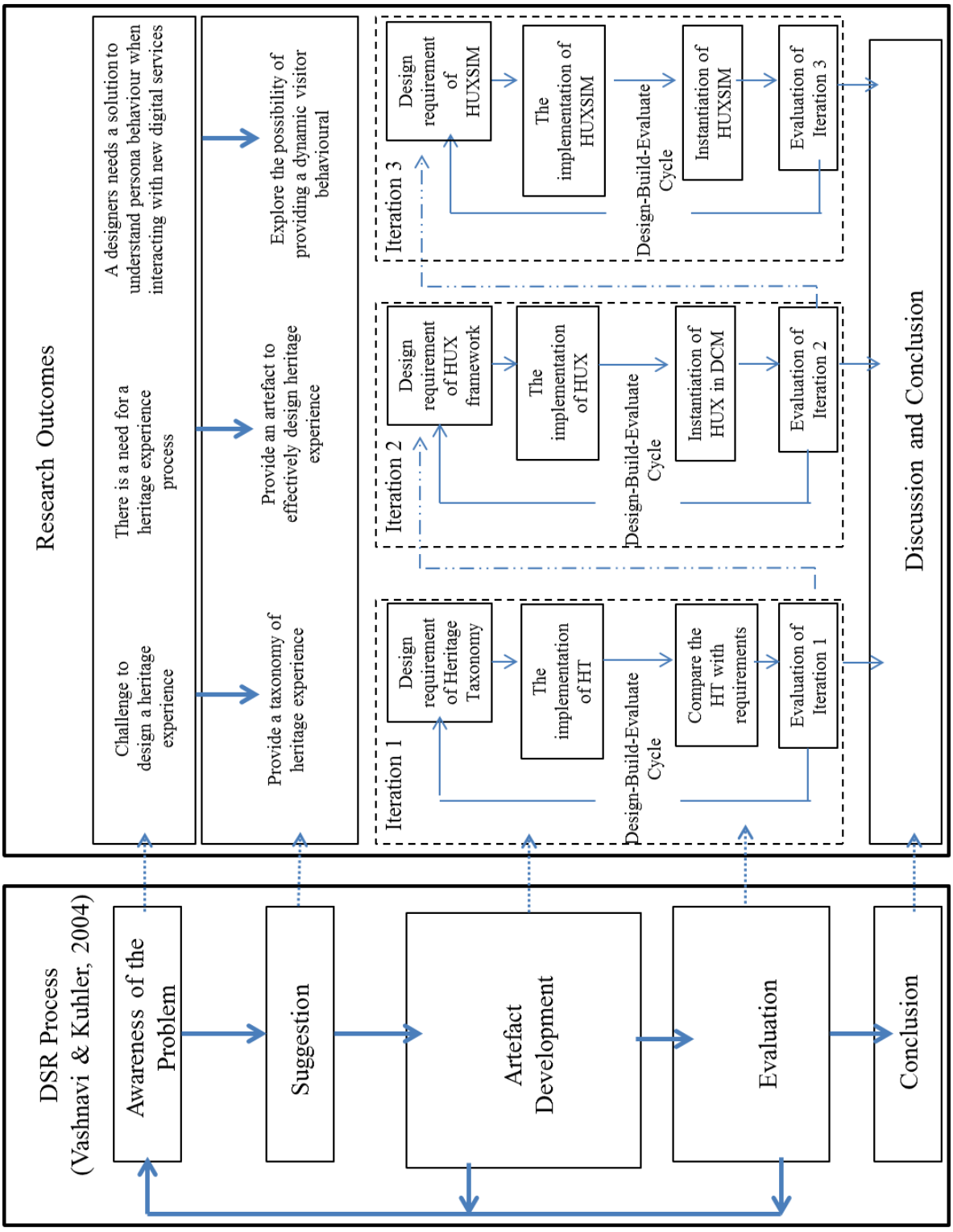


Figure 3.3: Research process based on DSR methodology
(Vaishnavi and Kuechler, 2004)

3.6.1 Awareness of the Problem

An awareness of the problem is described in Chapter 2, and this involved reviewing literature and analysing existing heritage experience techniques and technologies (Al Subhi, Bell and Lashmar, 2015). In addition, the recognition of the importance of the quality of experience (QoE) for interactive heritage is also detailed. An exploratory study of Dorset County Museum and Maiden Castle as historical locations was undertaken which developed an understanding of technologies through the perspective of visitors as a key stakeholders (Al Subhi, Bell and Lashmar, 2015).

A survey study was conducted to explore preferred technologies and the way in which digital media can be presented in natural environments, and how visitors prefer to describe such experiences. The results identified differences in visitors' perceptions regarding the importance of technologies at different heritage locations. The outcomes are applied to improve technology effectiveness in interlinked heritage landscapes through the development of a mobile prototype. However, when testing the prototype it has been recognised that one of the main obstacles to creating an experience is to be able to ensure that it is a high quality experience and how that can be built (Al Subhi, Bell and Lashmar, 2016). In addition, how can an experience be improved using design and system thinking as techniques to motivate and encourage heritage visitors? Thus, in order to obtain a better understanding of visitor behaviour, research studies need to examine visitors' journey experiences and investigate their emotions and behaviours in each phase of the journey.

3.6.2 Suggestion

Suggestion involves introducing a tentative idea of how a problem might be solved by reviewing the literature and analysing existing user experience techniques and methods. This step was performed in Chapter 2, which sought suitable elements of experience appropriate for developing a taxonomy to design high quality user experiences, by comparing existing QoE models and highlighting weaknesses. This phase focuses on leveraging insights gleaned from design and system thinking tools and techniques into the problem domain. The lack of a process to design heritage journeys and the limitations of the tools available motivated the author to propose a SD simulation as a new method to explore dynamic behaviours. At the end of this phase, and based on the outputs of the previous phase (awareness of the problem phase), general requirements and specifications of the user experience journey and SD simulation model were identified.

3.6.3 Development

The development phase involves three design iterations to build the artefact proposed in the suggestion phase, which is accomplished by building the research artefact as an HUXSIM framework. This framework consists of phases and steps that are significant in gaining a better understanding of the dynamic elements of journey experiences. During this phase the framework (artefact) is constructed in an iterative manner through the design-build-evaluate cycle. The outcomes of the iteration are used as an input for the next iteration. The aim of the HUXSIM framework is to allow designers to understand personal behaviour when interacting with new digital services. DSR was performed via iterative design cycles, which can be improvement iterations or improvement and incremental iterations (Hevner et al., 2004). This research is implemented as incremental iterations, whereby each iteration (Figure 3.4) is used to extend and refine the design problem.

First iteration: develops heritage taxonomy as a framework to design experiences in a digital interactive heritage context taking into consideration QoE models.

Second iteration: extends and refines the framework by developing a methodology for design journeys using a UCD approach and identifies different persona leading to visitor journey mapping (VJM) models.

Final iteration: refines the framework to include system dynamics (SD) tools to explore dynamic behaviours. Evaluation and validation of the artefact is conducted through the instantiation of the SD model with the persona of VJM.

The main DSR outcome is the development of a methodological framework for the heritage user experience using system dynamics (HUXSIM). The Oxford English Dictionary defines framework as “a basic structure underlying a system, concept, or text: the theoretical framework of political sociology”, while methodology is defined by Checkland (1981) as “a set of principles of method, which in any particular situation has to be reduced to a method uniquely suited to that particular situation”. The HUXSIM framework incorporates aspects of both a methodology and a framework.

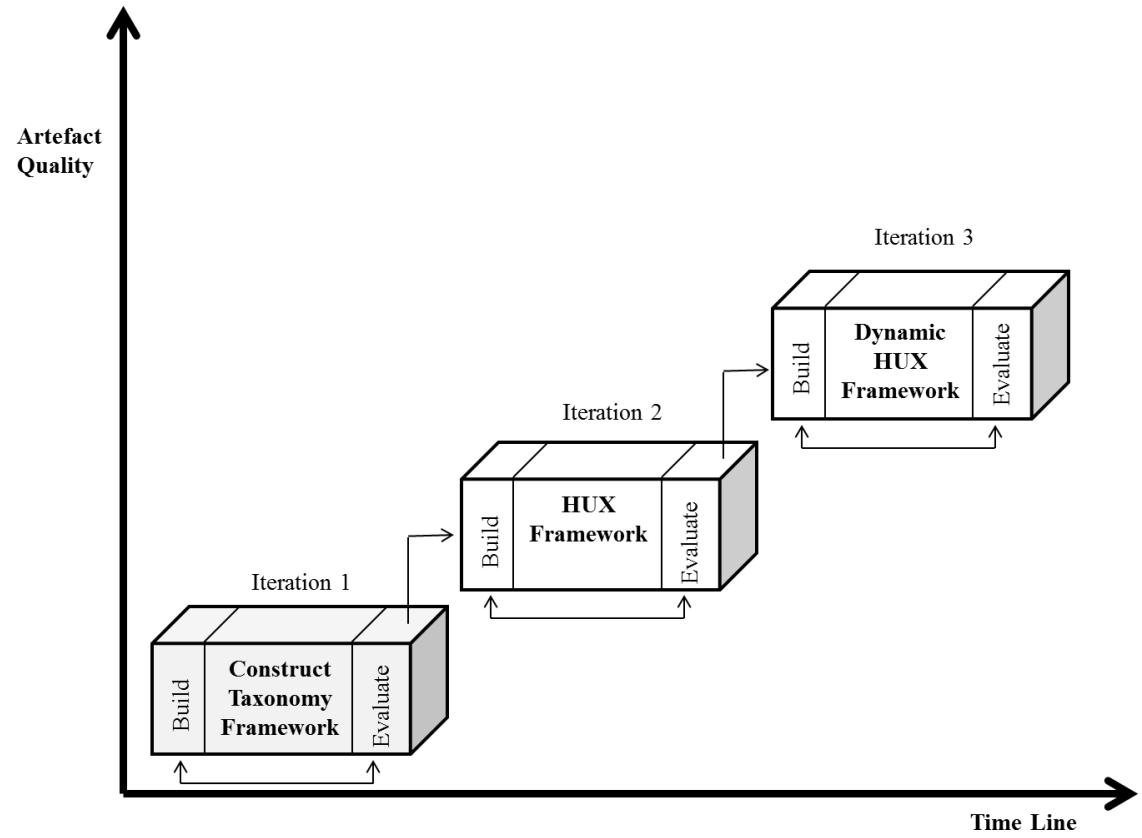


Figure 3.4: Research iterations

3.6.3.1 Iteration 1

To meet objective two of this research, in this iteration a taxonomy of heritage experience design is built whereby an improved heritage experience can be developed for the user experience journey. This study draws on primary and secondary data that proposes a taxonomy of user experience for heritage quality, and a technique derived from the suggestion phase is applied to collect the data.

Interviews are conducted with museum staff and interested parties to uncover specific elements of the heritage experience. There are three basic approaches to conducting interviews: structured, semi-structured and unstructured (Oates, 2005). Semi-structured interviews are conducted using a fairly open framework and are chosen for use in this study as they enable a focus on the issue under investigation and feel more like a conversation which involves two-way communication. In contrast, structured interviews are based on planned, standardised and identical questions for every interviewee, whereas unstructured interviews are freer with no set questions. In this study, data are collected from a historical organisation, Dorset County Museum, using semi-structured interviews. Grounded theory (GT) techniques are then employed to analyse the interviews in order to build a taxonomy, which is the basis for heritage journey design (Glaser and Strauss,

1967). Introducing a taxonomy for heritage experience design will help designers to design higher-quality experiences that will be embedded in the physical heritage landscape.

This iteration follows the well-founded recommendations of Hevner et al. (2004) to comprehend the existing knowledge base (literature review) and business need (expert interviews). The outputs of this iteration are a set of constructs that identify the appropriate experience design elements, and GT techniques are used to analyse the interviews and extract the main elements (Figure 3.5).

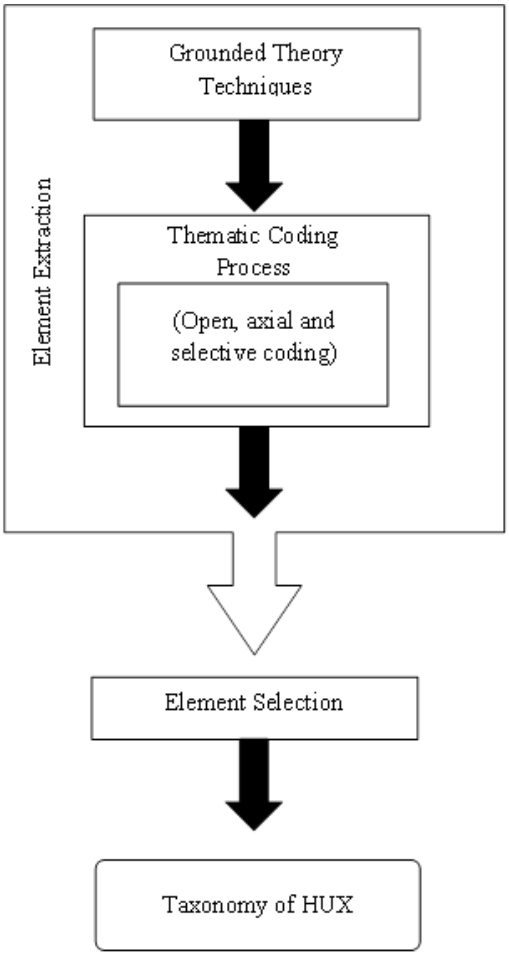


Figure 3.5: Taxonomy development framework

NVivo10 is qualitative analysis software which is used for organising and categorising data from the interviews (Richards, 2002; Denardo, 2002 ; Mgbemena, Bell and Saleh, 2016). This software is useful for content analysis, is easy to use, is stable in its operations, and has export facilities. In addition, it is suitable for manipulating and analysing the interview data in this study. GT techniques used in this iteration to analyse the data consist of three steps: open coding, axial coding and selective coding. Open coding consisted of analysing the interview transcripts and assigning a code to significant

data. The initial codes were then reviewed and words with the same meaning merged. Axial coding is the next step, and is used to review the remaining codes (free nodes in Nvivo10), and codes that are related are merged with a parent node. The axial coding process is iterative and takes account of changes in patterns and the emergence of new relationships (Glaser and Strauss, 1967). The final stage is selective coding, during which core categories are identified and "the process of integrating and refining the theory takes place" (Strauss and Corbin, 1998, p.143).

This iteration provides an artefact in form of a taxonomy of heritage experience, and Table 3.6 presents the steps taken during iteration one. This iteration demonstrates how designers could provide a specific experience identifying the device which will be used. This artefact is evaluated by comparing it with elements of experience design from the literature, which validates the outcome derived from this DSR cycle. The next iteration investigates elements of this taxonomy by utilising design thinking tools.

Table 3.6: Steps taken to achieve Iteration One

Iteration 1	**Aim: Develop taxonomy for heritage experience design.**
Step 1	Visit Dorset County Museum to investigate and discuses opportunities for digital technology in heritage
Step 2	Volunteers from the museum offer willingness to participate in the study
Step 3	Conduct semi-structured interviews and record the interviews using a recorder
Step 4	Transcribe the data from the interviews
Step 5	Import data into NVivo10
Step 6	Analyse the data using grounded theory techniques
Step 7	Identify elements and categorise them into teams.
Step 8	Build final taxonomy
Step 9	Compare the artefact to requirements from the literature to validate the findings.

A taxonomy of heritage experience design with consideration of high quality was developed as an outcome of this iteration. However, the significance of carrying out empirical research during the next iteration is clear, while utilising and building on the initial framework to build visitor journeys in iteration 2. Therefore, the importance of carrying out further iterative research is apparent, as this exploits and builds further onto the taxonomy. This is reflected using design thinking methods to represent visitor journey

models in Chapter 5. The resulting observations are utilised to investigate how heritage experiences can be articulated as part of a wider heritage design process.

New suggestions arose from the semi-structured interviews regarding user experiences and heritage journeys. As a new knowledge was gained during the development and evaluation of the developed taxonomy, new suggestions from the build and evaluate cycles are used to initiate subsequent iterations.

3.6.3.2 Iteration 2

The aim of this iteration is to develop a heritage user experience (HUX) framework to model heritage journeys. It applies the learning from the previous iteration to improve and extend the use of the developed heritage taxonomy. The improvement develops a framework to model experiences which identifies the main heritage experience elements, and includes persona and detailed specific journeys. The taxonomy from the first iteration is a model containing elements which help in designing experience journeys; however, a proven method is needed for the taxonomy to be used to model heritage experiences, namely a well-structured method aimed to assist heritage designers to design journey experiences. Therefore a user-centred design (UCD) technique is followed to design the HUX framework.

A UCD technique is conducted with the museum staff and visitors to design and build the process of experiences (HUX framework). UCD is a general term for a philosophy and methods which focus on designing for, and involving users in, the design of computerised systems (Rizzo, 2011; Abras, Maloney-Krichmar and Preece, 2004; Preece, Rogers and Sharp, 2002). Following this technique and involving users in the design, led to the development of more usable and satisfying designs.

There are advantages and disadvantages of UCD (Table 3.7), and one advantage is a deeper understanding of the use of technology which emerges from the involvement of users at every stage of the design and evaluation of an artefact. In addition, the artefact will be suitable for its purpose if users from the same environment are involved. The developments of artefacts are more effective, efficient and safe when utilising the UCD approach (Abras, Maloney-Krichmar and Preece, 2004). This approach also helps designers to manage users' expectations about an artefact. Thus if the users are involved in the design process, they know from an early stage what are the expectations of an artefact, and therefore they feel that their ideas and suggestions have been taken into account during the process, which leads to a sense of ownership of the final artefact. This

leads to higher customer satisfaction and smoother integration of the artefact into the environment (Preece, Rogers and Sharp, 2002). Some disadvantages of this approach are the time and cost required to gather data from and about users. The team involved in this approach needs to learn to communicate effectively and to respect each other's contributions and expertise. Thus it requires patient, financial and human resources (Dix et al., 1997; Preece, Rogers and Sharp, 2002; Mayhew, 1999).

Table 3.7: Advantages and disadvantages of UCD
(Abras, Maloney-Krichmar and Preece, 2004)

Advantages	Disadvantages
Products are more efficient, effective, and safe.	It is more costly.
Assists in managing users' expectations and levels of satisfaction with the product.	It takes more time.
Users develop a sense of ownership for the product.	May require the involvement of additional design team members (i. e. ethnographers, usability experts) and wide range of stakeholders.
Products require less redesign and integrate into the environment more quickly.	May be difficult to translate some types of data into design.
The collaborative process generated more creative design solutions to problems.	The product may be too specific for more general use, thus not readily transferable to other clients; thus more costly.

The process followed to develop the final HUX framework is shown in Figure 3.6. The analysis of Visitor Journey Map (VJM) components, which were identified in Chapter 2, and the outcome of iteration one are utilised as a scaffold for iteration two. VJM is an extension of customer journey mapping (CJM), which is the visualisation of customer experiences over time and space required to accomplish a certain goal (Hegeman, 2012; Alves and Nunes, 2013). It allows the identification of levels of satisfaction at each stage of a customer journey, and thus problems and opportunities can be identified. It originates from the technique of service blueprinting, and describes a collection of touch points from the beginning to the end of service delivery from a customer's point of view (Shostack, 1984; Chasanidou, Gasparini and Lee, 2014). In addition, it provides data about the processes and user experiences in the work environment (Nenonen et al., 2008).

CJM has been introduced in this research because it plays a vital role in understanding users' requirements in general, and more specifically in the experience design. CJM includes formal and informal touchpoints, which are factors affecting an experience from a user perspective. These factors can be later used to investigate and explore visitors'

behaviours during a heritage journey experience. In this research the term VJM is used in order to make this concept relevant for heritage designers and move it closer to the study area.

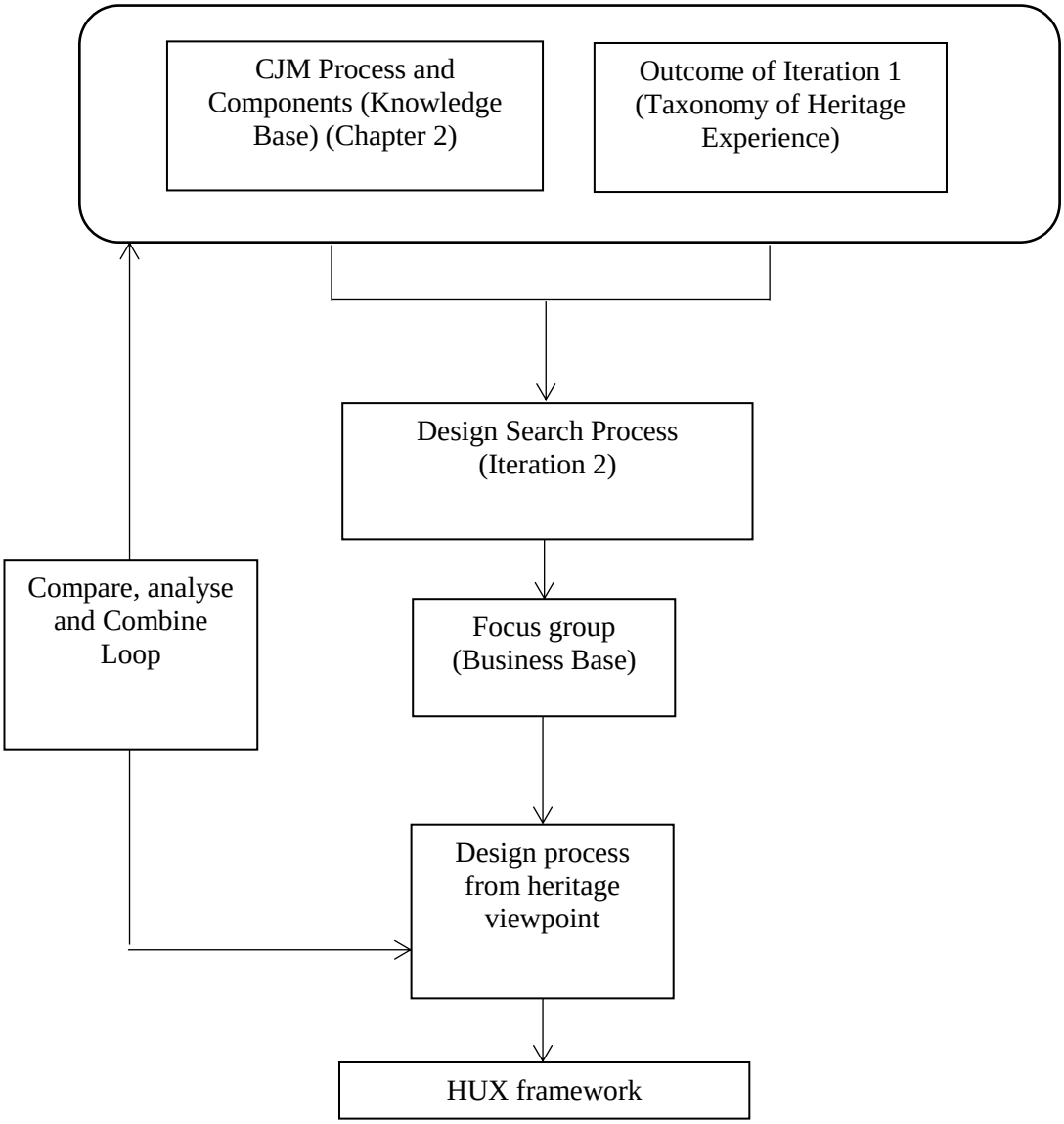


Figure 3.6: HUX development framework

There are a few characteristics of CJM which make it an appropriate tool for assessing heritage experiences. There is no standardised approach to building a CJM; however, there should be four characteristics, namely a team-oriented nature, highly visual non-linear nature, the use of touch-points, and an emphasis on real customers and consumers (Ortbal, Frazzette and Mehta, 2016). A diverse team is necessary to spark ideas and facilitate creative approaches, while the visual nature of journey mapping motivates participants to articulate their thoughts and ideas in ways other than through written or spoken words (Dahl, Chattopadhyay and Gorn, 2001). Visualisation also encourages system-level thinking and addresses the complex non-linear nature of customer journeys.

This dynamic nature enables a given visitor's journey to be understood and utilised as a communication tool. Touch-points are a critical part of mapping the customer journey, and are the points where a visitor interacts with the business, in this research a heritage site. Some researchers define these as navigation points before mapping, while others believe touch-points should emerge naturally through the process. This research uses the touch-points which emerge naturally whilst mapping. Touch-points have been described by Ortbal, Frazzette and Mehta, (2016, p.250) as follows:

"The Institute of Design at Stanford described touch-points in the following example: imagine an innovator is tasked with designing a new aspect to attract customers to a particular coffee shop; if the sole understanding is that people get coffee and then they drink it, the innovator has missed out on many different steps and stages in between."

There is a need to focus on the technique of UCD rather than an exact design centred research process. Techniques derived from specific papers may need to be modified to fit different use contexts, as users have real insights when designing their work environments.

"I am not sure that we will ever reach a point where we can specify exactly what process to follow for systems of particular types, but we can greatly improve our current methods of technique selection." (Karat, 1997, p.38)

Focus group technique in UCD:

To achieve the aim of this iteration, a workshop using a focus group technique was followed for data collection and design. Questionnaires are more appropriate for obtaining quantitative information and explaining how many people hold a pre-defined opinion, while focus groups are better for exploring exactly how these opinions are assembled (Morgan, 1996; Freeman, 2006; Stewart and Shamdasani, 2014). In the case of this research, it was significant to extract ideas and opinions from heritage workers and visitors in order to construct a design process for a heritage experience. As focus groups are more suitable for investigating how knowledge and ideas improve and operate within a context (Kitzinger, 1995), participants were encouraged to talk to each other and comment on each other's experiences and ideas.

Analysing focus groups is the same as analysing other forms of qualitative data. The researcher needs to draw together and compare discussions on similar themes and examine how these relate to each other, based on pattern-matching. Attention must be given to minority opinions and examples, and every opinion and viewpoint should be

noted. There is a need to indicate the impact of the group dynamic and to analyse sessions in ways that take full advantage of the interaction between the research and participants.

The analysis method used in this study is based on pattern-matching the findings against the theoretical propositions made earlier. The focus groups were analysed separately and a list of key steps identified. Figure 3.6 represents the process of developing the HUX framework, and the outputs of this iteration are a VJM that visualises the journey experience for different personas, showing their feelings/emotions throughout the journey phases.

Instantiation of the developed artefact (HUX) was carried out at the Dorset County Museum, where different VJM models were developed based on different personas and scenarios. The application of this process contributed a number of secondary design research products, including constructs, models and methods.

This iteration provides an artefact in the form of a method (HUX), and Table 3.8 presents the steps taken during iteration two. This artefact is evaluated through the instantiation of the framework in a museum, thus validating the outcome derived from this DSR cycle. The next iteration investigates behaviour dynamics using a simulation model as a system thinking tool.

Table 3.8: Steps taken to achieve Iteration Two

Iteration 2	**Aim: Develop a Heritage User Experience HUX framework to design journeys.**
Step 1	Participant identification (Stakeholders).
Step 2	Visit Dorset County Museum to conduct a workshop.
Step 3	Presentation about aim and objective of study, along with introducing the heritage taxonomy.
Step 4	Introduction about CJM and how it is used.
Step 5	Conduct focus group technique and observe discussion.
Step 6	Take notes and discuss stages of design
Step 7	Analyze data and decide together on the final stages.
Step 8	Present Stages and final framework.
Step 9	Museum experience instantiation
Step 10	Evaluate HUX framework.

New suggestions arise from focus groups regarding VJM models. As a new knowledge gained during development and evaluation of the developed HUX framework, new suggestions from the build and evaluate cycles are used to initiate subsequent iteration.

3.6.3.3 Iteration 3

The aim of this final iteration was to improve the developed framework to include SD, and it introduces an approach that embodies system thinking, including Causal Loop Diagrams (CLDs) and Stock-Flow Models (SFMs) from VJM, to design dynamic journey experiences. It applies the outcomes and learning from the previous iteration to improve and extend the HUX framework.

The HUX framework developed from iteration two is a method that helps in developing VJM; however, there is a need for a dynamic VJM, as this helps designers to explore the dynamic behaviours of different persona. In order to achieve this aim a conceptual model for the simulation needs to be built. It is vital to develop a SFM in order to represent the journey dynamics, and to do so a CLD and SFM are developed based on elements extracted from VJM.

It is important to note that modern hardware and software do not replace the thinking process, although they do provide a way to develop human mental models and design more effective policies, and thus everyone can contribute to the modelling process and increase the time available to focus on the issues of concern (Sterman, 2001). Simulations are not tools to predict the future, rather they are virtual worlds or micro-worlds, and managers can develop decision-making skills, conduct experiments and play (Sterman, 2001). Computer simulation is critical in systems with significant dynamic complexity, and modern SD modelling software makes it possible for anyone to participate in the modelling process. Moreover, graphical user interfaces enable modellers to quickly sketch a causal diagram, thereby capturing the feedback, stocks and flows, time delays, and nonlinearities that have been identified. Equations can be written using 'friendly algebra', meaning that advanced mathematical training is no longer necessary (Sterman, 2001).

SD was founded by Jay Forrester at MIT in 1961, and has been described as a:

Rigorous method for qualitative description, exploration and analysis of complex systems in terms of their processes, information, organizational boundaries and strategies; which facilitates quantitative simulation modeling and analysis for the design of system structure and control (Wolstenholme 1990; Sterman, 2001; Kunc, 2016).

System dynamics tools:

One of the SD tools which is used in this iteration is CLDs. This produces qualitative diagrams of mental models, which show causality and feedback loops. There are two

types of feedback loop, reinforcing and balancing loops (Williams & Hummelbrunner, 2010). CLD is utilised to explain the role of loops within a given system, and then the diagrams are further developed by categorising the types of variable and quantifying the relationships between variables. This process forms a SFM, which is a tool that is also used in this iteration and is a way of showing a system that can be used for model-based policy analysis in a simulated, dynamic environment. Stock and flow diagrams explicitly incorporate feedback to understand complex system behaviour and capture non-linear dynamics, and represent the accumulation and dispersal of resources (Sterman, 2000; Kunc, 2016 and Peters, 2014).

Stocks and flows are central to the dynamics of complex systems. Sterman (2001) explains them by providing meaningful examples, such as a bathtub where water flows in at a certain rate, and exits through the drain at another rate (Figure 3.7), or where a population is increased by births and decreased by deaths. Other examples include a firm's inventory, which is increased by production and decreased by shipments, spoilage and shrinkage (Sterman, 2001; Sweeney and Sterman, 2000).

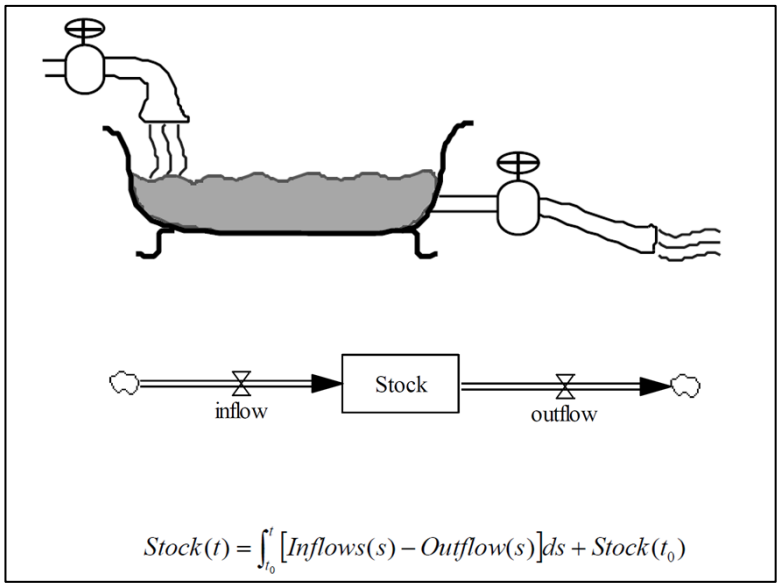


Figure 3.7: Bath tub metaphor for understanding stocks and flows with integral equation

One of the key aspects of stocks and flows representation is the differentiation between flows and the information feedbacks controlling these flows, which are responsible for closing the loops in the system (Sterman, 2000).

The platform used to perform simulations is Vensim PLE, which follows a philosophy to create simulation models in a very interesting and simple way (Sumari et al., 2013; Juan, Hui, and Pengji, 2018). It is based on three main entities: container variables (e.g., stock),

auxiliary variables (e.g., constant), and rate variables (e.g., inflow/outflow). This platform is useful and creates easy to follow models as it is a graphic based language. A freeware version which is available for students is used in this iteration.

SD development, via a generic, reusable SFM, is developed to investigate dynamic behaviour and how it improves the visitor experience journey. The model development process involves creating variables from the VJM models then importing them to build a CLD as a conceptual model. Based on the relationships in the CLD, a SFM is built to represent the behaviour which mimics behaviours during real-world journeys. The focus in this iteration is on modelling visitor interactions within the journey (experience). It is important to develop scenarios and VJM in terms of visit availability depending on user experience quality or touchpoints, and the efficiency of the journey experience.

Variables to build the model are extracted from the VJM of personas (Chapter 6, section 6.4). The application of the model contributes to a number of secondary design research products from this iteration, including constructs, models and methods. To achieve the aim of the research, this iteration executes the steps shown in Table 3.9. Each step applies a design language processing method to an input artefact and results in an output that is used as the input for the next step (March and Smith, 1995).

Table 3.9: Steps taken to achieve Iteration Three

Iteration 3	**Aim: Develop and refine the HUX framework to design dynamic journeys (D-VJM).**
Step 1	Identify experience elements from specific VJM
Step 2	Process of extracting elements from VJM to CLD
Step 3	Import elements to Vensim and Build CLD
Step 4	Choose specific variables to include in SFM
Step 5	Building SFM
Step 6	Simulation representation of Dynamic VJM model (SFM)
Step 7	Museum experience instantiation.
Step 8	Evaluate SFM model and HUXSIM framework.

A SD approach should involve a number of steps and features (Kunc, 2016; Senge and Forrester, 1980; Qudrat-Ullah, 2012), and these are used as a validation procedure to evaluate the process of modelling the SD in this iteration (Table 3.10). This evaluation is aimed at validating the output artefact; however, the HUXSIM framework is evaluated by instantiating the SFM created.

Table 3.10: Characteristics of basic SD models
(Kunc, 2016)

Steps to validate SD modelling
• Defining problems dynamically, in terms of graphs over time.
• Striving for an endogenous, behavioural view of the significant dynamics of a system, with a focus inwards on the characteristics of a system that themselves generate or exacerbate the perceived problem.
• Thinking of all concepts in the real system as continuous quantities interconnected in loops of information feedback and circular causality.
• Identifying independent stocks or accumulations (levels) in the system and their inflows and outflows (rates).
• Formulating a behavioural model capable of reproducing, by itself, the dynamic problem of concern. The model is usually a computer simulation model expressed in nonlinear equations, but is occasionally left without quantities as a diagram capturing the stock-and-flow/causal feedback structure of the system.
• Deriving understandings and applicable policy insights from the resulting model.
• Implementing changes resulting from model-based understandings and insights.

3.6.4 Evaluation

In order to demonstrate the utility of the DSR artefacts, an effective and rigorous evaluation process is conducted. The evaluation process is a very significant aspect of DSR because it establishes the validity and reliability of artefacts. Moreover, it can generate knowledge that can lead to a deeper understanding of the problem domain, and thus lead to improvements in the quality of the artefacts themselves. The evaluation methods used in this study to evaluate the quality and the effectiveness of the artefacts are listed in Table 3.11.

Table 3.11: DSR evaluation methods used in this study

Design Research Evaluation Method Types and their Description		**Methods used in this study**
1. Observational	**Case Study**: Study an artefact in depth in the business environment.	None
	Field Study: Monitor use of an artefact in multiple projects.	None
2. Analytical	**Static Analysis**: Examine structure of an artefact for static qualities (e.g. complexity).	None
	Architecture Analysis: Study fit of an artefact into technical IS architecture.	None
	Optimization: Demonstrate inherent optimal properties of an artefact or provide optimality bounds on artefact behaviour.	None
	Dynamic Analysis: Study an artefact in use for dynamic qualities (e.g. performance).	None
3. Experimental	**Controlled Experiment**: Study an artefact in a controlled environment for qualities (e.g. usability).	None
	Simulation: Execute an artefact with artificial data.	Simulation is used in SD models. Simulation experiments involve executing the SFM multiple times to mimic and imitate real scenarios.
4. Testing	**Functional** (Black Box) Testing: Execute artefact interfaces to discover failures and identify defects.	None
	Structural (White Box) Testing: Perform coverage testing of some metric (e.g. execution paths) in the artefact implementation.	None
5. Descriptive	**Informed Argument**: Use information from the knowledge base (e.g. relevant research) to build a convincing argument for the artefact's utility.	Information from the knowledge base (e.g. requirements and components from relevant research) to build a convincing argument for the artefacts utility.
	Scenarios: Construct detailed scenarios around the artefact to demonstrate its utility.	A simulation was used to present the utility of the VJM and SFM when it was used to instantiate the framework.

Different design evaluation methods are used in the three design cycles. Evaluation is performed through an evaluation strategy that measures the validity and effectiveness of the research based on potential performance improvements when using the developed

framework in the heritage domain. DSR evaluation criteria are used to examine the efficiency and generality of the framework. Applying the framework to a realistic heritage design experience resulted in extending the developed framework, which serves as an instantiation of HUXSIM, and this is used to validate a SD model for different persona and VJM models in Iteration 3.

3.6.5 Conclusion

This is where the research output is summarised and the results of the evaluation are identified. Future improvements are highlighted for improving heritage user experience design using SD simulations.

3.7 Application of the Design Science Research Guidelines

Hevner et al. (2004) provide a set of guidelines to establish rigours and relevance for DSR projects. This section illustrates the application of these guidelines to the whole research process used in this study.

3.7.1 Guideline 1: Design an Artefact

The roles of artefacts are significant in DSR and are considered the main outcomes of DSR research. March and Smith (1995) classified DSR artefacts into four types, as detailed earlier. Table 3.12 lists and explains the DSR artefact types, and matches the artefacts produced in this study with these types. March and Smith's grid relating a product (artefact) to a process, is used to highlight and summarise the overall products and processes of this research within an integrated and coherent framework. The first activity (design science) is meant to provide an understanding and proper explanation of how or why artefacts work within a real case scenario (heritage domain), while the second activity (natural science) serves to prove or disprove a theory scientifically.

Table 3.12: Research outputs versus research activities

Research Activities					
		Design Science		**Natural Science**	
		Build	**Evaluate**	**Theorise**	**Justify**
Research Outputs	**Constructs**	Heritage Taxonomy	Completeness Simplicity Ease of use Understand-ability	Explain why and how constructs work by employing them to describe real case scenarios (Ch.4, 5, 6)	Prove that constructs work scientifically by applying them in models and methods (Ch.4, 5, 6)
	Model	-Taxonomy scenario -VJM -HUX -CLD. -SFM. -HUXSIM	-Fidelity with real world phenomena. -Completeness -Level of detail -Internal consistency	Adapting current CJM theories and hypothesising that those models are true (Ch. 5 & 6)	Test the models on a real-life example to prove them (Ch. 5 & 6)
	Methods	-VJM Process. -Heritage Taxonomy Development process. -HUX Framework -CLD process -SFM process -HUXSIM Framework.	-Operationally (ability of others to efficiently use the method). -Efficiency. Generalisability -Ease of use	Explain why and how methods are applied (Ch. 4, 5, 6)	Prove that the methods work formally by instantiating them using real examples (Ch. 5 & 6)
	Instantiation	-HUX application. -SFM application -HUXSIM application	-Effectiveness -Efficiency -Impact on environment and its users.	Understanding how and why application works in heritage domain (Ch. 5 & 6)	Prove that HUXSIM works by testing it in the domain (Ch. 5 & 6)

3.7.2 Guideline 2: Problem Relevance

Section 1.2 provides information on the research problem and discusses the motivation for this study. Section 3.6.1 underlines the problem relevance and highlights the need for heritage experience design processes and tools.

3.7.3 Guideline 3: Design Evaluation

There are a variety of different research evaluation methods used in this study, and a set of evaluation methods identified by Hevner et al. (2004) are followed. Table 3.11 lists and describes these methods and matches these to the methods used in this study.

3.7.4 Guideline 4: Research Contributions

The contributions of this research are the HUXSIM methodological framework and design principles. The HUXSIM framework demonstrates the feasibility of using design thinking and system thinking models and tools to develop an artefact to model and study visitor journey experience. Moreover, the SD model is the first artefact to address visitor experience in the heritage domain; therefore this development process is itself a contribution to design science. Furthermore, examples of using the model to provide insights into visitor experience are provided, and the HUXSIM framework can be used to generate new insights which can be tested in future work. A detailed discussion of the contributions and value of this research is presented in section 7.3, followed by possible future work in section 7.4.

3.7.5 Guideline 5: Research Rigour

To ensure rigour in this study, best practice guidelines have been integrated into its design and research processes, and are employed in both the construction and evaluation of the designed artefacts. The guidelines cover the whole design and research process (Hevner et al., 2004), and section 3.7 demonstrates the application of these guidelines in the context of this study.

3.7.6 Guideline 6: Design as a Search Process

Applying best practice guidelines to developing the artefacts facilitates the search process for the best solution. Moreover, it provides a structured and systematic approach to conducting this research. This study seeks to model the problem, rather than directly working with the problem itself, and the modelling process is inherently iterative, while developing the models is essentially a search process to produce the best illustration for

the problem. The iterative design process followed in this study contributes to improving the designed artefacts and also enhances the research-learning process.

Executing the research in a DSR incremental iterative manner enabled learning to emerge from the first iteration by applying techniques and tools from the knowledge base on user experience. Table 3.13 summarises the three iterations illustrating the objectives and output artefacts of each. The research iterations are described in more detail in the following chapters.

Table 3.13: Summary of research iterations

Iteration	Activities	Output	Artefact Type
I	Constructing taxonomy of heritage design (Objective 1)	Taxonomy of HUX	Constructs and Method
II	Develop Persona (Objective 2)	Persona model	Model
	Taxonomy scenario (Objective 1)	Experience model	Model
	Develop visitor journey map (Objective 3)	VJM model	Model and Method
	Build HUX (Objective 1)	HUX framework	Model, Method and instantiation
	Suggest an improvement and extend existing framework (Objective 3)	Suggestions for future improvements.	Theories.
III	Build a causal loop diagram (Objective 4).	CLD	Model and Method
	Develop a stock-flow model (Objective 5).	SFM	Model and Method
	Develop SFM to assess some experience impact (Objective 5)	SD model	Instantiation and method
	Refine and Extend the HUX framework	HUXSIM methodological framework	Model and method
	Evaluate HUXSIM	D-VJM	Model

3.7.7 Guideline 7: Communication of Research

This research is relevant to both technology-oriented and management-oriented audiences. A detailed description of the artefacts and their design and implementation processes are provided in order to communicate the study findings to the technology audience. The detailed description enables practitioners to understand the processes of artefact development and evaluation, which aids in the further extension and evaluation of artefacts.

The goal of this research is to help designers explore different dynamics behaviours and their probable consequences. Thus an emphasis is placed on the significance of the visitor experience and the novelty and effectiveness of the HUXSIM framework as an experience journey investigation tool. A clear demonstration of how this methodological framework works and how it can be used is provided, which will enable designers and decision makers to effectively apply this model.

3.8 Summary

The research methodology adopted in this study is DSR, which involves the construction and evaluation of artefacts that develop a heritage experience design. This chapter describes the research approach adopted to conduct this study. The methodology is executed in five design research steps, which are adopted from Vaishnavi and Kuechler (2004): (1) Problem awareness, which is the design of heritage experiences in museums and historical locations; (2) Suggestions of suitable QoE models, design and system thinking from the knowledge base; (3) Development of the main DSR artefact (HUXSIM); (4) Evaluation of the artefact based on synthesising DSR evaluation methods in the heritage field; and (5) Conclusions. In order to achieve the research aim and objectives the research is executed in three incremental DSR iterations, whereby each iteration is used to build and evaluate a set of artefacts aimed at improving the process of designing visitor experiences within the heritage domain.

In the first iteration a heritage user experience taxonomy is developed, while the second iteration extends the output to better articulate the heritage experience journey by building a HUX framework and introducing VJM models. The third iteration extends the framework by applying SD tools and techniques. Hevner's (2004) DSR products classification is adopted to illustrate the research outputs produced from the iterations. Due to the central role of artefacts, the research products (artefacts) are discussed and

identified in the form of consequent constructs, models, methods and instantiations. In response to increasing calls for rigor and utility, this chapter concludes with illustrations of how this research has incorporated a set of best practice guidelines to improve the utility of the HUXSIM methodological framework and to ensure the rigour and validity of this study as a whole.

CHAPTER 4 Understand and Articulate Experience in Context

4.1 Introduction

This chapter presents iteration one of the research, which focuses on identifying elements of the heritage UX. Through the analysis and design of this phase, further insights are acquired into the problem domain before building a framework for the design of a journey experience. This chapter applies grounded theory techniques to build a taxonomy of heritage UX design that is to support the later design of heritage journeys. Robust problem definition and clear constructs provide the necessary underpinning for later iterations.

Section 4.2 discusses how design science research is applied to this iteration, and in addition, design research artefacts for this iteration are identified, along with the iteration plan and research outputs. Section 4.3 introduces the building and development of the artefact, presenting a method for identifying elements of UX and explaining steps involved in the method. An analysis of stakeholders' viewpoints with respect to the heritage experience is constructed in order to understand in-depth the requirements and main elements of the visitor experience. This achieved by conducting a set of interviews on a historical domain to determine the main constructs of the research by identifying the procedures needed to motivate visitors and design experiences. Section 4.4 shows the first design artefact heritage taxonomy. Section 4.5 evaluates the heritage taxonomy and; finally, a summary of the chapter is presented in Section 4.6

4.2 Design Artefacts from Iteration 1

As part of this study, a prototype mobile application was built under the Interactive Social Experience Engine for History and Heritage (iSEE) project at Brunel UniversityLondon, in coordination with the Dorset County Museum, in order to explore expected visitors' experiences. Figure 4.1 shows the museum and the historical location, Maiden Castle. This initial study investigates and illustrates the use of visitor experience in a museum and interlinked locations - in this case the Dorset County Museum and Maiden Castle.

Figure 4.1: Dorset County Museum and Maiden Castle

The prototype was based on a quantitative research study conducted with visitors to the Dorset County Museum and Maiden Castle (Al Subhi, Bell and Lashmar, 2015), and this prototype was tested in the field of Maiden Castle as an example of how physical heritage can be sited (in digital form) within the physical landscape, and accessed from experience based on location-based modelling. Each visitor was able to view a map using their smartphone and, based on their specific GPS location, a tagged pop-up presented video, photo or audio clips about a fact/scenario/incident related to that location was presented (Figure 4.2). The mobile application prototype was a technical exploration with popular artefacts and available media chosen as a basis for the work. It was clear that a more rigorous and robust approach to experience design was needed.

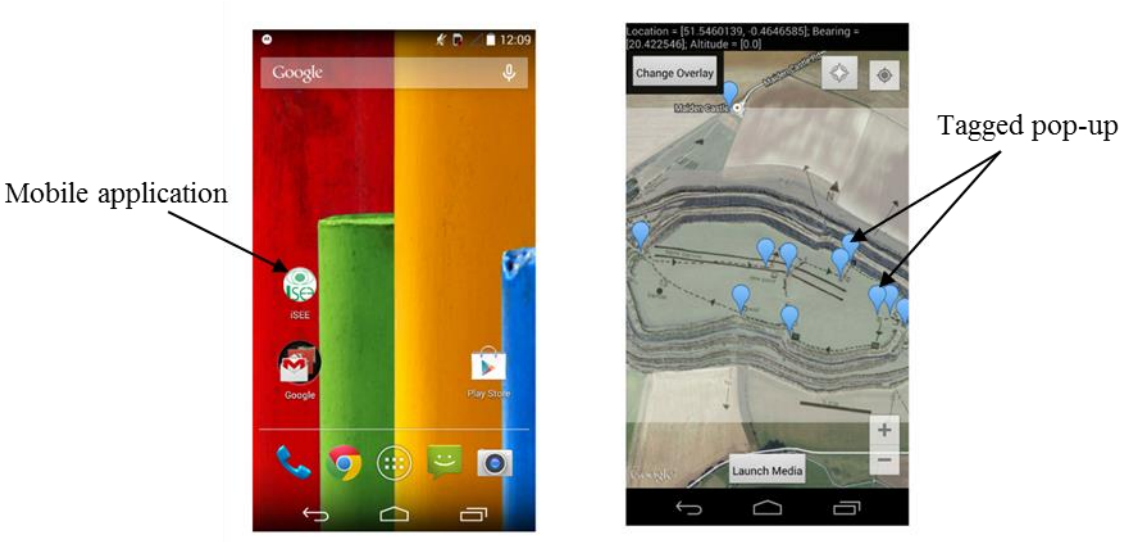


Figure 4.2: Snapshot of the smartphone app

While working on the iSEE project it became apparent that a high proportion of visitors to the Dorset County Museum did not visit Maiden Castle, despite it being a nearby historical landscape of significance, where many museum artefacts were found (Maiden Castle, 2015). Following this observation it was decided to conduct a study to investigate methods of designing experiences to visit interlinked locations and museums. From an initial review of the literature, it became evident that while there has been a substantial amount of research on digital experience in museums and end users, the existing research has focused specifically on the technology and tools, and none has investigated the process leading to the design of the journey experience for visitors in historical locations. Literature in this study (see Chapter 2, Section 2.2.1) also indicates that there was a gap in the process for designing experiences to better engage visitors in a personal way. This motivated the desire to develop a subtler understanding of how design thinking tools can help to explore the various influences on visitors that act to shape their aspirations and choices.

This chapter develops an appropriate experience scaffolding method, and as new knowledge is gained during the development and evaluation of the developed artefact, new suggestions from the build and evaluation cycles are used to initiate subsequent iterations. DSR is applied to assist artefact development, and consists of a set of steps which are followed in order to accomplish a specific task (March and Smith, 1995). Design constructs are uncovered through a combination of expert perspectives and literature. In this iteration, a GT technique was conducted with the aim of constructing a heritage experience taxonomy, and Figure 4.3 illustrates the overall framework of the first iteration.

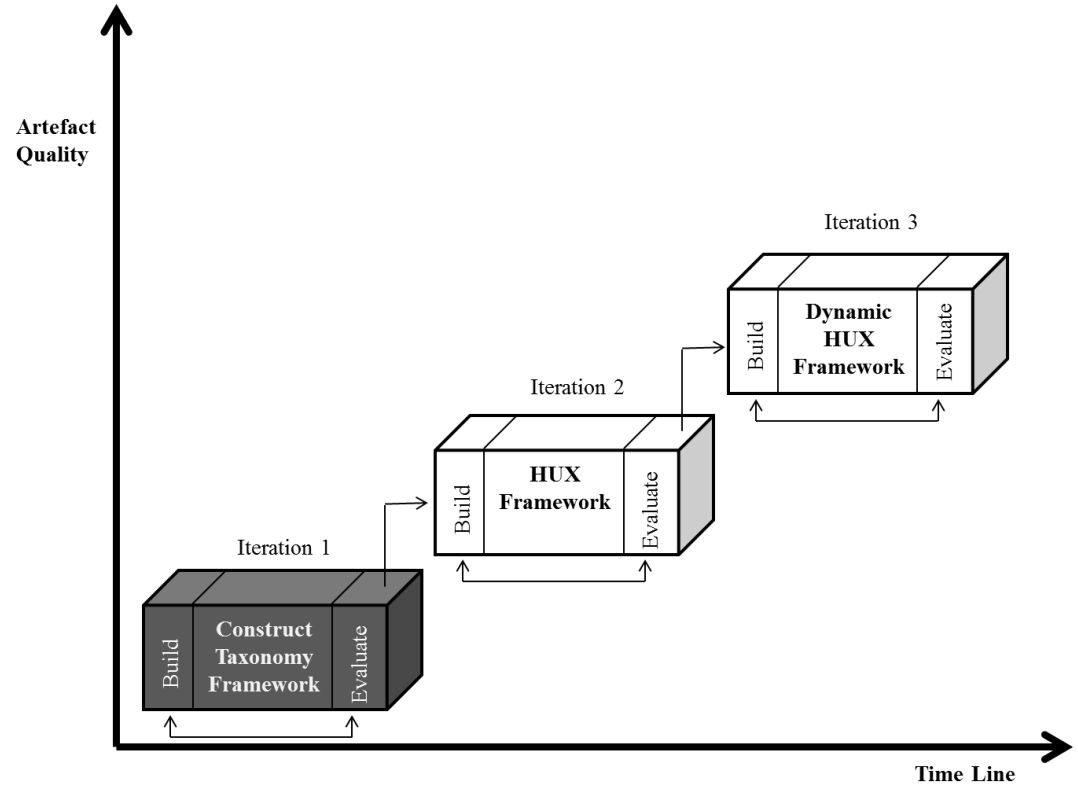


Figure 4.3: Iteration 1 overall framework

4.2.1 Design Research Artefacts

UX design is "The process of applying proven principles, techniques and features to create and optimise how a system behaves, mapping out all the touchpoints a UXs to create consistency in the interaction with the brand" (Stokes, 2015, p.96). In this research the requirements/elements of experience design are identified and are later evaluated to validate the outcome, the taxonomy of the heritage experience (Table 4.1) .

Table 4.1: Requirements/elements of experience design

Experience design requirements/ Elements	Description
Goal	During a design of an experience it is important to indicate the aim of an experience and why the visitor is visiting this location or using a specific tool.
Human	This includes the requirements of feelings and emotions when designing an experience. Study the user deeply.
System	This includes software and hardware to accomplish a design experience, as well as a digital experience, and the simplicity of the system.
Context	The refers to the whole environment of the experience, including devices used, business, community, etc.
Interaction	The experience should include interactions between a user and the application/system.
Business	The design should consider the needs of an organisation or company.
Multimedia	This includes video, audio, speech, text, etc.
Action	This includes movement, work effort, and all activities the user does in order to achieve their goal.

In this iteration, a taxonomy is constructed to identify the practical elements that embody the heritage experience through the analysis of the interviews conducted. The technique involves a one-step process resulting in one output. This step applies a method to an input which results in an output that is used as input for the next iteration, as shown in Table 4.2.

Table 4.2: Iteration steps: input-output model

Step	Method	Input Artefact	Output Artefact
Constructing taxonomy of heritage experience.	Semi-structured interviews - grounded theory techniques.	Museum expertise interviews as a domain of concern in heritage experience.	Heritage experience taxonomy model (constructs and model).

UX design is unsurprisingly challenging, specifically when attempting to classify an experience within a customer journey. It is challenging as it deals with the feeling and empathy to the service or product. Thus it is hard to find a single answer to the problem of identifying a general framework to design experiences. Consequently exploring

various approaches is needed to resolve user issues, considering the situation and conditions where a user uses a service or product.

4.3 Taxonomy Building and Development

Initial steps are identified and described during the awareness of the problem and suggestion phases (Chapter 2, Section 2.3.1) in order to construct the heritage experience taxonomy. This entails reviewing the QoE models reported in the literature and confirming the need for a high-quality heritage experience. However, the next section explains the data collection and analysis using GT techniques, which is the main concern for this iteration.

4.3.1 Process of Building the Taxonomy

While the construction process for design science artefacts is not widely understood (March and Smith, 1995), this iteration design follows well-founded prescriptions gathered from the IS literature (Hevner et al., 2004) in order to understand the existing knowledge base (literature review) and business need (expert interviews).

This research was undertaken in accordance with ethical standards. Prior to data collection an ethical approval was allocated to ensure the privacy of the participants and to maintain confidentiality of their statements. Permission was sought from the informants prior to each interview (see Appendix C for a consent form). Additionally, where the interviews took place in the Dorset County Museum, formal permission from the management of the museum was granted. The participants were assured that their data will not be disclosed to anyone and will be used for the purpose of research only. Moreover, they were assured that they were free to refuse to respond to questions if they were uncomfortable and they could withdraw from the interview process anytime. The process of interview transcription ensures creditability in the study (Noble and Smith, 2015; and Cope, 2014).

Semi-structured interviews were used as the main method of data collection. The interview protocol was determined and prepared based on the literature areas reviewed earlier to guide the interview without constraining it (Castillo-Montoya, 2016). Respondents were allowed to express their views and opinions on any aspects they considered significant, and the focus was on enhancing the understanding technologies

that link historical locations and improve heritage experiences. The questions were based on Castillo-Montoya's 2016 Interview Protocol Matrix that reflects the research issues (questions) with the interview question. To develop a protocol that encourages a discussion, it is significant to create interview questions that reflect research issues (Maxwell, 2013). Using this approach helped in creating and checking the alignment of questions for mapping interview questions onto research questions. Table 1 in Appendix D, presents the Interview Protocol Matrix with interview questions listed in rows and research issues in columns. The cells were marked to show when a specific interview question has the potential to stimulate information associated with a research issue (Neumann, 2008; Castillo-Montoya, 2016). Of course the research issues, questions, came from literature reviews, the knowledge of contexts, norms and every-day practices of potential participants. Thus, using this knowledge helped in writing interview questions that are understandable and accessible to participants (Castillo-Montoya, 2016). This research also preserved conversational and review objectives of the research by including four types of questions: (1) introductory questions, (2) transition questions, (3) key questions, and (4) closing questions (Creswell, 2007; Krueger and Casey, 2009; Merriam, 2009; Rubin and Rubin, 2012).

The questions used in the interviews for this study were designed after developing the conceptual model (Chapter 2, Section 2.3.4)and choosing the data collection methodology. All of the questions were piloted with six participants in order to make sure that they were relevant, clear and comprehensible. The pilot test helped the researcher in this study to modify and improve some of the questions, to make them more appropriate for the outcomes needed from this study. Also, this helped to adapt the questions to become more understandable for the participants. Based on the feedback the researcher received from the pilot stage, some of the questions have been revised and improved. For example, question 3.4, What kinds of multimedia are used as visitors' journey around the museum? This question was a general question, which asked about kinds of media used and why. This question was not clear and does not match with the research issue. Also question 4.4, How would you present these stories to the visitor on a mobile device? This question aims to dig down about the design of experience and allow for imagination about missing elements for design. This question was written in a different way, but after the pilot test. It was refined and reformed.

The focus of this study was to build a structured framework to help categorise visitor experience. Thus, the interview protocol (see Appendix D) focused on questions concerning: (1) The history and background of the research context; (2) The motivation for considering technologies in the historical landscape; (3) How users will benefit from the technology and its efficiency and effectiveness; (4) How users interpret experience and journey; (5) How users collect and save objects, e.g. database strategies; and (6) The organisational context, e.g. structure, users' jobs and autonomy. However, each interview was different and the nature of discussion varied according to the data provided by the participants. The questions in the guide assisted in remaining on track in accordance to the research goal.

To discover more about the reason(s) for the lack of technology in local museums and issues within the heritage domain, interviews were conducted with museum experts. This iteration seeks to enrich the literature review by investigating: (1) The different strategies of the museum to improve visitors' experience; (2) The influential motivation aspect for attracting visitors and the factors that affect patterns; and (3) The key value of an interlinked heritage landscape experience and the possibilities of designing an interface. Ten semi-structured interviews lasting approximately 40 minutes were conducted with key experts and managers at Dorset County Museum (Table 4.3).

Table 4.3: Semi-structured interview participants

Actors from the Heritage Domain	
Position	Participant Code
Experimental Archaeology (Ancient Wessex Network)	PC 1
Local Radio DJ (X-DCM worker Volunteer for DCM)	PC 2
Fundraiser (Dorset Town Council)	PC 3
Art Curator (DCM)	PC 4
Collections Manager Assistant (DCM)	PC 5
Collections Manager (DCM)	PC 6
Volunteer working with DCM databases	PC 7
Archaeologist (National Trust)	PC 8
Earth Science Manager (Jurassic Coast)	PC 9
Hardy Collection (DCM)	PC10

The iSEE project mobile application and images of Maiden Castle was demonstrated during the interview along with asking the questions (Figure 4.4).

Figure 4.4: Images from the interviews

Technique for analysis

Interviews were recorded before being transcribed, verified and analysed thematically using grounded theory techniques. Grounded theory (GT) methods are the process of producing theory from collected data (Glaser and Strauss, 1967; Miles and Huberman 1994; Strauss and Corbin, 1997). While grounded theory is traditionally associated with sociology, nursing and health, and organisational studies, in recent years it has started to be utilised in information systems, marketing and consumer research. In contrast to other traditional experimental research methods, grounded theory starts from a set of empirical observations or data, and aims to develop a well-grounded theory from that data (Lee, Saunders and Goulding, 2005). However, in this research the GT techniques ,not methods, are used to analyse the data and extract elements. The analysis classified textual material from the transcribed interviews, which semantically delivered significant and manageable data (Weber, 1990). Figure 4.5 presents the methodological framework used to analyse the data.

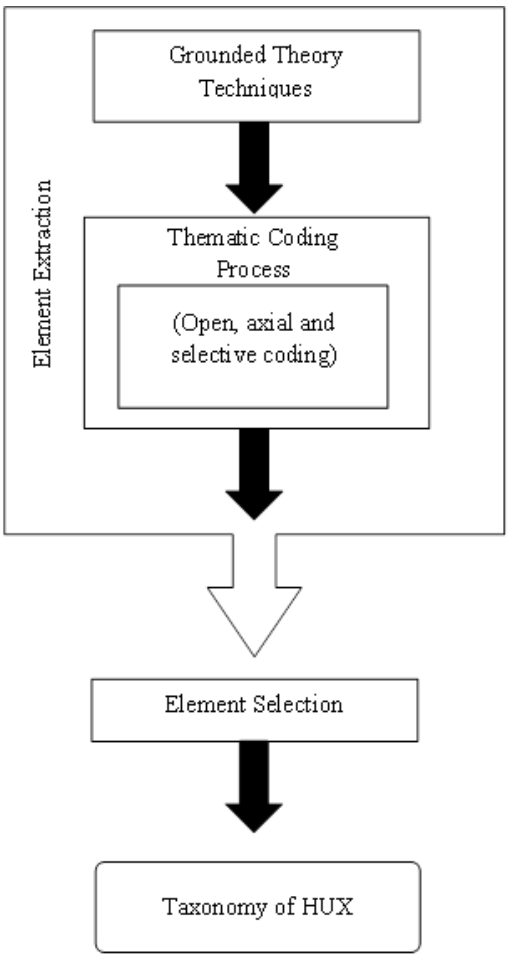


Figure 4.5: Data analysis framework

Thematic coding was used to analyse the data, which assists in building relationships and comparing between elements (Strauss and Corbin, 1998); thus, helping to identify elements and relationships between constructs and strengthen the final model. The main process of coding involves open coding, which is the initial basic coding of the original data, followed by axial coding, which draws together categories and sub-categories into a hierarchy, ready for selective coding, which is the process of integrating and refining categories in order to establish a theory (Strauss and Corbin, 1998, p.21). The software NVivo10 (Richards, 2002; Denardo, 2002 ;and Mgbemena, Bell, and Saleh, 2016) was used for organising, categorising and searching the textual, documented data. NVivo10 is a comprehensive tool which can generate an enormous number of standard reports and has export facilities, thus it helped in manipulating and analysing the data collected.

All the documents and notes from the interviews were imported into NVivo10 for analysis, and each imported file was reviewed and every significant sentence, phrase or word allocated a code, known as the node. These base codes were then re-reviewed and, through a process of consolidation, codes with the same meaning were merged, which

completed the first phase of the grounded theory (GT) technique of open coding. Moving to the second phase, which is axial coding, the remaining codes, the nodes, were linked to the previously related codes under a set of new higher-level codes. It is important to note that this process was repeated many times as new relationships and ideas emerged. This is a key feature of GT, termed 'constant comparison' (Glaser and Strauss, 1967), and is similar to the feedback loop in the design research stages identified by Vaishnavi and Kuechler (2004). Thus, the coding structure underwent several iterations with minor and major hierarchical restructuring.

4.3.2 Interview Analysis and Discussion

Heritage experience enhancement requires the input of heritage experts, thus the analysis of the interview data helps in understanding the qualities and experiences available at the museum, as well as the technologies used to guide visitors, which are the basis of experience design.

The purpose of this analysis is to create a heritage taxonomy; which is a scaffold for heritage experience design. The data used for creating the taxonomy are the interviews conducted earlier with 10 key workers in the heritage domain. Using NVivo, as illustrated in Figure 4.6, the interview outcomes were fed into the tool, with each interviewee's feedback grouped into nodes that represent the main elements which affect the user design experience, e.g., types of visitor, age group, multimedia visual aids (Figure 4.7).

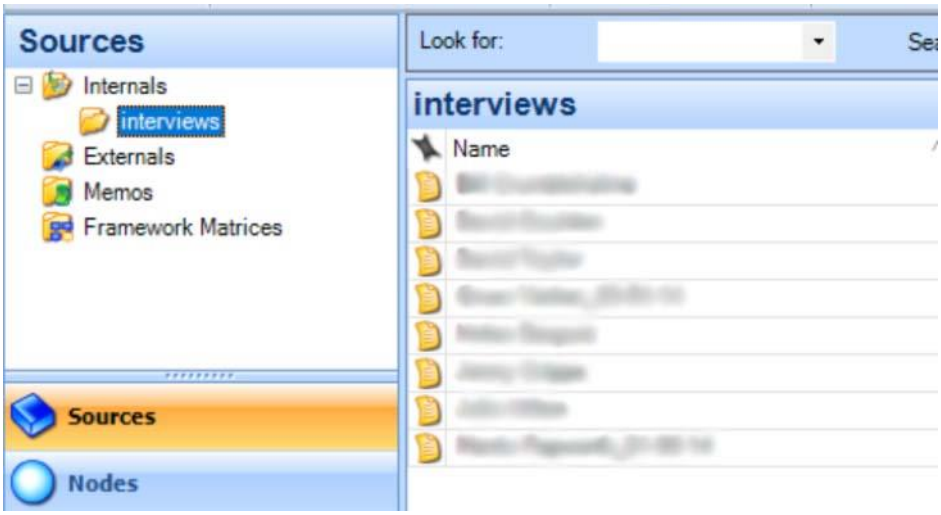


Figure 4.6: Importing the interview data into NVivo

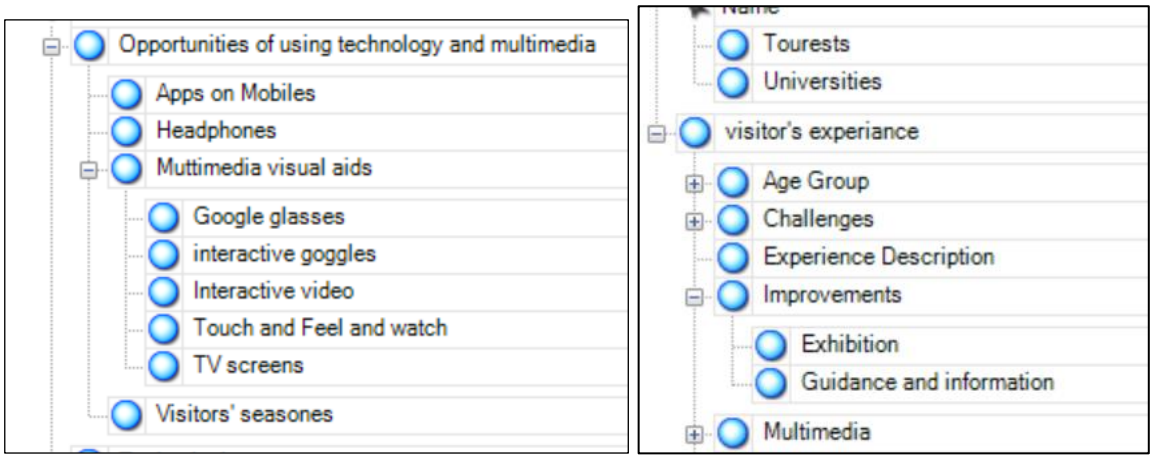


Figure 4.7: Examples of the early elements extracted from the interviews

Each of the elements within the nodes were grouped according to the number of sources that were referenced throughout the interviews. In the GT technique, this represents the internal coding stage, or open coding (Strauss and Corbin, 1998; Figure 4.8).

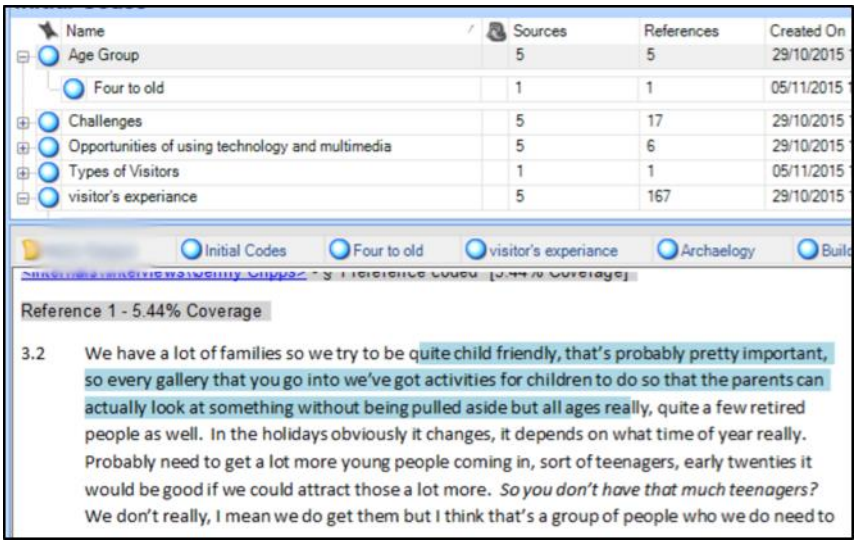


Figure 4.8: Open coding phase

These elements were then grouped into small clusters during axial coding (Table 4.4). The clusters were then refined further into more meaningful groups and close to a detailed development stage, as in selective coding, (Heath and Cowley, 2004; Lee, Saunders and Goulding, 2005).

Table 4.4: Themes arising from the axial coding

Theme	Sub-Themes
Main journey experience	Visitor experience, challenges, experience description, app on mobile, attractive parts, resources.
Goal/purpose of visit	Tourists, university, school, exhibition, age group, seasons.
System control	Technologies, interlinked locations, interconnection between devices and systems within museum.
Media and multimedia	Multimedia, story, guidance and information.

The next sections explain the coding by presenting some examples from the participants' interviews. The PC# refers to the participant code number.

4.3.2.1 Main Journey Experience

A range of responses were collected, for example, one interviewee specifically mentioned that this depends on visitors' interests, personality, and who they are, e.g., a family, children or older visitors.

"A complete variety of ages and I believe there's up to 50,000 people per year visiting the museum. I am very aware that we need to cater for that huge variety so from very young children to highly educated more mature researchers." PC5

Other interviewees stated that Thomas Hardy, Maiden Castle, dinosaurs, skeletons, fossils and the Roman corner are attractive parts and should be linked to each other whenever possible:

"…I think it's a shame that the notice boards in the car park don't say "this way to the museum". Almost have a piece of string to follow sort of thing." PC1

They specifically encouraged designing journeys for visitors but thought that they should give them some freedom and choices. One mentioned a bad experience of their own when visiting a museum, which they advised should be considered during any design process:

"I just felt like, actually I really don't want to do that I just want to experience it the way that, you know if my son wanted to run up there and look at that then let's go and do that, you know. So I felt it was too controlled and I think it's very important to try if people are lost and they don't know what to do it's very important to try and help them, show them what's important and significant but I don't think you want to control people and

say you must go this way, you must go round anticlockwise or whatever you know. I think they need some freedom". PC6

"..playoff between how easy it is to access focusing trying to sort of ascertain what people's interest is although recognising that you can sometimes find a bit of interest just from random access almost that your interest might be whatever it is bits of pottery but oh look there's a whatever it is over there a building and actually that's quite interesting but if you'd narrowed down the field of interest too quickly you would have missed that so there is a difficulty there." PC 7

A further consideration when designing a journey experience is to keep up with the dynamic things that are happening outside, otherwise people will not visit the museum:

"I think one of the issues about bringing young people into museums is that it's a lot of old stuff and there's so many modern things, exciting things, very quick, dynamic things happening outside that we need to try and keep up otherwise people will not be coming in so we certainly have to and I think we need.." PC6

However, they also mentioned the importance of resources and expenses, which need to be considered too:

"The other thing is keeping up because technology seems to change so quickly and obviously that gets expensive if every six months you've got to bring in something new." PC6

"While a 5D cinema in X country used a set of projectors in all dimensions, allowing visitors to experience history as if they were immersed in it as an adventure; however, these approaches have significant cost implications." PC9

In order to use multimedia and digital services, resources are needed but staff may lack the technical resources to deliver them:

"... because I don't know much about this, I think we need people who do know a lot about this to come in and help us and direct us so that we're not completely missing the plot with what we're doing." PC6

"I am not particularly technologically minded so it certainly would be a designer or computer programmer who would be involved. I wouldn't know how to design such an interface. But the content interests me enormously." PC5

Another reason for the greater use of digital services and technologies is that there are many objects in collections that are not displayed. As space is limited and some objects are extremely delicate, including them in a digital tool/technology could solve this problem. Regarding this issue PC3 and PC1 commented that:

"We currently hold in the exhibition room various exhibitions booked out to 2018 now. Within the museum also we have leaflets and pamphlets and information online regarding all projects and the collections within the museum and outside the museum which currently we only exhibit 3% of the entire collection we own". PC3

"I think there is a place for that information because people want to do background reading but not actually in the museum itself, so being able to look at a website for instance that picks up on that is a good way of backing that up because obviously you haven't got the space to put a lot of display boards out and that sort of thing." PC1

From the interviews it can be concluded that multimedia is employed in rolling images, handsets, handhelds, and touchscreens, which are used to guide visitors, but the technology is often broken and requires maintenance. However, these could be replaced by other digital services and technologies. Thus to shape experiences and specify requirements, it is important to identify the most attractive parts of a journey (Figure 4.9), in addition to representing the required digital services or devices for each stage or site of heritage experience. Moreover, it is significant to investigate the business and community aspects of the proposed design of a journey.

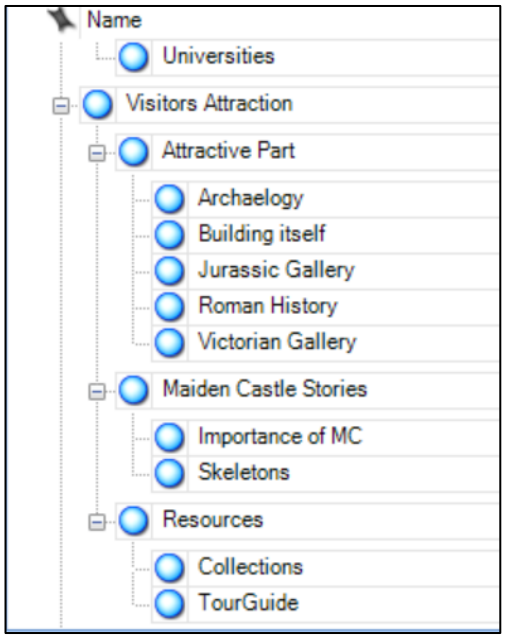


Figure 4.9: Nodes showing the main attractions as extracted from the interviews

4.3.2.2 Goal / Purpose of Visit

The purpose of visits and visitor categories are very important for developing the most appropriate journey experience. Many Dorset County Museum visitors are families, school trips or retired individuals, yet the museum would like to attract more teenagers and is trying to be child-friendly by including more interactive material.

"We currently engage a lot with schools, colleges, universities and world events, so basically our age group is from four to old. I can't say a final age because there isn't one because that is like our current…. they all come to the museum." PC3

"There's always a playoff here between information you can access, how long it takes to access and how much, if you're going up there for a walk you don't want to be, most people will not want to spend three hours up there looking at everything so it'll be a pick and mix I would guess so that people can almost select their areas of preferred interest but on top of that you might have some generalities…" PC7

They mentioned that as a designer it is significant to consider that different visitors have different goals from a visit and there is no need to restrict them to a specific journey:

"I went into the ….. [X museum]and the people who are in every room were trying to tell me what to do and I have two children, they were trying to tell my children what to do which wasn't working and I felt like they were trying to control us, they were saying, you must look at this, ignore that, look at this and then you must fill out this, the kids had a form they had to fill out, you must do that and then you must go into this room." PC6

"let's say there are going to be 50 different objects or pieces of information and everybody is not going to want to access all of those so you're going to somehow have to lead them down a route that they want to go and introduce them to the things that they are going to be most receptive to but somehow you want to offer them the possibility you want to attract them into other areas if you can.." PC7

Other interviewees noted that when designing an experience it would be useful to show specific stories during a walk around Maiden Castle and Dorset County Museum, but it is better not to control visitors by restricting them to certain points; instead, visitors should be able to choose their experience and stories.

"…when they might say well actually yeah that's interesting [part of Maiden Castle] I wouldn't have thought of that but I'll go that way so it seems to me there's going to be a

balance between focusing too much and not focusing enough because if you don't focus enough people will just I can't be bothered with this I'm just going to walk over there and I'm going but equally if you go too narrow they're going to miss that opportunity to see something interesting that they would have really appreciated." PC7

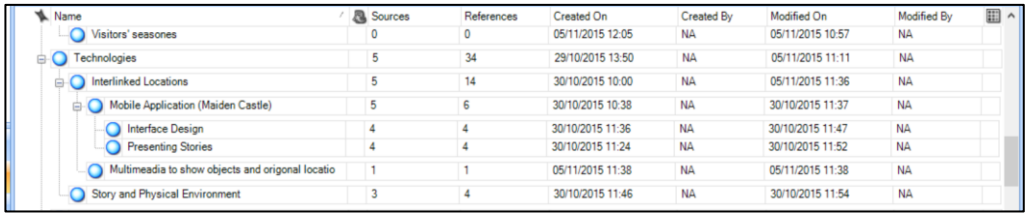
"I suppose there are many parts and different people go to the museum for different things in terms of the archaeology works differently works differently to the Hardy Country and the… and everything. I think different people go there for different reasons." PC1

4.3.2.3 System Control

Participants indicated that there are some challenges to understanding how, what and why people use service technologies. However, opportunities exist to use smartphones but depend on the design experience, the technology available, and the format of the multimedia (Figure 4.10).

"..you already know what the app [iSEE application] does, that's right, I mean there are obviously ways you can get people to find the app, come across the app and once they've got the app enhance their experience with competitions, I don't see why it can't be, again… group of people return to the same mobile app and then… yeah, again it's a functionality with it, definitely I can see some use for that. The list is endless really as to how far you can develop it but like I said earlier I suppose it's through creating you sort of see how it's working and then get a bit of user feedback and just sort of then redevelop it and so on.." PC2

"That sort of stuff, you know with GPS you can actually point the thing and say there's … barrow, there's all the other barrows around and I think that would be incredibly exciting for people to be able to do that and to actually use their technology because people like gizmos and gadgets and things and to be able to actually do it and say 'that was good'." PC1



Name	Sources	References	Created On	Created By	Modified On	Modified By
Visitors' seasones	0	0	05/11/2015 12:05	NA	05/11/2015 10:57	NA
Technologies	5	34	29/10/2015 13:50	NA	05/11/2015 11:11	NA
Interlinked Locations	5	14	30/10/2015 10:00	NA	05/11/2015 11:36	NA
Mobile Application (Maiden Castle)	5	6	30/10/2015 10:38	NA	30/10/2015 11:37	NA
Interface Design	4	4	30/10/2015 11:36	NA	30/10/2015 11:47	NA
Presenting Stories	4	4	30/10/2015 11:24	NA	30/10/2015 11:52	NA
Multimeadia to show objects and origonal locatio	1	1	05/11/2015 11:38	NA	05/11/2015 11:38	NA
Story and Physical Environment	3	4	30/10/2015 11:46	NA	30/10/2015 11:54	NA

Figure 4.10: Nodes showing the significance of using technology in interlinked locations

They also mentioned that; designers should consider what digital services and technologies offer to what type of visitors. Older people typically use mobile phones to receive and make calls, while others use them for communication, games, and education.

"Well at a guess that things become obsolete too quickly and that things need to be easily accessible for everybody so that people don't feel put off by complexities that they feel they can't handle. I think it has to be a challenge to create something that, it would be nice to think that you know maybe a 12 year old or a 10 year old could use as well as a 90 year old and that would be the ideal and that has to be a challenge." PC5

There are so many technologies applied in museums and in other sectors, and ideas for the future could include the application of games via a mobile phone app, such that a group of people play together virtually. However, the interviewees mentioned that designers should be careful not to spoil the enjoyment of getting together when using technologies. Thus, there should be a focus on the designing of digital experiences before and after visiting a site:

"I think although it's a very powerful tool you've got to be careful it doesn't get in the way of people's enjoyment of going for a walk and looking around and talking to their friends about it as they go round. So a part of me wants to see that interpretation done before or after the event of going there but then using it to pinpoint where you are in the place, I can see that as a positive benefit." PC1

4.3.2.4 Media and Multimedia

According to the participants, it would be useful to show the historical link between Maiden Castle and Dorset County Museum. Dorset County Council is trying to provide basic links between locations via the distribution of leaflets to visitors. The participants were excited about the idea of providing links through technology; however, they also emphasised media and multimedia. They assumed it would be fascinating to bring the historical experience to Maiden Castle and to display stories in video or sound through investing in visual branding and by showing artefacts from Maiden Castle, while allowing the visitor to choose from different stories and multimedia.

"…history is a bit like picking up a book that you really enjoy, you've really, really got into, you know history is about telling stories but because they're factual it's real, history is real. I think if you engage people in the right way, like I say people will be hooked, so

history's got a lot to say I think in terms of saying it via sort of modern day social media and multimedia". PC2

"I think people actually look for that sort of thing [videos explain historical stories], it's expected and it definitely enhances the experience for the visitor." PC5

"I think certainly I do a certain amount of work on the web myself and I think the web is obviously where people are getting their information from these days and so I think if you can have something based on the web or as we were talking about with the GPS of modern mobile phones, being able to use that I think as an interpretive tool can be incredibly powerful if it's done sensitively and cleverly I think you can tap into so much information that would help that." PC1

Possible features in a smartphone application would include video enriched with sound and colour, while other features could include a map of Maiden Castle whereby the visitor could tap a corner for more information.

"… that's a really good way of giving a huge amount of depth to the information that's available as well as giving people a sign posted tour around the place. I think the idea that a walk around the ramparts or whatever and being told as you go around, well this is where the archaeological dig was done in the 1980s and this is the sort of stuff they found and some pictures would actually come up and then you can go home and look at that on the internet and do a bit more research about something like that." PC1

"… there are many websites dedicated to history and so to move the technology on as more and more things are developed I don't see why cultural history shouldn't be embracing these things as much as any other." PC2

4.4 Taxonomy of Heritage Experience

This section discusses and explains the components to which the heritage experience taxonomy can be typically applied to design high-quality experiences from the perspective of stakeholders and based on the QoE model presented in Chapter 2 (Floris et al., 2014). It is important to change from the traditional quality model, which specifies a fixed context and has simple interactivity via one or two media, to a new model which takes into account multi-parameter contexts, complex interactions and real multimedia (Floris et al., 2014). To facilitate a high-quality heritage experience designers should choose components depending on both the objectives and the visitors.

Table 4.5 presents the taxonomy resulting from the literature and GT analysis of the interviews (using the coding approaches described earlier). The results show some overlap. For example, there is overlap between two elements (context) in QoE model literature and (Main journey experience) resulted from the interviews.

Table 4.5: Elements from QoE and elements from GT technique on interviews

QoE Model (Literature)	**GT on Interviews**	**Element Integration**
Context	Main journey experience	Journey experience
---	Goal	Goal/ Purpose of journey
Control	System control	Journey control
Combination	multimedia	Multimedia
Components: Video, Audio, Speech, Text, etc.	Media	Media

The following diagram shows the integrated elements taken from the two sources: 1) Elements from QoE model, 2) Elements generated from GT analysis, and finally builds the concluding heritage taxonomy elements (Figure 4.11).

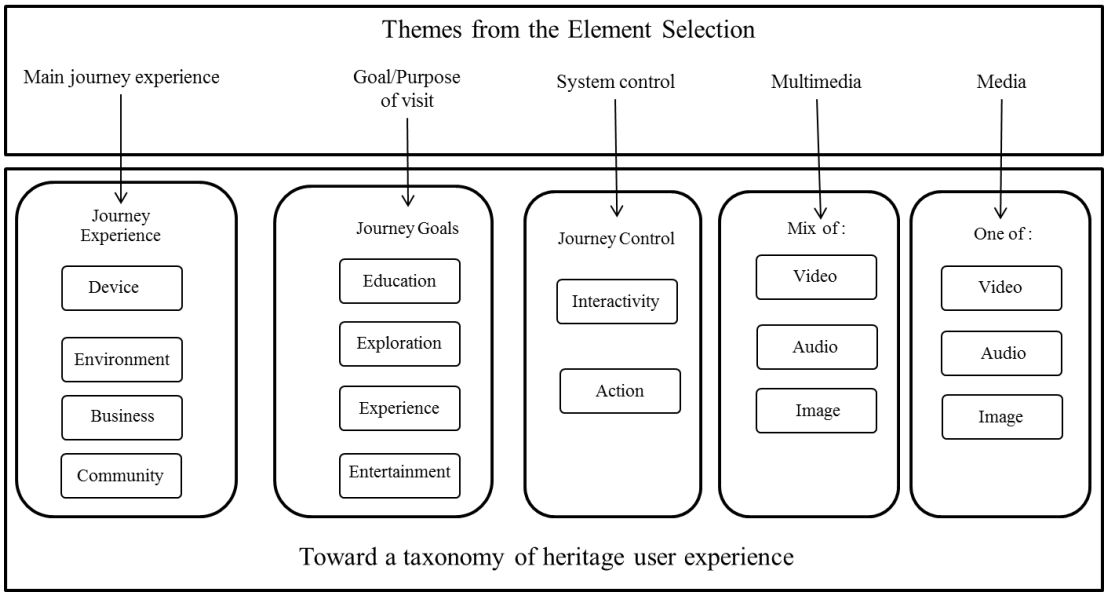


Figure 4.11: Elements of heritage taxonomy

Five main components of the taxonomy are as follows : (1) Journey experience, which presents guidelines for the design process; (2) Journey goal, which shows possible means of interactions between visitors and an experience; (3) Journey control, which deals with

the interactivity component and system actions; (4) Multimedia of a journey; and (5) Media of a journey. All five components represent the building blocks for designing and implementing an experience, the taxonomy is shown in Figure 4.12.

Journey experience accounts for the context of the experience which the designer should reflect. For example, in order to design a journey the designer should consider which device (e.g. smartphones, tablets) to use, along with a study of the environment, business, and community. Secondly, it is important to consider the different goals of a visit, as well as considering personalising the journey. The third component is also imperative as it contains the significant elements of interactivity and action. These last two components account for media, as the experience designer should focus on the media qualities and the multimedia integration functions As discussed earlier (see Chapter 2, Section 2.3.1) , human elements are not included in this taxonomy since they influence, and are influenced by, all the other components.

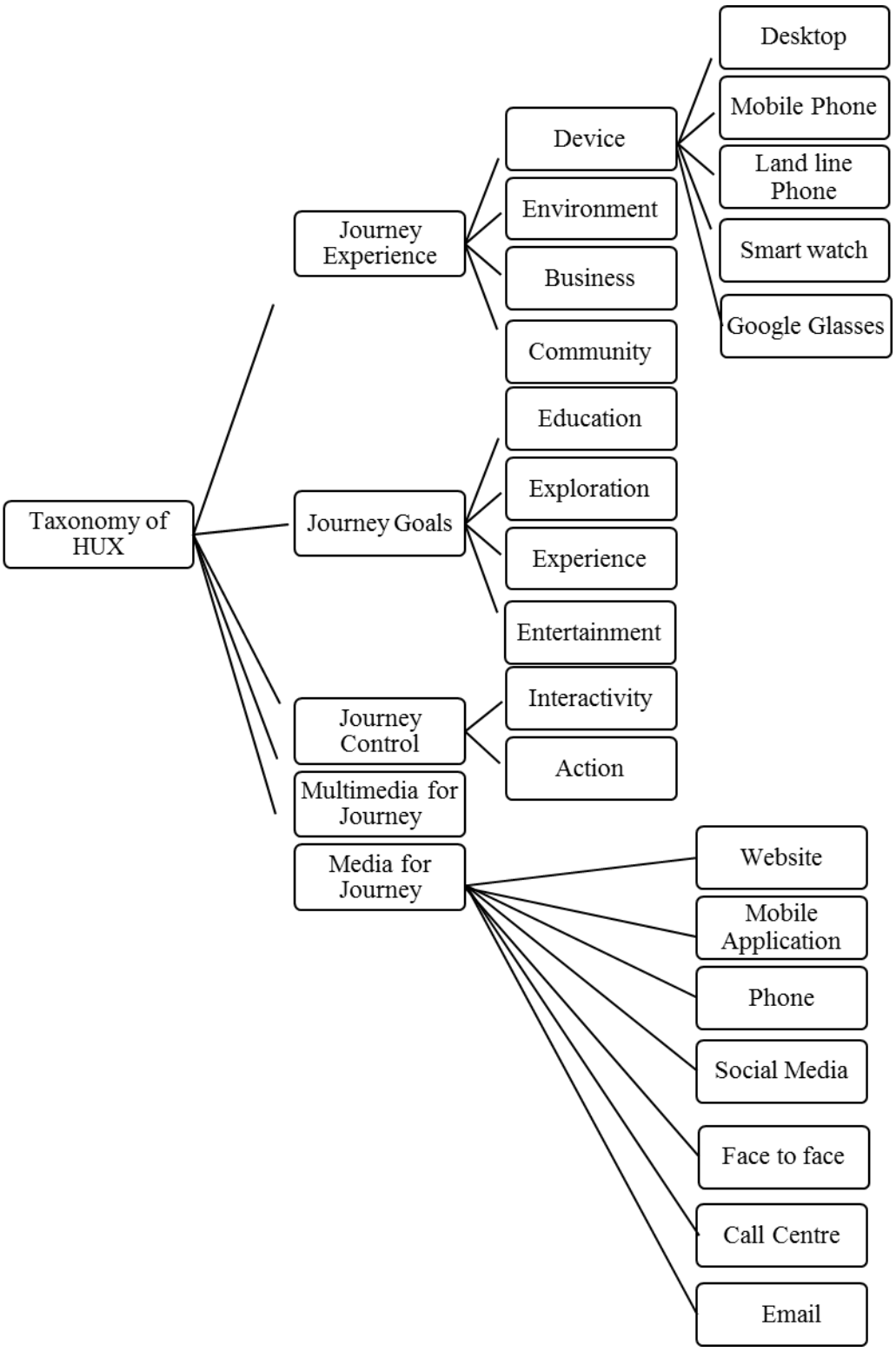


Figure 4.12: Taxonomy of the heritage experience

The main outcomes from this study are: (1) In order to enhance the visitor experience it is important to assess services from the visitors' point of view (see Section 4.2); and (2) Service development should be prioritised at times of financial constraint by collecting appropriate information from museums and their existing collections and archives, in order to sustain a high-quality design (see Section 4.3).

The taxonomy created can be used as part of an investigation to assess the overall quality of a heritage design. For example, elements such as interactivity under journey control (Figure 4.12) can be assessed using a video that pops up in a map and how a visitor interacts with it according to their location, which can be assessed with and without the interactive features of a smartphone app. Similarly, the same can be applied to the other elements independently, such as entertainment, educational, and action. However, this iteration is focusing on building the taxonomy, while further development and iterations will be presented in subsequent chapters.

4.5 Evaluation

It was clear that a more rigorous and robust approach to experience design was needed. Thus, the implication of this iteration is the importance of designing journeys to suit each visitor's requirements. The problem definition for next iteration is how to design the visitor journey (making use of the constructs)? Therefore, the importance of carrying out a further iteration of research is clear. This will be reflected using UCD utilising design thinking methods to represent visitor journey models.

4.5.1 Threats to Validity and Reliability

There are criteria for demonstrating rigour within qualitative data - truth value, consistency, neutrality and applicability. These terminologies associated with the credibility of qualitative research (Noble and Smith, 2015) are explained in Table 4.6

Table 4.6: Terminologies/criteria associated with the credibility of qualitative research

Threats to validity	Description (Possible biases)	How it was dealt with in this research
Truth value	One or multiple realities: Representativeness of the findings in relation to the phenomena. For example there is no audio recording and the interviewer's notes were not complete. -Only one coder was used in the coding process. -Details relating to recruitment and thoroughness of each participant are not available.	-Semi-structured audio recorded interviews allow for repeated revisiting of the data to check emerging themes and remain true to participants' accounts of heritage domain. -All the interviews were used in the coding process. -Use of rich and thick verbatim extracts from workers and volunteers working in heritage assists the reader to make judgements about whether the final themes are true to participants' accounts. -Most of the details of the research design are included in this thesis (guide development and the analytical process).
Consistency/ Dependability	-Consistency of the findings in replicated inquiries. An audit trail is a key strategy to enhance consistency and is a collection of materials and notes used in the research process that documents a researcher's decisions and assumptions (interview transcripts, data analysis and process notes). -Appreciating and understanding how the themes were developed is an essential part of demonstrating the robustness of the findings.	-Transcriptions were created by qualified transcriptionists who were familiar with the language/terminology used by the participants. -All the interview transcripts, data analysis and process notes of this research enhance the credibility of the data. -Transparent and clear description of the research process from initial outline, through the development of the methods and themes and reporting of findings.

Threats to validity	Description (Possible biases)	How it was dealt with in this research
Applicability/ Transferability	Findings can be applied in other contexts, settings or groups.	-The rich detail of context and the heritage taxonomy setting enables transferability to other user experience settings. -The findings have meaning to the individuals not involved in the study. The researcher provided sufficient information on the informants and the research context; trying to enable the reader to assess the findings' capability of being transferable.
Neutrality/ conformability	This is achieved when truth value, consistency and applicability have been addressed. Freedom from bias by prolonged contact with the informants and acknowledgement of the biases.	-This was achieved by allowing adequate time for collecting data and obtaining an understanding of the information through rigorous analysis. -The researcher's was able to demonstrate that the data represents the participants' responses and not the researcher's biases or viewpoints. That is by describing how conclusions and interpretations were established and exemplifying that the findings were derived directly from the data. this exhibited by providing rich quotes from the participants that depict each emerging theme.

The aim of the taxonomy developed is to help designers to create a heritage experience by following some structured basics. As explained in Table 4.1, there are some requirements when designing experiences, and in this section, these requirements are compared with the outcomes in order to validate the taxonomy developed. Table 4.7 shows the required elements and examines whether these appear in the taxonomy created, and it is clear that all the requirements are present, although with the taxonomy they are sometimes represented by a different name (Table 4.8).

Table 4.7: Validation of the derived taxonomy with the requirements

Experience design requirements/ Elements	Description	Validate with taxonomy
Goal	During the design of an experience it is important to indicate the aim of an experience and why a visitor is visiting this location or using a specific tool.	This is included under journey goals.
Human	This includes the requirements of feelings and emotions when designing an experience. Study the user deeply.	As discussed earlier, human elements are not included in the taxonomy as a separate element, however, they influence and are influenced by all the components.
System	This includes software and hardware to accomplish a design experience, as well as a digital experience, and the simplicity of the system.	This is included under journey control.
Context	The whole environment in the experience, including devices used, business, community.	This is included under journey experience.
Interaction	The experience should include interactions between users and the application/system.	This is included under journey control.
Business	The design should consider the needs of an organisation or company.	This is included under journey experience.
Multimedia	This includes video, audio, speech, text, etc.	This is included under multimedia for journey.
Action	This includes movement, work effort and all the activities a user does in order to achieve the goal.	This is included under journey control.

The following table justify and validate the heritage taxonomy elements. This is by comparing and confirming the elements with participants' statements. The justified elements are also presented along with authors and scholars who identify them in their work and article (Table 4.8).

Table 4.8:Justification of the heritage taxonomy

Heritage Taxonomy Elements		Interview statement related to elements	Authors
Journey Experience	Device	*"…there's so many modern things, exciting things, very quick, dynamic things happening outside that we need to try and keep up otherwise people will not be coming in so we certainly have to and I think we need…"* PC6	Stokes, 2015; Floris et al., 2014; Kuniavsky, 2010; Garrett 2010; Schmidt and Etches, 2012; Hassenzahl, 2008.
	Environment	*"…as well as giving people a sign posted tour around the place. I think the idea that a walk around the ramparts or whatever and being told as you go around, well this is where the archaeological dig was done in the 1980s…"* PC1	Stokes, 2015; Floris et al., 2014; Kuniavsky, 2010; Garrett 2010; Schmidt and Etches, 2012.
	Business	*"The other thing is keeping up because technology seems to change so quickly and obviously that gets expensive if every six months you've got to bring in something new".* PC6	Stokes, 2015; Floris et al., 2014; Garrett 2010; Hassenzahl, 2008
	Community	*"…I am very aware that we need to cater for that huge variety so from very young children to highly educated more mature researchers."* PC5	Stokes, 2015; Floris et al., 2014; Schmidt and Etches, 2012; Hassenzahl, 2008
Journey Goals	Education	*"We currently engage a lot with schools, colleges, universities and world event, so basically our age group is from four to old. I can't say a final age because there isn't one because that is like our current…. they all come to the museum."* PC3	Schmidt and Etches, 2012.
	Exploration	*"let's say there are going to be 50 different objects or pieces of information and everybody is not going to want to access all of those so you're going to somehow have to lead them down a route that they want to go and introduce them to the things that they are going to be most receptive to but somehow you want to offer them the possibility you want to attract them into other areas if you can.."* PC7	

Heritage Taxonomy Elements		Interview statement related to elements	Authors
	Experience	*"I would guess so that people can almost select their areas of preferred interest but on top of that you might have some generalities…"* PC7	Stokes, 2015; Kuniavsky, 2010; Garrett 2010; Hassenzahl, 2008
	Entertainment	*"I just want to experience it the way that, you know if my son wanted to run up there and look at that then let's go and do that, you know."* PC6	Hassenzahl, 2008
Journey Control	Interactivity	*"...come across the app and once they [the visitors] have got the app enhance their experience with competitions, I don't see why it can't be, again… group of people return to the same mobile app and then… The list is endless really as to how far you can develop it but like I said earlier I suppose it's through creating you sort of see how it's working and then get a bit of user feedback and just sort of then redevelop it and so on…"* PC2	Stokes, 2015 ; Floris et al., 2014; Garrett 2010; Kuniavsky, 2010; Schmidt and Etches, 2012; Hassenzahl, 2008
	Action	*"That sort of stuff, you know with GPS you can actually point the thing and say there's … barrow, there's all the other barrows around and I think that would be incredibly exciting for people to be able to do that and to actually use their technology because people like gizmos and gadgets and things and to be able to actually do it and say "that was good"."* PC1	Stokes, 2015; Floris et al., 2014; Garrett 2010; Kuniavsky, 2010; Schmidt and Etches, 2012; Hassenzahl, 2008
Multimedia for Journey		*"...so I think if you can have something based on the web or as we were talking about with the GPS of modern mobile phones, being able to use that I think as an interpretive tool can be incredibly powerful if it's done sensitively and cleverly I think you can tap into so much information that would help that."* PC 1	Stokes, 2015; Floris et al., 2014;Kuniavsky, 2010; Garrett 2010; Schmidt and Etches, 2012; Hassenzahl, 2008

Heritage Taxonomy Elements	Interview statement related to elements	Authors
Media for Journey	*"... that's a really good way of giving a huge amount of depth to the information that's available as well as giving people a sign posted tour around the place. I think the idea that a walk around the ramparts or whatever and being told as you go around, well this is where the archaeological dig was done in the 1980s and this is the sort of stuff they found and some pictures would actually come up and then you can go home and look at that on the internet and do a bit more research about something like that."* PC 1	Floris et al., 2014; Garrett 2010; Schmidt and Etches, 2012; Hassenzahl, 2008

The following model (Table 4.9) represents application of the heritage taxonomy to iSEE prototype, whichassessed in evaluating the taxonomy. This outcome will be used for next iteration to identify elements in order to build a HUX framework. These verify the utility of the heritage taxonomy for later iterations. Thus the taxonomy will be used to introduce main elements for designing a visitor journey.

Table 4.9: Application of heritage taxonomy to iSEE prototype design

Maiden Castel Experience Model		
Journey Experience	Device	Mobile
	Environment	Open heritage location
	Business	_
	Community	Family of four visiting the location
Journey Goals	Education	✓
	Exploration	✓
	Experience	
	Entertainment	
Journey Control	tivity	✓
	Action	✓
Multimedia for Journey	✓ (Video, Audio, images)	
Media for Journey		

4.6 Summary

In this chapter, a taxonomy of heritage experience design is presented, providing a basis from which more effective experience can be developed for the UX. This study draws on primary and secondary data to propose a taxonomy of UX for heritage quality. The primary purpose of this framework is to guide designers when making choices in the design of a high-quality UX in a heritage context. Included are journey goals, organisational atmosphere, and technological, behavioural or economic basis. This taxonomy is also valuable for designers when specifying the scope of a quality heritage experience and to researchers when proposing further studies. Interview data were collected from a heritage organisation in the UK using semi-structured interviews, and then analysed using grounded theory techniques. The importance of the UX was highlighted and prioritised with respect to the journey design process.

This early work is important and relevant as it categorises experience elements. In this study a complementary view of the heritage domain was taken by focusing more on the design of heritage experiences, specifically, the how, when, what and where, of the design process. This focus led to the proposed taxonomy of elements within heritage experience design and the characteristics that influence these experience designs. This taxonomy can

be used as a system for naming and organising experience design into groups which share similar journeys. Experience design refers to the techniques and tools used to achieve a high-quality experience. The proposed taxonomy can be used: (1) To identify relevant design tools given a specific experience context; (2) to allow the design of an experience or techniques for a particular experience; and (3) to provide an overview of the heritage domain in terms of experience quality.

It has been shown that journeys are needed to suit each visitor's requirements. Therefore, the importance of subsequent iterations is clear, designing an effective framework for heritage UX. This early work also highlighted the need to further investigate how heritage experiences can be articulated as part of a wider heritage design process.

CHAPTER 5 Model Experience using Visitor Journey Mapping

5.1 Introduction

The aim of this iteration is to develop a design process (called the HUX framework) based on the taxonomy created in Chapter 4 - applying user-centred design (UCD) as a technique to develop the framework. Steps in the design process are identified after comparing the results from two focus group meetings (Dorset County Museum employees and visitors), together with the relevant conclusions drawn in Chapter 2. An preliminary HUX framework is developed and then instantiated via focus groups consisting of visitors and workers at Dorset County Museum. Based on the results of the focus groups and an evaluation, areas for further development of the HUX are proposed for the next iteration.

Section 5.2 describes the output artefacts of this iteration, while section 5.3 presents the UCD technique followed to develop the HUX framework, and illustrates some of rigorous techniques incorporated into design thinking tools. Section 5.4 describes the museum experience instantiations and section 5.5 presents an evaluation of the process and methods, before a summary of the chapter is presented in section 5.6.

5.2 Design Artefacts from Iteration 2

This research applies DSR as aniterative process through which the development of a HUX framework is accomplished. Consequently, in order to design the method based artefact; a set of steps are undertaken (March and Smith, 1995). In this iteration, a method is conducted to construct the HUX process design. In doing so, a process method for designing a heritage user experience is proposed; an instantiation of the framework was then implemented in Dorset County Museum. The implementation resulted in different journey map models. The customer journey mapping technique is commonly used in marketing and falls with the field of design thinking. CJM is a visualisation of customer experiences over time and space required to accomplish a specific goal (Hegeman, 2012; Alves and Nunes, 2013). In this chapter CJM is representative of the journeys visitors take at a heritage experience and is therefore referred to as Visitor Journey Mapping (VJM). Then an evaluation of the HUX framework was conducted.

As illustrated in Figure 5.1, an iterative cycle of artefact building and evaluation is employed based on the general methodology of DSR proposed by Vaishnavi and Kuechler (2004).

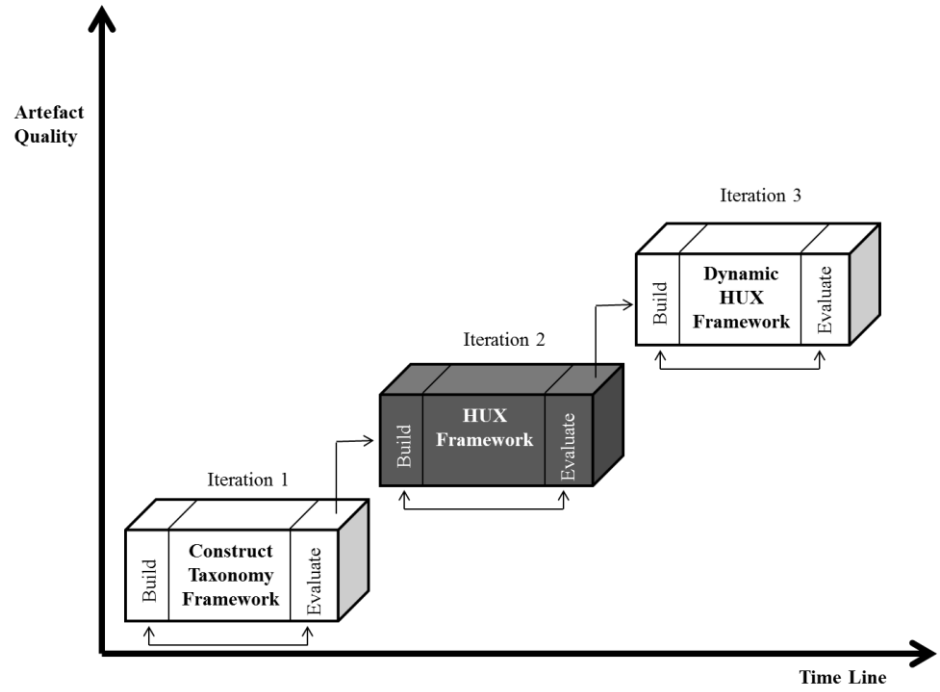


Figure 5.1: Second research iteration

5.2.1 Design Research Artefacts

This iteration applies UCD techniques to design the process steps required to define visitor experience journeys. To achieve the aim of this research, this iteration executes the steps shown in Table 5.1.

Table 5.1: Iteration two steps: input-output model

Steps	Method	Input Artefact	Output Artefact
Build HUX framework.	UCD technique (focus group)	Heritage taxonomy Iteration 1 and literature about CJM (chapter 2).	Visitor Journey Map (Model). HUX framework (Method).

5.3 User-Centred Design Technique

As reported by Rizzo (2011), UCD methodologies have been historically based on two key concepts: (1) Placing the users at the centre of design and evaluation activities; and (2) evaluating intermediate results that arise from the design process. UCD is a broad term to describe design processes in which end-users influence how a design takes shape (Abras, Maloney-Krichmar and Preece, 2004). UCD techniques have been adopted to design and develop a HUX framework, and the reason for choosing this technique is because it focuses on designing and involving users in the design of computerised systems (Preece, Rogers and Sharp, 2002). Consequently, the involvement of users in the design process should result in the development of usable and satisfying designs.

The design stage incorporates techniques to build a whole process which places the users (designers and visitors) at the centre of the design (Table 5.2). A focus group was used to involve users in the design process, and the proposed framework can be efficiently adopted as guidelines for the development of a heritage experience. The main goal of the framework is to enrich the heritage field with a process that enables visitors to enjoy an experience.

Table 5.2: Detailed steps of iteration two taken to develop a HUX framework to design visitor journeys

Steps	Work done
Step 1	Participant identification (Stakeholders)
Step 2	Visit Dorset County Museum to conduct a workshop
Step 3	Presentation about aim and objective of the study, together with an introduction to the heritage taxonomy
Step 4	Introduce CJM and how it is used
Step 5	Conduct focus groups and observe the discussions
Step 6	Take notes and discuss stages of the design
Step 7	Analyse the data and decide on the final stages
Step 8	Present the stages and final framework
Step 9	Museum experience instantiation (another focus group)
Step 10	Evaluate the HUX framework

The process followed to develop the final HUX framework is shown in Figure 5.2. The analysis of Visitor Journey Map (VJM) components, which were identified in Chapter 2, and the outcome of iteration one (heritage taxonomy) are utilised as a scaffold for iteration two. Two focus groups, consisting of three heritage workers aged between 45-55 years

and three visitors aged between (20 and 22 years), were operated to construct the HUX framework. The reason of having only two focus groups is that one group (the workers), are the same people who worked in Dorset County Museum. Those people are considered from the exploratory study done during the prototype test; as the same people were involved in the initial study it would be appropriate to use the same participants to build HUX framework. It was difficult to bring more people to the workshop, as indicated by the collection manager of Dorset County Museum. For the second group and for the purpose of the research, there was a need for teenagers. That is because as mentioned in the exploratory study, there is a lack of visitors from this age group. Thus, the other group (Visitors) are teenagers who visited the museum. As was mentioned earlier, it was difficult to arrange this kind of workshop, however; for the purpose of UCD, there is a need for participants from the same museum or at least who know about the place.

This technique provides a clear understanding about the feelings and opinions of the participants. In addition, data is collected quickly, and the researcher can reintroduce a topic if it is not covered adequately (Zikmund, 1997), and can obtain access to a range of ideas from different respondents (Lankshear, 1993; Fern, 2001). This technique encourages discussions about experiences, feelings and the perceptions of the participants (Porcellato et al., 2002), thus it is suitable for the purpose of this iteration, as developing a process for heritage experience design is a new phenomenon, despite there being many applications of the design itself.

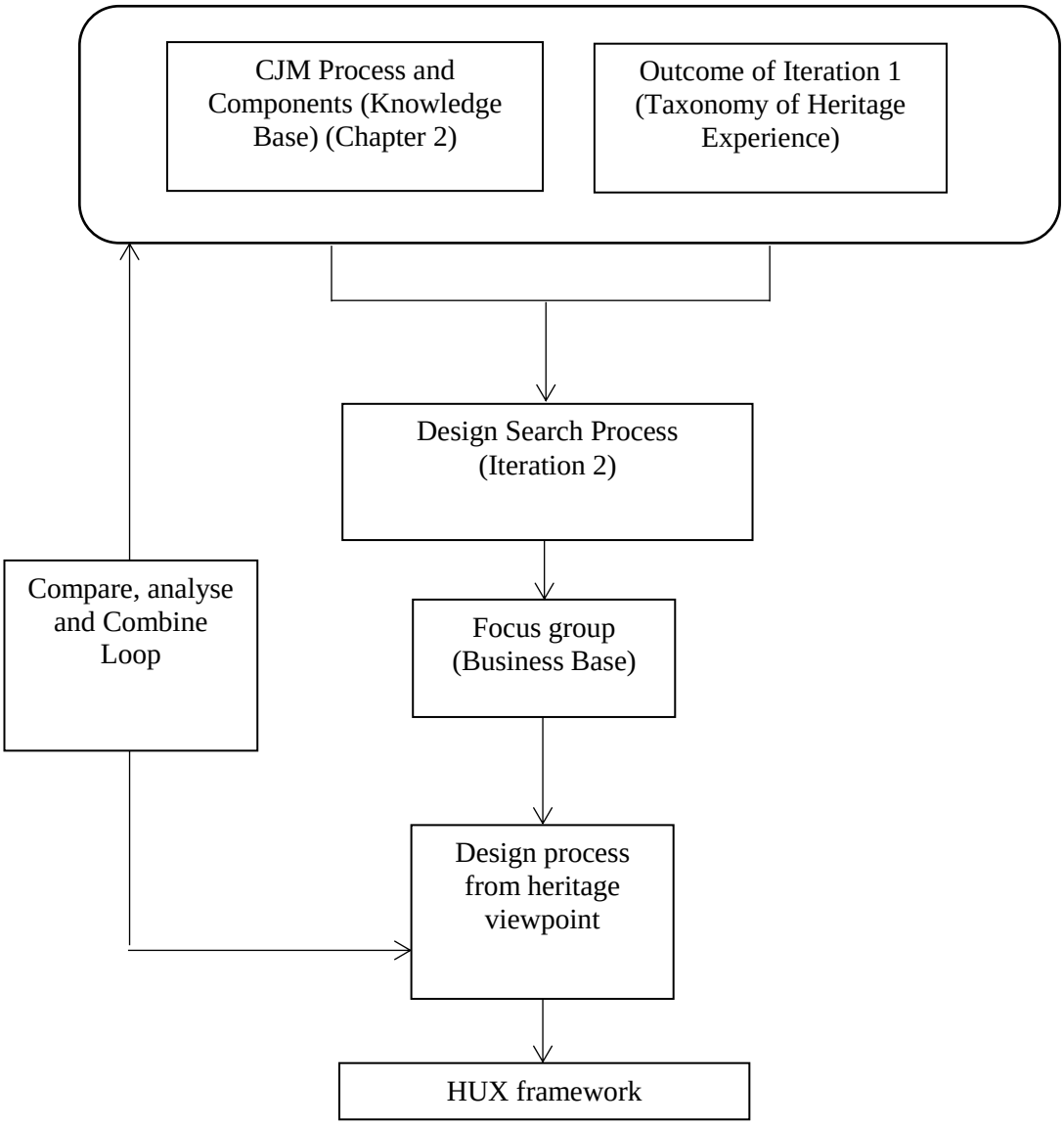


Figure 5.2: Iteration 2 – the design search process

5.3.1 Workshop Plan and Technique

In December 2015 an email was sent to a DCM worker to arrange a date to conduct a workshop (Focus group technique) describing the aim of the study. The researcher also visited Dorset County Museum and Maiden Castle three times as it proved to be a difficult and long process to arrange a convenient time with the participants. The workshop was finally held in April 2016 with a number of participants, and an overview of the research, its aim and objectives were introduced to the participants. The heritage taxonomy and how it is expected to be used was also presented, together with a description of CJM and how it is related to the aim of the focus groups.

Figure 5.3: Maiden Castle images taken during the field study

There were two main questions for the focus groups: (1) What steps does the designer need to follow in order to design a heritage experience? and (2) What are the clear steps to follow when taking into consideration the CJM process and its components? The participants were introduced to other members in the group and were given five minutes to make themselves comfortable. Participants were asked to express their opinions, motivations, concerns, ideas and problems, freely (Asquith, 1997). Examples of different CJMs were introduced and also images of historical locations, together with some pictures from the iSEE project prototype. The group was moderated in order to keep the focus of the discussion on the points concerning the research aim. The participants were asked to brainstorm their thoughts and write key words on sticky notes, which were then gathered and organised on a white board. The sticky notes were the foundation for the conversation and helped participants to keep other opinions in mind. Each group conversation lasted around 45 minutes, and each was observed by the researcher who also took notes.

The analysis method used was based on pattern-matching the findings against the theoretical propositions made earlier. The focus groups were analysed separately and a list of key steps were identified. During this stage discussions with similar patterns were drawn together and compared, and the relationships between them examined. Attention was paid to the minority opinions and examples, and everything was noted. Thus the discussions and post-it notes were analysed by reorganising them into a table according to the components of CJM. In addition, the sessions were analysed by considering the

interactions, and any issues and specific ideas were extracted and categorised. The way the researcher asked the groups to present their outcomes (design process) at the end of the session was significant, as it helped make the analysis more straightforward.

Table 5.3 and Table 5.4 present the syntheses from the two focus groups: Visitor group and Dorset County Museum staff group. Different ideas and opinions were captured and noted from the two focus groups, and the notes were analysed carefully and points extracted relating to the different themes. The themes and syntheses were then combined and summarised in terms of the final design process for each group.

In Table 5.3 the participants inthe visitor focus group arrived at five main steps for designing a heritage experience: (1) visitor types; (2) what visitors like and follow; (3) Feeling notations; (4) important locations during the journey; and (5) delivering an experience via a device or exhibition. This group emphasised the type of visitors and considers this to be significant for the whole journey. Interestingly, they specified a step which was concerned with emotions and feelings; however, they did not place a clear importance on channels.

Table 5.3: Synthesis from visitor focus group

Steps	Ideas from the participants	Final process from participants
1	Check what visitors need (children, older people) Sometimes families, other times school trips	Visitor Types
2	Study different social media sources, e.g. Facebook See what visitor like to use in different sections	What visitors like and follow
3	Check the expected feeling	Feeling notations
4	Where to visit during an experience	What are the important locations in a journey
5	What technology to use in every location	Delivering an experience via a device or exhibition.

In contrast, Dorset County Museum staff focus group (Table 5.4) talked less about types of visitor, and failed to mention say anything about feelings or emotions. Instead, they focused more on stories and how to deliver them, and where. They perceived channels to be significant and gave examples of different types, such as social media and mobile phones. This focus group came up with different steps to design a heritage experience:

(1) Story of experience and visitors; (2) Journey steps; (3) Compare channel and steps; and (4) Analyse locations.

Table 5.4: Synthesis from DCM staff focus group

Steps	Ideas from the participants	Final process from participants
1	Give different story for different people Think about visitors' needs	Story of experience and visitors
2	Specify every step in an experience.	Journey steps
3	Should focus on the different channels available to deliver an experience	Compare channels and steps
4	Provide detailed information about locations and objects	Analyse locations

The findings and analysis from both focus groups were compared and combined with CJM components to create the final HUX design.

5.3.2 Heritage User Experience Framework Design

The outcomes from both of the focus groups were combined and synthesised with the components of CJM to create the final framework, and Table 5.5 outlines the six steps that emerged. By relating back to the outcomes from the focus groups, the notes taken and the participants' final proposed process steps, the names of the steps were refined and identified.

Table 5.5: Combined outcomes from the focus groups and CJM components

Combination	Design Steps (Visitor focus group)	Design Steps (DCM staff focus group)	CJM components
(1) Understanding and characterising visitors.	(1) Visitor types	--	(1a) Represent your customer's perspective (1b) Include customer goals (1c) Represent customer segments
(2) Visitor scenarios	(2) What visitors like and follow	(1) Story of experience and visitors	(2) Use research
(3) Define journey phases	--	(2) Journey steps (3) Compare channels and steps	(3a) Include time (3b) Include stages
(4) Emotional gathering and touchpoints	(3) Feeling notations	--	(4) Focus on emotions (4) Highlight moments of truth
(5) Analysis of heritage journey	(4) What are the important locations in the journey	(4) Analyse locations	(5) Represent touch points
(6) Design final model	(5) Delivering an experience via a device or exhibition.	--	(6) Ditch the PowerPoint

The steps shown in Table 5.6 represent the HUX framework for designing a heritage experience journey. Designing a VJM can be broken down into six steps based on the developed framework (HUX). The first step is understanding and characterising visitors, which means that visitors should be interviewed and data collected via focus groups, and the outcomes of this step are the personas of different types of visitors. The second step is identifying visitor scenarios and stories for the selected personas, and the third step is defining journey phases, what a persona should follow to achieve the aim of their visit. The fourth step is emotional gathering and touchpoints, and is a significant step which represents the feelings of the visitors during each step according to the expected journey. The fifth step is analysing the whole heritage journey using the emotions from each persona and scenario, while the sixth step is representing the phases and journey using software to design the final VJM.

Table 5.6: HUX process design

Step	Description	Resulting Output
(1) Understanding and characterising visitors	Interview visitors using workshops/focus groups	Personas for different visitor groupings
(2) Visitor scenario	Design a story for each persona presenting a realistic and contextualised storyline	Scenarios from museum employee and visitor perspective
(3) Define journey phases	Represent the journey of each persona and their preferred channel	List of phases which represent the whole journey
(4) Emotional gathering and touchpoints	Asking the participants about their emotions during each phase and representative touch points	Emotional representation in each phase and the important phases (touch point)
(5) Analysis of the heritage journey	Transcribe the focus group discussions and extract the word(s) which represent the emotions during each phase.	Documents of different persona, showing phases of journey and emotional expressions.
(6) Design of the final VJM	Contstruct the VJM using earlier taxonomy, scenarios and coded transcripts	VJM representing the visitor experience

5.4 Museum Experience Instantiation

This section presents the instantiation of a HUX framework in Dorset County Museum, and shows the implementation of design thinking tools, personas and scenarios in the museum. The methodological framework emerges after meeting real museum visitors, their personas and scenarios used to ground and contextualise visitors in order to design heritage experience models. The application of personas and scenarios during the focus groups enabled the modelling of a heritage experience and helped in generating and brainstorming ideas.

This research follows qualitative techniques to analyse and illustrate CJM, or rather VJM in this study. Table 5.7 shows the different techniques that are commonly applied to represent conclusive outcomes. Consequently, VJMs illustrated at the end of the next section are demonstrated using qualitative techniques.

Table 5.7: Techniques applied to analyse CJM

Method	Research Object	Research Techniques	Presentation of results
Customer journey	Process	Interviews (qualitative) Focus group (qualitative)	CJM illustrations
		Surveys (quantitative)	Process descriptions Diagrams.

5.4.1 Application of HUX Framework

Designing a VJM can be broken down into six steps using the already designed HUX framework. The first step in the methodological framework is to understand and characterise visitors, and this step is to determine the journey goals, activities and main requirements of the experience. In addition, the appropriate type of device or application needs to be chosen in this step in order to design the heritage experience. Identification of all the requirements and the needed applications/digital services in early stages of the UX design helps later in visualizing the journey phases. This step is based on the heritage taxonomy described in Chapter 4, which was built in part to evaluate heritage experiences. The taxonomy is used as an input for the design thinking tools to produce a VJM for different scenarios. Elements from the taxonomy are fed into understanding and describing visitor characteristics and enabling the first modelling of the heritage experience.

Focus groups are used as a technique to instantiate the framework to design a VJM. The technique used during the focus group followed that of Marquez et al. (2015, p.142):

> "The research team should prompt the user to verbally describe the steps as he or she writes or draws. For example, if a user writes, "look up call number and then go to stacks," researchers may want to dig deeper to get a better understanding of the in-between steps or a fuller description of the steps. Does the user look up the call number on his or her phone? Does he or she use a laptop? Does he or she head to an information desk for assistance? Does he or she consult a map? Does he or she consult a friend, librarian, or staff to find the way? How does he or she capture the call number?"

It was essential to understand the individuals chosen for focus groups, and to identify clear reasons for choosing participants. In this study, the main focus was to have participants from Dorset County Museum. Thus it is significant that they understand the services and the environment of the museum and its available technologies and tools. Those who were involved in improving overall experience in the museum were chosen.

The total sample size was nine, and there were three focus groups (X, Y, Z), with the age of the participants ranging between 15 and 60 years. There were two sessions organised, morning and afternoon, and discussions were videotaped so that they could be reanalysed later if required. An introduction to the aim and objectives of the research were presented to the participants, and examples of personas and CJM images were also introduced in order to clarify their use. The steps of designing a heritage experience were emphasised, highlighting the aim and expectations of the focus groups.

The following scenario models were employed: (1) a museum manager wishing to increase the number of visitors; (2) a collection manager wanting to drive interest in a specific exhibit; and (3) an English Heritage manager of Maiden Castle looking to get people to engage with the site.

i. Museum manager wishing to increase the number of visitors.

A museum manager wishes to increase the number of visitors to the museum and has reduced the cost of tickets. The manager has a plan to rebuild the museum and introduce innovative technologies. Examples of recent technologies are a projector, headset guide and documentary films within different sections. The manager has also opened a section for children in order to attract more visitors and has introduced an e-game to motivate younger visitors.

ii. Collection manager wanting to drive interest in a specific exhibit.

A collection manager would like to advertise a new and exciting exhibit which will be displayed over the summer. This exhibit will open within two months. Thus, the collection manager has begun to print lots of flyers, post cards, and posters for the event, and will also be sending e-mails to people.

iii. English Heritage manager of Maiden Castle looking to get people to engage with the site.

An English Heritage manager of Maiden Castle would like to get people to engage with the site and has sent invitation cards to nearby schools to encourage more informative school trips. Posters about the site have been placed in the museum to motivate tourists and business visitors and let them see what is at the site. The manager has also sent e-mails to experts in the heritage field.

Those scenarios were presented to each of the focus groups. The application of personas and scenarios during the focus groups enabled the modelling of a heritage experience.

Justifications for the selection of the mentioned persona and scenario were generated from interviews (Chapter 4). Therefore, the selection of scenario and persona types was derived directly from the interviewee (the museums experts) answers. During the interview there was a direct question that referred to the type of visitors that commonly visits the museum.

In addition, the use of UCD approach (see Section 3.6.3.2, Chapter 3) in this study, made it more practical and meaningful to use the same type of visitors for the purpose of simulating the visitor experience. In addition, the listed persona by the interviewee experts did cover a solid mix of character and behavioural differences that would result in a more in depth experience analysis. Regarding scenarios, this was built and generated also from the interviewees' answers.

Specific personas were chosen to model and analyse according to the interviewees' recommendations, for example:

> *"…. I mean there are probably specific visitor groups to the museum, very specific groups. I mean if, for example, you were looking at the archaeological galleries, for example school trips, school visits, adults, families, family groups say an adult coming along with a child, small groups of highly knowledgeable adults they all have their own requirements and yes it's really interesting to work out how to personalise things so that there's something there for everybody in the different layers, yeah quite tricky." PC5*

During the focus group the design of VJM models were achieved following the steps 1, 2, 3 and 4 presented in Table 5.6 (HUX framework). The participants were asked to imagine, illustrate and talk about a heritage journey, which represent their experience when preparing to visit Dorset County Museum and Maiden Castle. A variety of media for documenting the steps were provided to participants, including sticky notes, sheets of blank paper, notepads, and a whiteboard. The participants were also asked to verbally explain their journey, and the researcher asked them to sketch their steps. Next, the participants described the method and channel for performing the whole experience through drawings and descriptions, as well as using a sticky note for each phase. Drafting the journey in this step-by-step way allowed the researcher and participants to turn ideas into drawings and actual steps (Marquez et al., 2015). Occasionally, the participants generalised the steps, and when this occurred the researcher drew out the in-between steps, so that each step was fully comprehended.

Figure 5.4: Example of the focus groups in DCM

Figure 5.5, Figure 5.6 and Figure 5.7 represent the outcomes from the three focus groups (VJMs) and illustrate the different experiences of different types of visitors. The focus groups also applied and identified journey phases according to the HUX framework, and specified different channels/digital services according to the different scenarios. Figure 5.5 shows the experience journey (X) for visiting DCM for three different visitors, a schoolteacher (aged 50), a business person (aged 40) and an archaeology expert (aged 30), while Figure 5.6 shows the experience journey (Y) of visiting Dorset County Museum and Maiden Castle for a college student (aged 21), high school student (aged 16) and a mother (aged 46). Finally, Figure 5.7 shows the experience journey (Z) for the Roman Times display in the Dorset County Museum for a mother (aged 30), an international tourist (aged 60) and a high school student (aged 15). These outputs were analysed and are illustrated using Visio 2010 software.

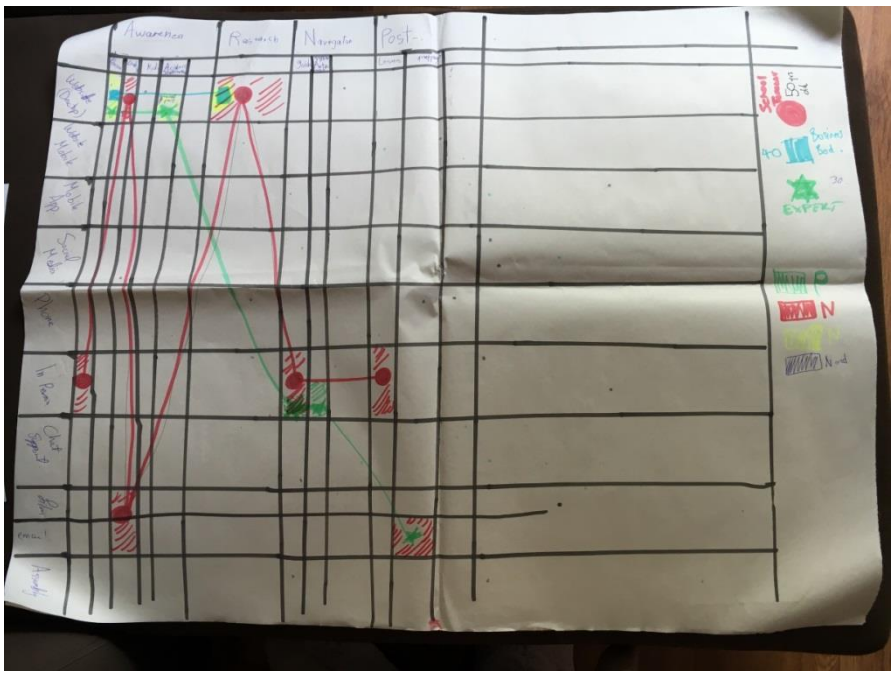


Figure 5.5: VJM model of visiting a Museum (Group X)

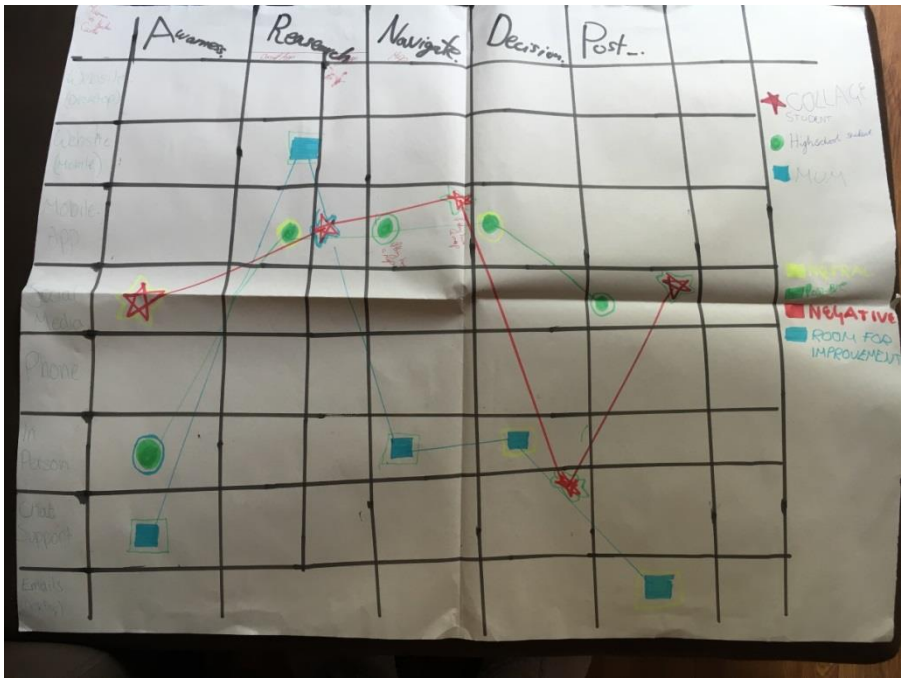


Figure 5.6: VJM model of visiting a Museum and Maiden Castle (Group Y)

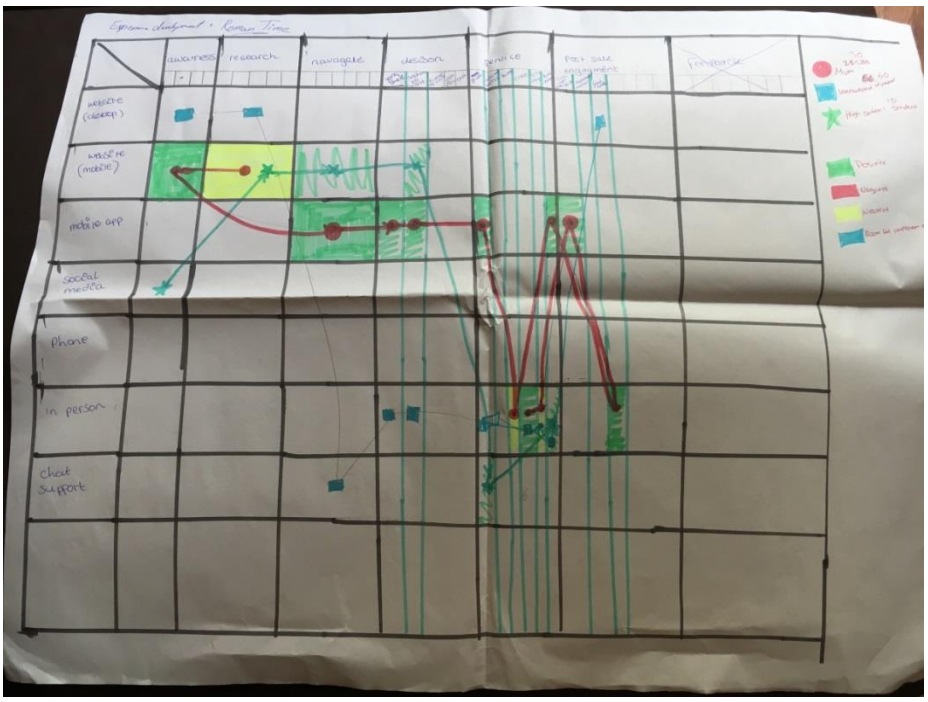


Figure 5.7: VJM model of visiting the Roman Times display in the Museum (Group Z)

5.4.2 Visitor Journey Mapping Models

The participants were asked to explain their experiences for the different scenarios related to Dorset County Museum, and then the taxonomy outcomes from each scenario were used to brainstorm and build the final VJM. The following diagram (Figure 5.8) shows a worked example of the process of information extraction from a VJM to create an instantiation of the HUX taxonomy. Annotation of elements from each category is shown in the taxonomy. Process steps followed to analyse outputs and generate final VJM were: 1) annotate devices, channels and digital services used in the journey experience; 2) specify the environment and context of the journey; 3) identifying the purpose of the visit; 4) categorize and classify the journey phases: Before visit: awareness and research, During visit: navigate, decision and service; and After visit: post-visit and feedback; 5) specify interactivity and actions of the persona in each phase; 6) draw the emotional expressions in each phase of the journey, to represent the UX quality and; 7) introduce the multimedia/media used for each journey phase.

Analysis Process Steps
1) Annotate devices, channels and digital services used in the journey experience. 2) Specify the environment and context of the journey.
3) Identifying the purpose from the visit.
4) Categorize and classify the journey phases. 5) Specify interactivity and actions of the persona in each phase. 6) Draw the emotional expressions in each phase of the journey, to represent the UX quality.
7) Introduce the multimedia/media used for each journey phase.

Museum Experience Model			
Journey Experience		Device	✓ (Desktop, In person and Email)
		Environment	Archelogies expert would like to visit and see an object in the museum
		Business	
		Community	Academies and universities
Journey Goals		Education	✓
		Exploration	✓
		Experience	✓
		Entertainment	
Journey Control		Interactivity	✓
Before visit:	Awareness	Action	✓
	Research		
During visit:	Navigate		
	Decision		
	Service		
After visit:	Post-visit		
	Feedback		
Multimedia for Journey		✓	
Media for Journey		✓	

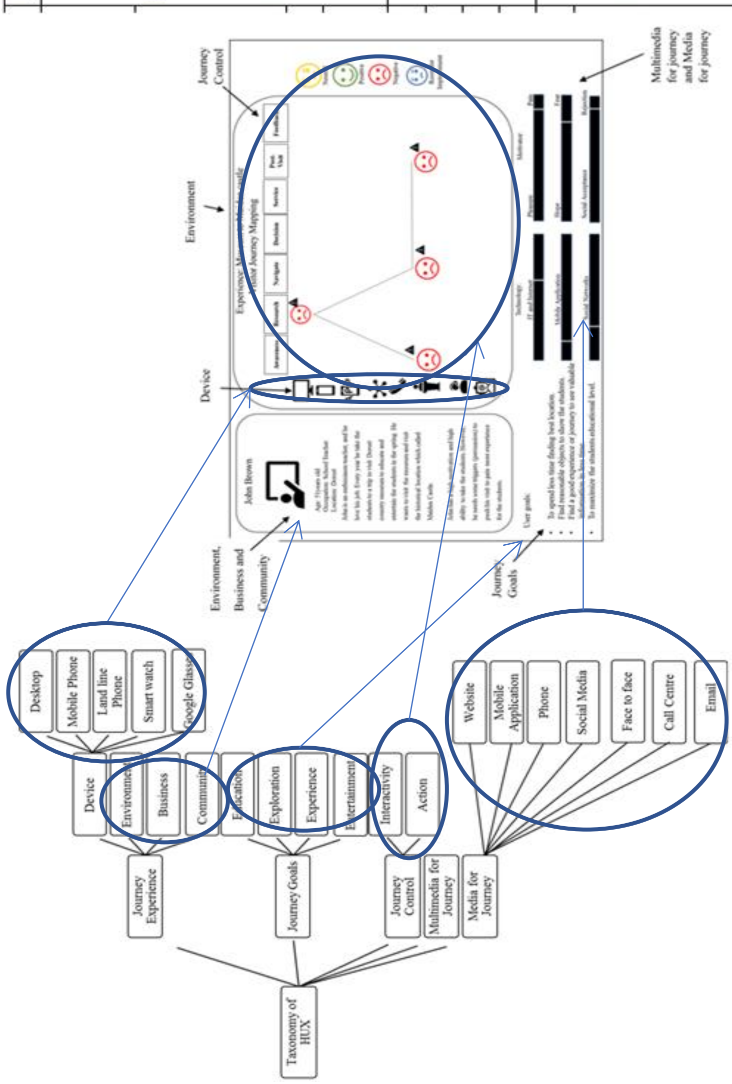


Figure 5.8: Process model of information extraction

The taxonomy, was utilised as a basis to convert focus groups outputs into the final artefact model, VJM.

5.4.2.1 Archaeology Expert Persona

Table 5.8 presents the application of the taxonomy to analyse the focus groups in Dorset County Museum, which represents the fifth step in the HUX framework. The first step was the annotation of the device and channel used. Then the contexts of the journey were identified in the journey experience as the second step. The third step was the purpose of the journey, which was for education, exploration and gain more experience. After that the fourth step; where the main journey phases were presented as before visit: awareness and research, during visit: navigate and after visit: post-visit. The fifth and sixth steps were specifying interactivity and action of persona besides drawing their emotional expressions in each phase. The seventh step was identifying the media and multimedia in each phase.

Table 5.8: Application of the HUX taxonomy (Group X Archaeology expert)

<table>
<tr><th colspan="3">Museum Experience Model</th><th>Analysis Process Steps</th></tr>
<tr><td colspan="2" rowspan="4">Journey Experience</td><td>Device</td><td>✓ (Desktop, In person and Email)</td><td rowspan="4">1) Annotate devices, channels and digital services used in the journey experience.

2) Specify the environment and context of the journey.</td></tr>
<tr><td>Environment</td><td>Archelogies expert would like to visit and see an object in the museum</td></tr>
<tr><td>Business</td><td></td></tr>
<tr><td>Community</td><td>Academies and universities</td></tr>
<tr><td colspan="2" rowspan="4">Journey Goals</td><td>Education</td><td>✓</td><td rowspan="4">3) Identifying the purpose from the visit.</td></tr>
<tr><td>Exploration</td><td>✓</td></tr>
<tr><td>Experience</td><td>✓</td></tr>
<tr><td>Entertainment</td><td></td></tr>
<tr><td colspan="2">Journey Control</td><td>Interactivity</td><td>✓</td><td rowspan="8">4) Categorize and classify the journey phases.
5) Specify interactivity and actions of the persona in each phase.
6) Draw the emotional expressions in each phase of the journey, to represent the UX quality.</td></tr>
<tr><td rowspan="2">Before visit:</td><td>Awareness</td><td rowspan="6">Action</td><td rowspan="6">✓</td></tr>
<tr><td>Research</td></tr>
<tr><td rowspan="3">During visit:</td><td>Navigate</td></tr>
<tr><td>Decision</td></tr>
<tr><td>Service</td></tr>
<tr><td rowspan="2">After visit:</td><td>Post-visit</td></tr>
<tr><td>Feedback</td></tr>
<tr><td colspan="2">Multimedia for Journey</td><td colspan="2">✓</td><td rowspan="2">7) Introduce the multimedia/media used for each journey phase.</td></tr>
<tr><td colspan="2">Media for Journey</td><td colspan="2">✓</td></tr>
</table>

The output from the focus group (Figure 5.5, Figure 5.6 and Figure 5.7) were analysed, re-drawn and illustrated in a meaningful format using Microsoft Visio 2010 (Figure 5.10). The same approach was undertaken to construct the VJM using focus group outputs. It is worth mentioning that there were differences between scenarios/VJM. Actually that is because each persona utilized different digital services in journey phases, which made a different journey experience.

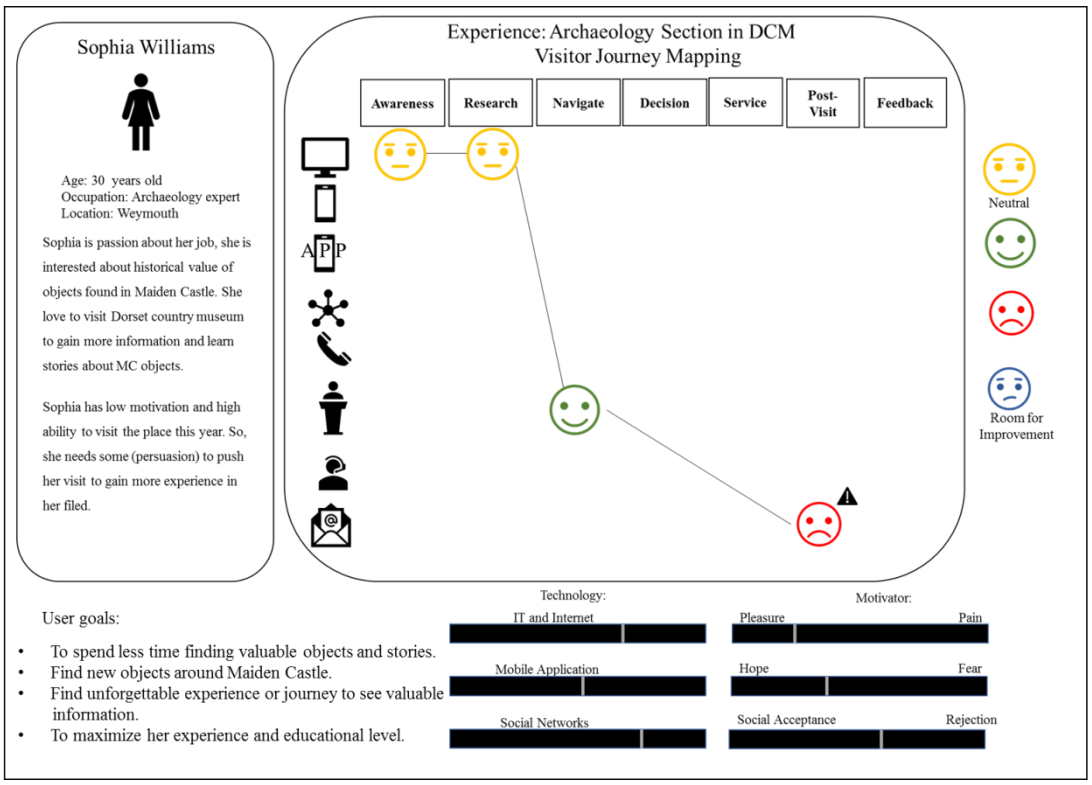


Figure 5.9: VJM experience – archaeology expert (Group X)

5.4.2.2 School Teacher Persona

Group X, School Teacher Persona defines that organizing a trip for a school community needs proper planning. The goals of the journey are educational and exploration. Thus the teacher needs some interactive digital services and lots of communication to organize the trip. Table 5.9 represents the analysed outcome from the VJM and represents the experience of a schoolteacher booking a trip to a museum for their class. The goal of this trip is to find valuable information in a short period of time to maximise the students' educational level. As it can be clearly seen in the journey map (Figure 5.10), the overall emotions clearly reflect that this experience was not satisfactory.

Table 5.9: Application of the HUX taxonomy (Group X School teacher)

Museum Experience Model		
Journey Experience	Device	✓ (Desktop)
	Environment	Teacher organise a trip for school students
	Business	
	Community	School
Journey Goals	Education	✓
	Exploration	✓
	Experience	
	Entertainment	
Journey Control	Interactivity	✓
	Action	✓
Multimedia for Journey	✓	
Media for Journey	✓	

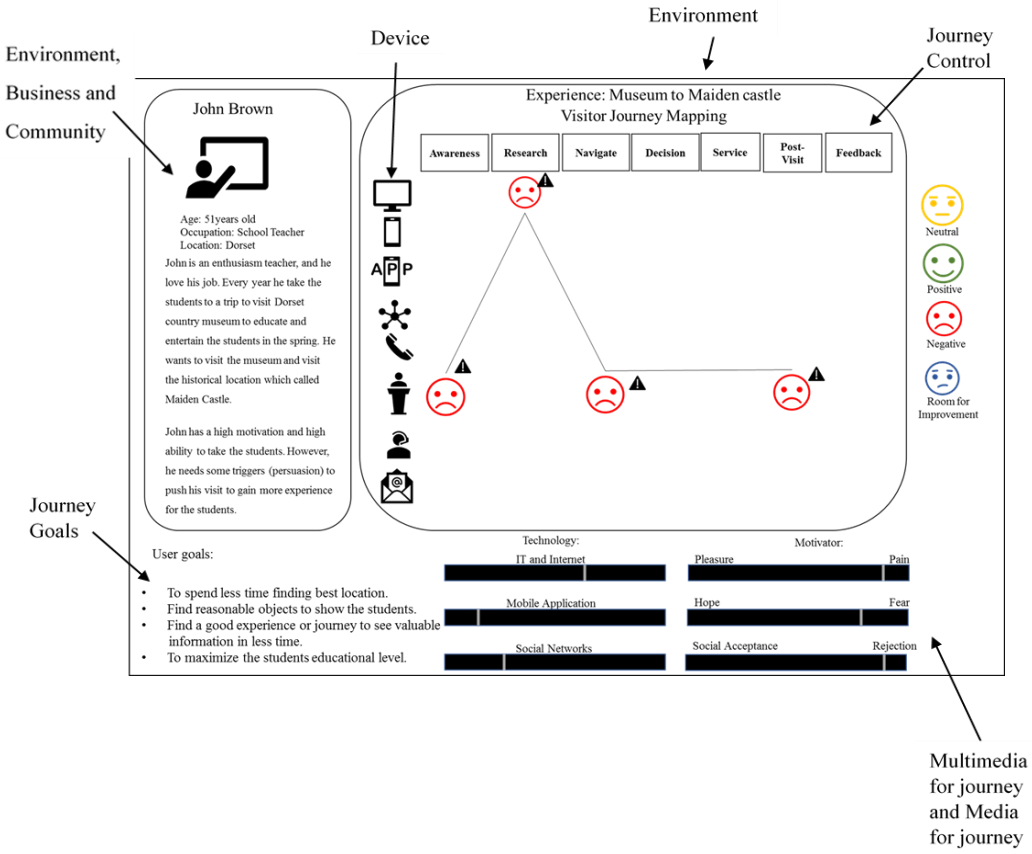


Figure 5.10: VJM experience – schoolteacher (Group X)

5.4.2.3 Mum Persona

Table 5.10 represents a family of four visiting Maiden Castle to explore the location and educate their children about the related heritage and stories associated with Maiden Castle.

Table 5.10: Application of the HUX taxonomy to visiting Maiden Castle (Group Y)

Maiden Castel Experience Model		
Journey Experience	Device	Mobile
	Environment	Open heritage location
	Business	_
	Community	Family of four visiting the location
Journey Goals	Education	✓
	Exploration	✓
	Experience	
	Entertainment	
Journey Control	tivity	✓
	Action	✓
Multimedia for Journey	✓	
Media for Journey		

Figure 5.11 shows the implementation of the scenario experience of a mother visiting the museum, and the map demonstrates the changes in behaviour over the course of the journey. For example, the mother received an invitation advertisement about an activity during the Easter holiday, and then searched for the museum in order to obtain more information using her smartphone from home, and was happy about the experience at this point (Navigation). However, when making the decision regarding which location and department to visit, she used the face-to-face assistants in the museum but she was not satisfied with this experience. As no one was there during that time, which is normal and happens; however there was a need for other sources of information or channels (for example; mobile application). A visitor must be able to understand how to find a specific section within a museum using different channels, and if there are multiple stories in different sections, then visitors must also navigate from one section (e.g., dinosaur section) to another (e.g., Maiden Castle).

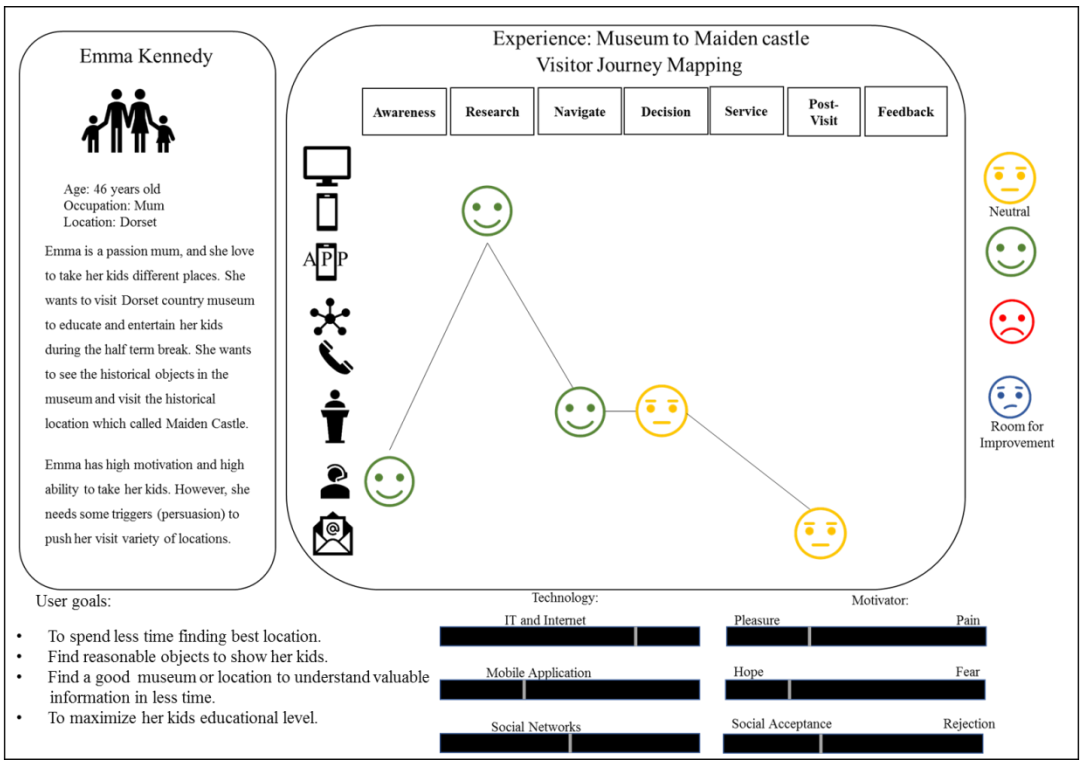


Figure 5.11: VJM experience – mother (Group Y)

Moreover, the participants mentioned that there was a need for different channels and digital services to guide the visitor during the visit. Thus not depending on one source of guide:

Persona 1:

"Again, I would say you haven't got sufficient guides and you have no guides trained up to do this.."

Persona 2:

"Audio guide or …? I know it's not available at the moment …"

Emphasised by another persona 3:

"Which you haven't got one …"

5.4.3 Analysis of VJM Models

A comparison between the different VJMs for the archaeology expert, school teacher, mother, and college student, reveals that there are significant differences in their journey maps and experiences. For example, the college student (Figure 5.12) is not satisfied with the marketing of the museum via social media and reports that the awareness stage is

frustrating for them. Thus, the spread of museum advertisement via social media channels is not being fulfilled. However, the journey of the archaeology expert (Figure 5.9) is different in terms of using the channels and satisfaction, for instance, there is a pain point in the post-visit stage, while the awareness and research stages employ the same channel, a desktop PC.

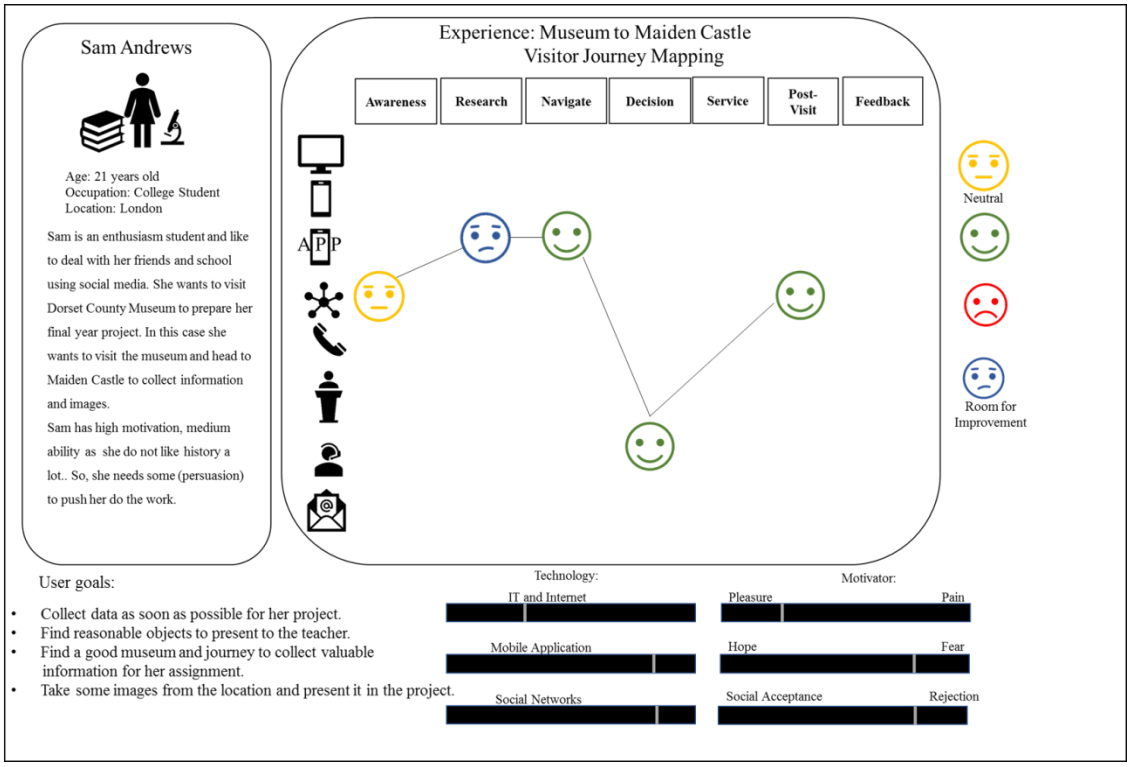


Figure 5.12: VJM experience – college student (Group Y)

By focusing on the actual journey, museum workers can see where the confusion arises leading to the visitor becoming frustrated. In addition, designers can see why visitors give up before completing a journey. In this case the VJM can inform workers and designers on areas where they can make improvements, and it demonstrates the complexity of visiting a heritage location.

While some workers may see the post-visit stage as a separate stage from the journey, to the visitor it is very much an integrated system, complete with elements, interaction, and goal of the journey. It is clear from the journey maps that there are areas of confusion around the experience in some channels, and the ability of the participants to make a decision regarding where to visit and post-visit are an issue. Digging deeper into the map issue facilitated the disclosure of detailed thoughts that could theoretically solve this problem.

To sum up, the instantiation of the HUX framework was implemented and all the steps were followed. Doing so, helped in designing a heritage journey experience; which can be utilized by designers to investigate and explore the significant of digital services preferred for specific journey phase. In addition, all scenarios/VJM were constructed with the same process, presented earlier in section 5.4.2. This contributes to the literature with a taxonomy to analyse journey scenarios. The evaluations of the framework are explained in the next section.

5.5 Evaluation and Effectiveness of HUX

Evaluation is the observation and measurement of how well the artefact supports a solution to a problem (Hevner et al., 2004; March and Smith, 1995). This involves comparing the objectives of a solution to the actual observed results from use of an artefact in the instantiation. This could include items such as a comparison of the artefact's functionality with the solution objectives and the objectives of the artefacts. In addition, instantiations can be viewed as existing implementations, and be used to evaluate constructs, models and methods (March and Smith, 1995). To meet the objectives of this iteration, the HUX framework was instantiated in DCM to test the implementation of the process, and an evaluation of this iteration is accomplished through assessing the completeness and simplicity of the process. The adopted evaluation strategy is aimed at evaluating the competency of the implemented HUX process against similar research efforts (customer journey mapping, Table 5.12). This is considered as a validation of the process.

5.5.1 Threats to Validity

The outcomes are based on traceable data, thus rigorous and objective instrumentation and data analysis methods were used to deal with possible threats to the validity of the outcomes. The threats arising from group dynamics, social acceptability, hidden agendas and limited comprehension are explained in Table 5.11.

Table 5.11: Threats to validity

Focus group threats to validity	Description (Possible biases)	How it was dealt with in this research
Group Dynamics	As a focus group discussion takes place without a predefined format, it is possible that group dynamics or communication styles influence the level of activity.	Semi-structured discussion techniques were used. The researcher moderated the discussions and encouraged less active participants to provide their ideas.
Social acceptability	A focus group can influence points made during a discussion. For instance, participants give incorrect information and disagreement may take place accordingly.	The threat of social acceptability was moderated by the outlining of instructions at the beginning. Thus the researcher took a role in driving the discussion to avoid as much as possible social acceptability issues.
Hidden agendas	Business relationships between participants, motivation to appear in positive way or not because of the result of publication, and internal politics of participants' companies.	In this study it was clearly communicated to the participants that the outcomes would be presented anonymously. It was also highlighted that the outcomes are important for both academics and industry.
Limited comprehension (Knowledge/ Understanding)	These could be complex issues or points which some participants may not understand. Time for discussions can be limited and communication happens most often only orally during the discussions.	The selected participants were of equal knowledge in each focus group. Any point which was not clear during the workshop was clearly explained by the researcher.

Human risk and effectiveness evaluation strategy, emphasising formative evaluations, was followed in this stage as the artefact is user-oriented. That is also because the critical goal of this evaluation is to rigorously establish whether the utility/benefit will continue in real situations and over the long term (Venable et al., 2016). Formative evaluation episodes were conducted by William and Black (1996) and Venable et al., (2016) at this stage to qualify improvement as development progresses. This is in contrast to a summative evaluation which is used to qualify outcomes completed during development or before development begins.

The purpose of this evaluation is to assess the new artefact in comparison to other artefacts found in the literature (Venable, Pries-Heje, and Baskerville, 2012; Venable, 2015), and to define whether the new artefact is an improvement. The quality of the HUX framework was evaluated (Table 5.12), and by observing and analysing articles in the field of journey/experience design, a summary of the components required for every CJM has been established. These components were described in Chapter 2 (Table 2.8); however,

in this section a comparison between the literature and findings is presented. The analysis of CJM articles in Chapter 2 identified the main components of CJM, and in this evaluation the use of these components in this iteration was assessed. This shows that more than 70% of the components have been used in this iteration, thus validating the purpose of this evaluation and the outcome. The HUX framework, which was nearly all based on CJM components derived from the literature review, helped in pattern-matching between the environment and knowledge base outcomes (section 5.3.2).

Table 5.12: Representation of VJM components in this evaluation

Main Components from Table 2.8 presented in the literature review	VJM components in this research
Represent your customer's perspective	✓
Use research	✓
Represent customer segments	✓
Include customer goals	✓
Focus on emotions	✓
Represent touch points	✓
Highlight moments of truth	✓
Measure your brand promise	--
Include time	✓
Ditch the PowerPoint	✓
Channel	✓
Include stages	✓

This table shows it meets current state-of-the-art elements. Moreover the focus groups evidence the effectiveness of the framework in the museum. In addition, the repeatability between scenarios showed robustness of the method and reliability.

When considering validity, during the instantiation of this framework participants in the focus group were happy about the process; it was easy to follow and resulted in lots of discussion between the participants. In addition, the participants generated a productive VJM using the HUX framework, and said they were very excited about the heritage experience process framework. They were also happy to see further development to the framework, and the museum workers were thrilled about the successful outcomes, thus the implementation of the framework in practice enabled a 'proof-of-concept' level of validation of the method (Peffers et al., 2007).

The proposed framework can be efficiently adopted as guidelines for the development of a heritage experience. The main goal of the framework is to enrich the heritage field with a process to make visitors enjoy their experience. Completeness was evaluated by comparing the VJMs for the different scenarios against all of the elements of the heritage taxonomy. Evaluation of the different scenarios was applied to evaluate the completeness of the VJM with the taxonomy. In Table 5.13 and Table 5.14 the heritage taxonomy elements and sub-elements are identified in the first column and then cross checked against the different scenarios implemented in this iteration to ensure most of the elements have been used. This ensures that the researcher has a list of heritage elements that exist in the HUX to validate the framework. It was observed that evaluating the VJM elements in Dorset County Museum scenarios helped to establish which elements were covered in the study, and in fact most of the elements were utilised in the different scenarios.

Table 5.13: Element evaluation in the three museum workers scenarios

Evaluation elements		Scenario 1 (iSEE project)	Scenario 2 (New display event)	Scenario 3 (Museum expansion)
Journey experience	Device	✓	✓	✓
	Environment	✓	✓	✓
	Business	✓	✓	✓
	Community	✓	✓	✓
Journey goals	Education	--	✓	--
	Exploration	✓	✓	--
	Experience	✓	✓	✓
	Entertainment	--	✓	✓
Journey control	tivity	--	--	--
	Action	✓	--	--
Multimedia for journey		✓	✓	✓
Media for journey		✓	✓	✓

Table 5.14: Element evaluation in the four visitors scenarios

Evaluation elements		Scenario 1 (Schoolteacher)	Scenario 2 (Mother)	Scenario 3 (College Student)	Scenario 4 (Archaeology Expert)
Journey experience	Device	✓	✓	✓	✓
	Environment	✓	✓	✓	✓
	Business	--	--	--	--
	Community	✓	--	--	✓
Journey goals	Education	✓	✓	✓	✓
	Exploration	--	✓	--	✓
	Experience	--	--	--	✓
	Entertainment	--	--	--	--
Journey control	tivity	--	✓	✓	✓
	Action	✓	✓	✓	✓
Multimedia for journey		✓	✓	✓	✓
Media for journey		✓	✓	✓	✓

Another purpose of this evaluation is in relation to utility and style, which is considered to be complex as these are composed of a number of different criteria, for example, quality and efficacy of a design artefact. Quality attributes include functionality, completeness, consistency, accuracy, performance, reliability, usability, and fit with an organisation (Hevner et al., 2004). Some of these criteria were achieved during this stage, as shown in Table 5.15.

Table 5.15: Evaluation criteria of the research output

	Research Activities				
Research Outputs		**Build**	**Evaluate**	**Theorise**	**Justify**
	Constructs	Heritage Taxonomy	Completeness Simplicity Ease of use Understand-ability	Explain why and how constructs work by employing them to describe real case scenarios (addressed in Ch.4 and Ch.5)	Prove that constructs work scientifically by applying them in models and methods (Ch.4, 5)
	Model	VJM Taxonomy scenario HUX	Fidelity with real world phenomena Completeness Level of detail Internal consistency	Adapting current CJM theories and hypothesising that those models are true (achieved by theorising VJM in Ch. 5)	Test the models on a real-life example to prove them (addressed in Ch. 5)
	Methods	VJM Process Heritage Taxonomy Development process HUX Framework	Operationally (ability of others to efficiently use the method) Efficiency Generalisability Ease of use	Explain why and how methods are applied (achieved in Ch. 4, 5)	Prove that the methods work formally by instantiating them using real examples (achieved in Ch. 5)
	Instantiation	HUX application	Effectiveness Efficiency Impact on environment and its users	Understanding how and why application works in heritage domain (achieved in Ch. 5)	Prove that HUX works by testing it in the domain (achieved in Ch. 5)

When considering the HUX process it was found that:

- Applying the HUX framework without a dynamic view of the VJM can be difficult.
- There is a need for live feedback to ensure that the HUX framework with dynamic VJM is applied correctly.

Thus these outcomes can provide further research opportunities which will be addressed in a new design cycle (iteration) in the next chapter. In the next iteration, collecting similar experiences and analysing them would be impractical and would never provide a sample of sufficient size. Therefore, the use of simulations is an ideal method to analyse similar experiences and be able to design the appropriate tool to transform an experience into a more enjoyable one. The use of system dynamics will be applied in the next iteration to design a dynamic VJM.

5.6 Summary

This iteration represents the development of a methodological framework to design VJM experiences using UCD techniques. The focus group technique was utilised to instantiate the HUX framework, and different VJMs were developed as model artefacts and utilised to recognise key visitors' journey phases when interacting with heritage locations. The development of a heritage experience design method in this chapter is contribution to the research literature. The method applies design thinking tools and techniques, and builds on the heritage taxonomy developed in iteration 1 (Chapter 4). Elements from the taxonomy were applied to build experience models, and the HUX framework was developed, which contains six steps. The first step is understanding and characterising visitors, and to achieve this, visitors should be interviewed and data collected using focus group; the outcomes from this step are the personas of different types of visitors. The second step is identifying visitor scenarios and stories for a selected persona, while the third step is defining the journey phases that a persona should follow to achieve the aim of their visit. The fourth step is emotional gathering and touchpoints, and is a significant step which represents the feelings of visitors during each step in their expected journey. The fifth step is analysing the whole heritage journey, including emotions, for each persona and scenario. Lastly, the sixth step is to represent the phases and journey using software to design the final VJM.

An instantiation of the framework was applied in Dorset County Museum, together with the implementation of different VJMs for different personas in order to evaluate their experiences. The HUX was instantiated in a focus group which was used to identify touch points from the VJM as a model of experience, and these will be used in the next iteration.

The developed VJMs were evaluated by applying them to the Dorset County Museum scenarios as summarised in Table 5.13 and Table 5.14. In addition, the developed VJM models and techniques were evaluated through comparisons to the main components and requirements of CJMs (Table 5.12). The outcome of this iteration illustrates that it is both efficient and effective to apply design thinking tools and techniques in the design of high-quality heritage experiences. Extracting experience elements and applying design thinking tools can be used as a starting point in the heritage design experience development process, and there is a need to further investigate how effectively this represents a whole journey and to investigate its qualities. Identified elements and techniques for assessing heritage qualities are taken forward into the next DSR iteration.

CHAPTER 6 An Exploration of Visitor Behavioural Dynamics

6.1 Introduction

The previous chapter discussed the development of the HUX framework based in part on UCD techniques, and concluded by instantiating the framework in Dorset County Museum using a range of VJM models. The purpose of this chapter is to extend the HUX framework enabling a more detailed examination of visitor behaviour using system dynamics. The tools being used include causal loop diagrams (CLD) and stock-flow models (SFM). The purpose of using system dynamics (SD) is to simulate different types of visitor behaviour - providing an effective tool for heritage stakeholders. This iteration utilises previously-generated artefacts, namely the heritage taxonomy developed in Chapter 4, and visitor journey map models described in Chapter 5. The outcomes of these chapters are used as inputs into the design process as a basis from which to add dynamic elements. The SFM is created using the software VenSim PLE (Sumari et al., 2013; Juan, Hui, and Pengji, 2018), which can be used to assess the experience design using SD artefacts. At the end of this iteration a methodological framework for experience design at heritage sites is developed.

This chapter is structured as follows: Section 6.2 summarises the generated artefacts from this iteration, while section 6.3 presents the building and development of the HUXSIM framework, which includes the addition of SD models followed by an implementation of the framework. Section 6.4 describes the instantiation of SFMs illustrating the application of the framework steps using a VJM model and scenarios from heritage stockholders, and also shows the CLDs detailing the simulation settings. Section 6.5 evaluates the effectiveness of applying a methodological framework in a heritage environment, and a summary of the chapter is presented in section 6.6.

6.2 Design Artefacts from Iteration 3

Iteration 2 ended with a novel method of modelling heritage experiences using VJM. The resulting framework in Chapter 5 was lacking in its support of dynamic visitor behaviour, representing the dynamic behaviour in a static form. The simulation of user experience allows persona behaviour to be examined when interacting with new digital services. Journey maps are static and lack any ability to explore the dynamics of UX or context.

Although extensive research has been carried out on UX in museums, as seen in the literature in Chapter 2, Table 2.2, no study exists that provides methods for UX design using simulations (Hinrichs et al, 2008; Wang et al., 2009; Varvin et al., 2014; Chan and Cope, 2015; Rubino et al., 2015; Vosinakis and Tsakonas, 2016; Mason, 2016; Hughes and Moscardo, 2017; Smolentsev et al., 2017; Pedersen et al., 2017). Thus, in this iteration SD models are typically designed after data exploration and by experts, with UX not usually included (Tako and Kotiadis, 2015; Vermeeren et al., 2016 and, Kiourt et al., 2017).

Visitor dynamics are included by introducing SD models to the HUX framework. Consequently, the purpose of this DSR iteration is to develop new methods for heritage stakeholders to utilise VJM and SD in order to design new journey experiences. The method can be seen as a set of steps that can be followed in order to accomplish a specific task (March and Smith, 1995). In this iteration, a method for dynamic interaction impact is proposed, as to design a dynamic journey experience it is critical to utilise complex adaptive systems and system thinking. Thus to support realising the impact of dynamic interactions, instantiations are developed, taking into consideration different dynamic aspects, for example types of visitor, time and behaviour. As illustrated in Figure 6.1, an iterative cycle of artefact building, development and evaluation is employed, which is adopted and based on the general methodology of DSR proposed by Vaishnavi and Kuechler (2004).

As noted in Chapter 2, models which help in understanding a phenomenon need to comprehend unintentional consequences of complex adaptive systems. For this iteration the principles of SD modelling are used to develop an understanding of non-linear interactions within defined systems (Forrester, 1961). This chapter extends the HUX framework to include CLD and SFM tools for experience design based on David Bashai's approach: "being able to generate a phenomenon without pre-supposing it is the best way to understand it, and this is best done in a simulation" (Bishai et al., 2014, p.2). CLDs provide: "… a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static snapshots" (Senge, 2006, p.68).

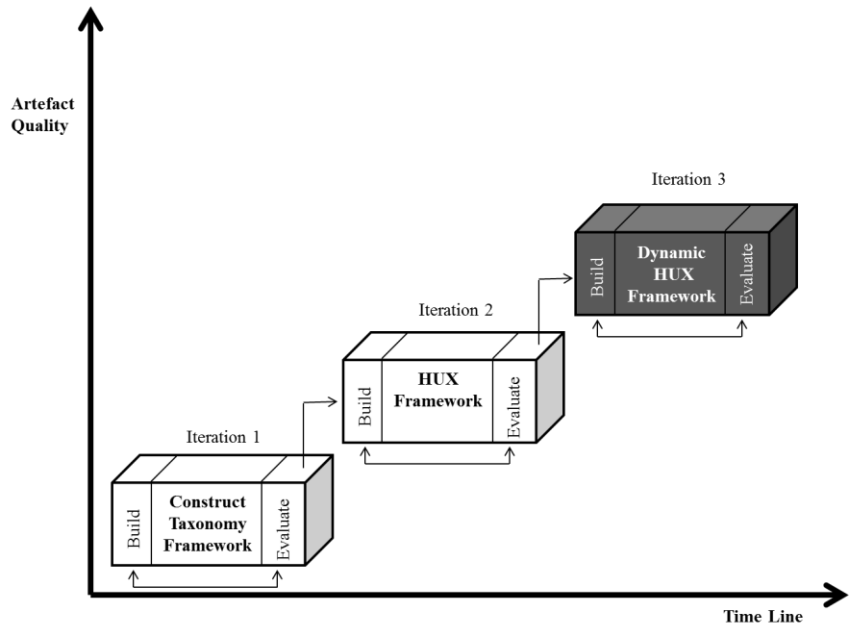


Figure 6.1: Research iteration

6.2.1 Design Research Artefacts

The aim of this iteration is to extend the framework to include SD – in order to explore the dynamics of persona behaviour and validate the effectiveness of the HUXSIM framework. It introduces a novel method for transforming journey experiences articulated in the VJM into more structured CLD and SFM notation. Consequently, the designer is moving from design to more system thinking. CLD are used to build relationships of elements constructed from VJM, and these elements are based on explicit behaviours during the experience journey in a museum context (Figure 6.2). VJM is based on mapping a consecutive series of touchpoints between the visitor and the service where user experience is actively shaped. The visual map incorporates both the physical and emotional journey with the aim of capturing visitor behaviour and feelings of each journey phase. Data transformation from VJM to SD models includes the following steps (Figure 6.2 and Figure 6.4): (1) annotating the digital services used, (2) journey phases extraction, (3) UX quality extraction, (4) touchpoints statements, (5) identify relationship statements.

Annotating and extracting dynamic touchpoints through a journey phase is the basis from which to build the SD models. This approach is unique in its use of jouney mapping as a modelling primative. Pragmatically, it shows how to extract different digital services used in different phases of a visitor journey. The process is operationalised in sections 6.4.1

and 6.4.2 for a school teacher (See appendix G for other scenarios).

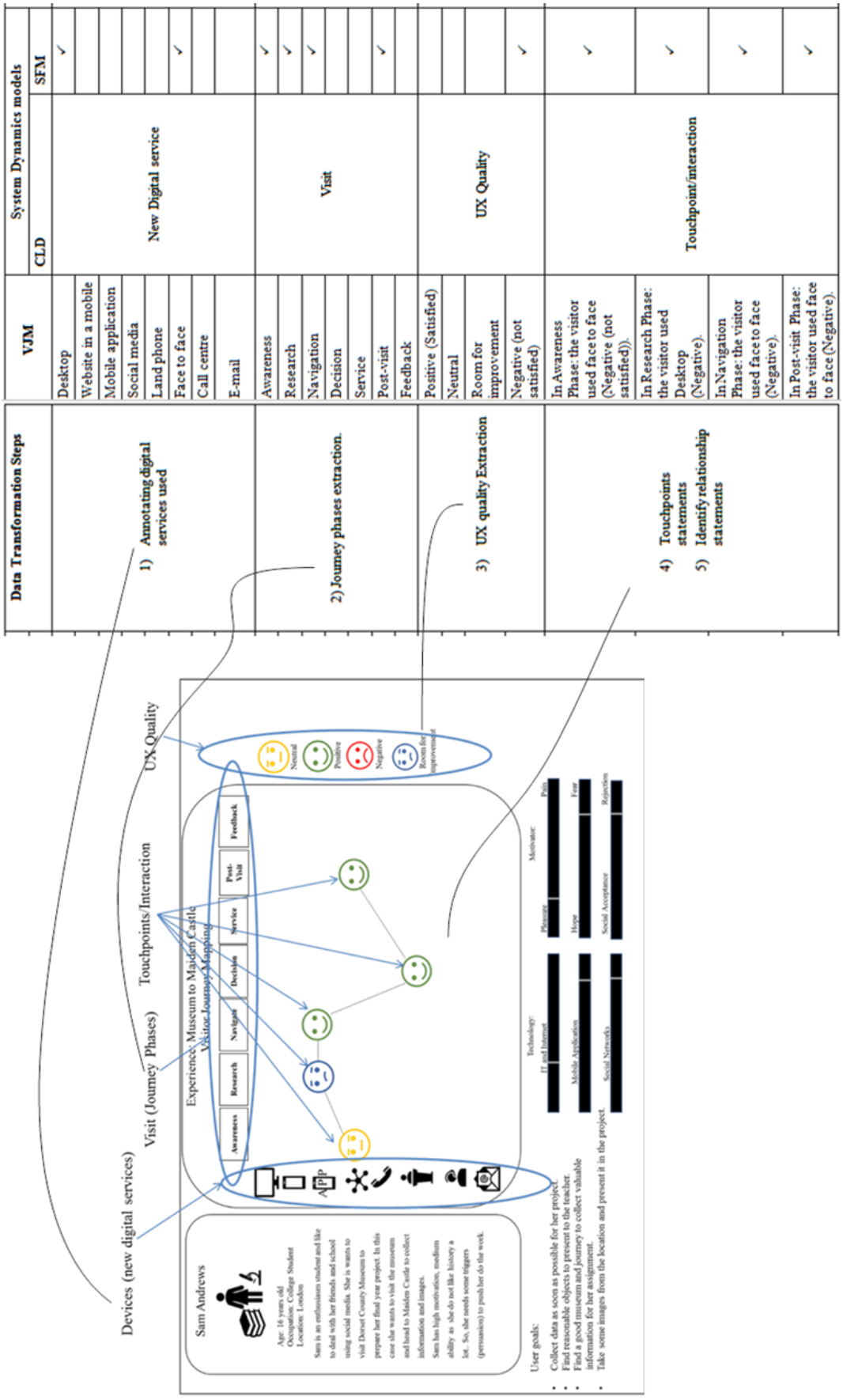


Figure 6.2: Process Model of extracting elements to create CLD and SFM

Behaviour dynamics of an experience journey are then explored, and it is significant to model the elements and convert a CLD into a SFM. The characteristics of SFMs help in presenting the elements based on stock and flow variables. The HUXSIM approach allows designers to further understand dynamic persona behaviour when interacting with new digital services using simulations and presentations.

In order to achieve the aim of the research, this iteration executes the steps shown in **Error! Not a valid bookmark self-reference.**. Each step applies a design language processing method to an input artefact and results in an output that is used as the input for the next step (March and Smith, 1995).

Table 6.1: Steps within iteration three: Input-output model

Steps	Method	Input Artefact	Output Artefact
1. Extracting elements from VJM	Design language process to extract elements	VJM elements	Data Transformation Method and Model
2. Build a causal loop diagram	Design language process to build a CLD	Data Transformation Model	Causal loop diagram model
3. Develop a stock-flow model	Design a language process to develop a stock-flow model	Causal loop diagram model	Stock-flow model
4. Validate the SD models	-Structural validity of the system dynamics model.	CLD and SFM Models	-Visitor dynamics behavior (instantiation) -Model and method validity
5. Evaluate the HUXSIM framework	-Domain Expert Evaluation.	- HUXSIM framework. - Demonstration of SFM instantiation.	-HUXSIM Framework validity -Expert evaluation.

Involvement of stakeholders in the modelling process results in the increased credibility of a model (Kleindorfer et al., 1998); for instance, what to model and what not to model is decided based on a user's needs and a model builder's approach to modelling. Consequently, the conceptual modelling stage allows a realisation of what is relevant to

stakeholders, which then increases the acceptance of the model-based recommendations (Coyle and Exelby, 2000). Although the SD modelling process is typically iterative in nature; the principle of an SD type model lies in how well the problem has been conceptualized. Also how well the causal relationships are identified or the qualitative model is constructed (Qudrat-Ullah, 2010).

Kunc (2016) provides a list of seven characteristic requirements that validate a structural model of SD, while five tests for the structural validity of a SD type simulation model have also been proposed (Senge and Forrester, 1980, Qudrat-Ullah, 2012). These will be used to assess the model produced in the evaluation stage of this iteration (section 6.5.2).

6.3 HUX + Simulation Framework

This section presents the building and development of a refined HUX, HUXSIM methodological framework. The SD elements are derived from the VJM models, and this methodology can be applied to different heritage sites. To further explain the structure of the HUXSIM methodology, a scenario is presented below.

A museum provides a number of objects and digital services with different heritage stories for their visitors. In order to understand visitor behaviours and to generate more visits, a VJM model is designed based on the heritage taxonomy. VJM is effective in understanding touch points and behaviour during different journey phases. In addition, the criteria for selecting VJM lies in their visualisation techniques and capacity to enhance communication inside multidisciplinary teams, together with their straightforwardness which enables their use by non-specialists (Chasanidou, Gasparini and Lee, 2014). The evaluation in Chapter 5 showed that different visitors use different digital services. However, dynamic behaviour cannot be shown in a static VJM, thus the process of adding SD tools to represent VJM is significant in allowing a dynamic VJM to be created. The model for designing a heritage experience starts by defining the issue and the steps required to build an experience journey. The right hand side of this model represents VJM (Chapter 5), while the left side visualises the SD (Figure 6.3).

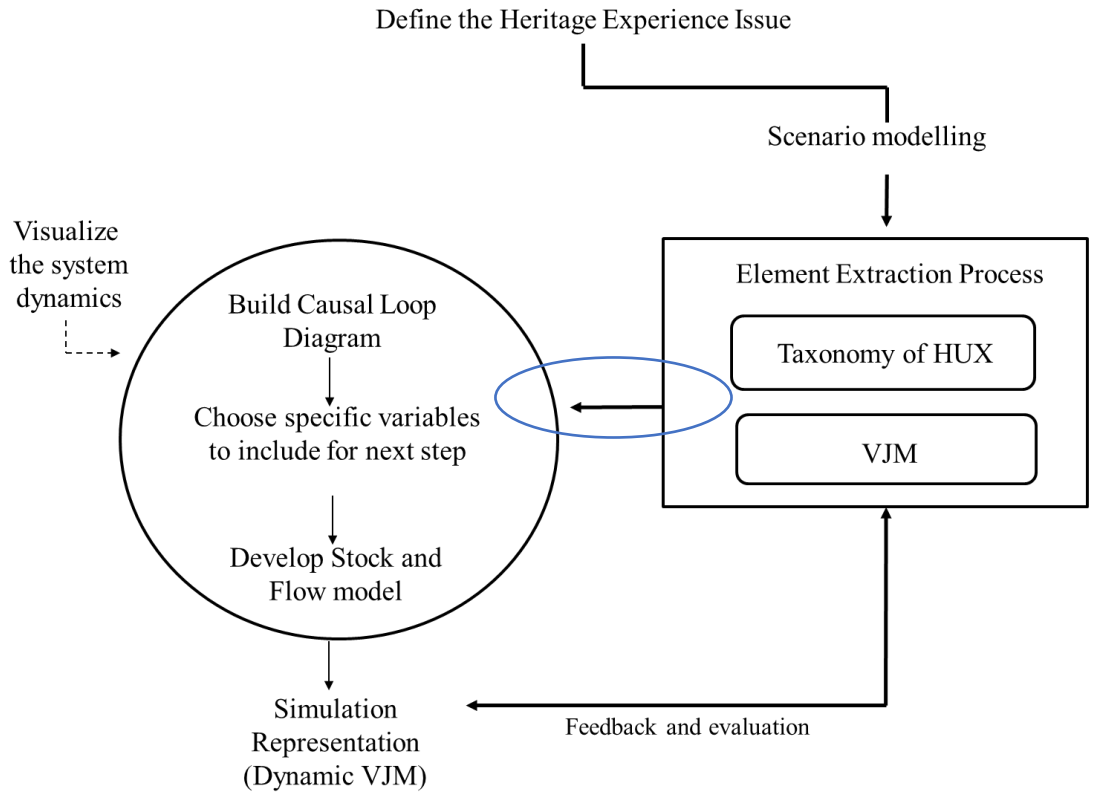


Figure 6.3: Dynamic HUX framework design

The framework is composed of two main phases: (1) Model of experience and heritage journey (right hand side) and (2) Heritage simulation (left hand side). The outcome of the first phase is then fed into the second phase to represent a simulation. Figure 6.3 shows the model experience with a simulation phase to represent a dynamic heritage experience. The design of the heritage journey (Iteration 2) is based on the outcomes from the HUX taxonomy, the focus groups and discussions with the participants based on their experiences.

First, a heritage experience issue is selected, and data are nominated by applying the HUX taxonomy to a specified scenario. Persona are included with their emotional elements. Next, experience elements are selected from the VJM to create a CLD, and specific variables are chosen for inclusion in the SFM. Finally, the model is simulated showing the dynamic VJM. This represents the impact of the dynamic interaction when considering three aspects: types of visitors, time, and behaviour. The steps shown in Table 6.2 are then followed to derive a SFM; the process of VJM was explained in detail in Chapter 5.

Table 6.2: HUXSIM design process

Dynamics Modelling Steps	Definition	Explanation	Resulting Output
(1) Understanding and characterising visitors	Explained in detail in Chapter 5		
(2) Visitor scenario			
(3) Define journey phases			
(4) Emotional gathering and touchpoints			
(5) Analysis of the heritage journey.			
(6) Design of the final VJM	Designing the VJM using visio software	Construct the VJM using earlier taxonomy, scenarios and coded transcripts	VJM representing the visitor experience
(7)VJM transformation into system dynamics tools	**System dynamics tools are used to visualise the simulated elements for example, CLD and SFM.**	**This step is concerned with simulating the VJM to represent the dynamic visitor experience.**	**List of relational elements.**
(8) Build a CLD	CLDs are a system dynamics tool that create a qualitative representation of mental models. These concentrate on the significance of causality and feedback loops. (Williams & Hummelbrunner, 2010)	This step reflects the specific scenario and incorporates all the elements that can be represented into a diagram to illustrate the effects of elements, whether positive or negative.	A causal loop diagram showing the relationships.
(9) Choose specific variables	Variables that represent a scenario and are interesting to the designer to analyse, so that they can be used in the next step.	The main effects from the above step are summarised and then used as an input into the final step.	Table of different variables that represent a solution for one issue.

Dynamics Modelling Steps	Definition	Explanation	Resulting Output
(10) Develop a stock and flow model	Stock and flow diagrams are a quantitative system dynamics tool. They are utilised for showing a system that can be used for model-based policy analysis in a simulated, dynamic environment. They clearly include feedback in order to understand complex system behaviour and capture non-linear dynamics (Sterman, 2000).	This is an important step that illustrates the whole simulation of the design and represents the actual visitor interaction.	Represent the elements as variables in the stock-flow model.

The proposed methodology clearly shows that the approach places great emphasis on how to work closely with stakeholders and identify issues (touch points), and to create solutions and evaluate them. The model ultimately tries to illustrate how to design a dynamic journey experience that can be utilised by heritage designers. SD tools and techniques are sufficient to model a dynamic visitor journey (for details of why, see Chapter 3, section 3.4), and in this research, two dynamic tools are utilised to build a HUXSIM framework: CLD and SFM. The following section explains the data transformation process as a novel approach which contributes to this iteration.

6.3.1 Data Transformation Process

The key process of data transformation is the seventh step in the HUXSIM framework. Taking a scenario modelled as a VJM as an input for the simulation, model elements are selected. By doing so, a determination is made of how different elements affect the cost/expenses of the museum and user's activity. VJM is based on mapping a consecutive series of touchpoints between the visitor and the service where user experience is actively shaped. The visual map incorporates both the physical and emotional journey with the aim of capturing visitor behaviour and feelings of each journey phase.

Data transformation from VJM to SD models includes the following steps (Figure 6.4):

1) Annotating digital services used
2) Journey phases extraction
3) UX quality extraction
4) Touchpoints statements
5) Identify relationship statements

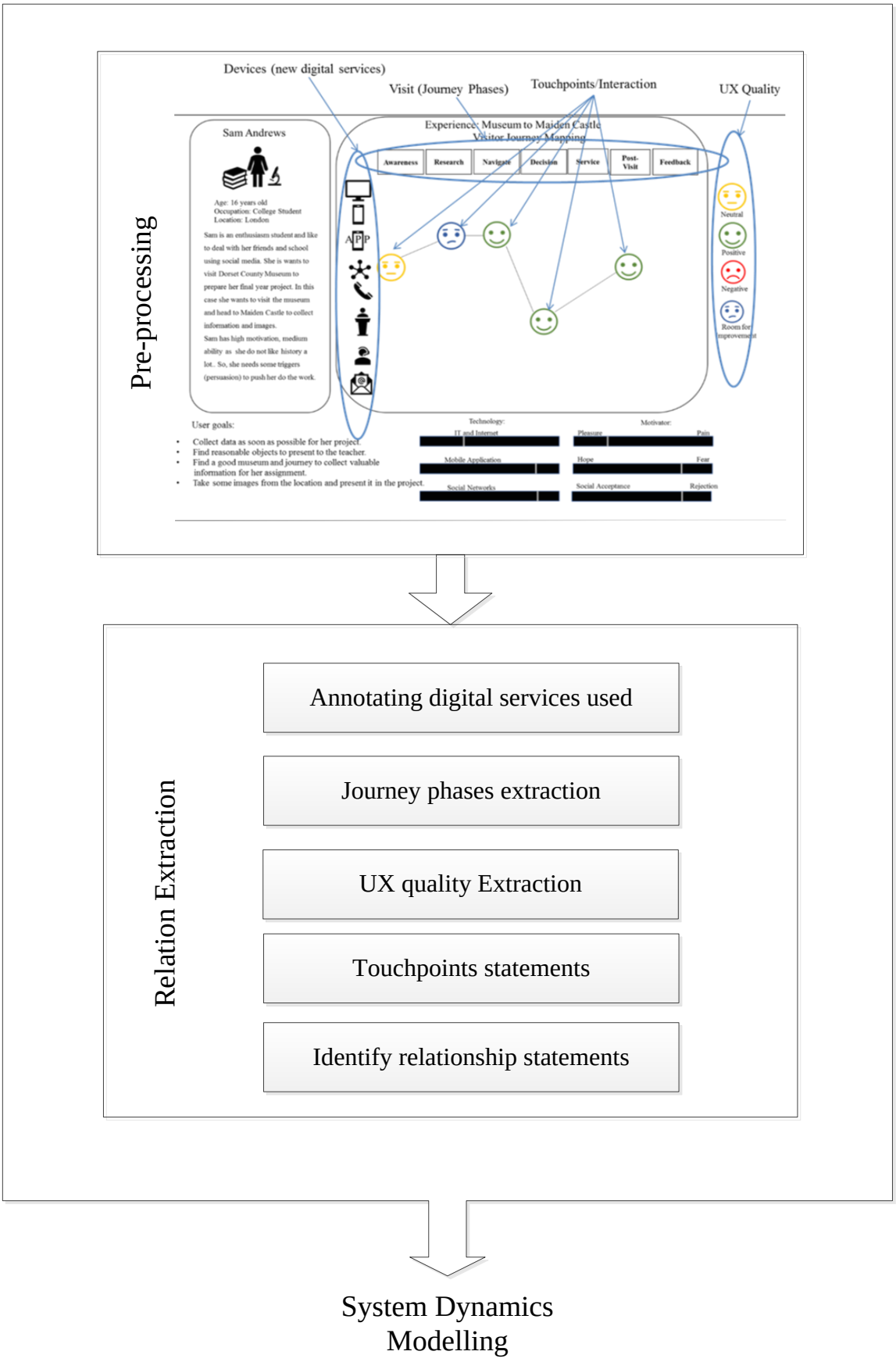


Figure 6.4: Data transformation process

6.3.2 Causal Loop Diagram

A CLD is a foundational tool used in SD and is a method of analysis used to develop an understanding of complex systems. It is a language which helps to present an understanding of the dynamic, interconnected nature of a world (Qudrat-Ullah, 2010, Kim, 1992), and is constructed as sentences linked together by key variables with causal relationships between them. It creates a coherent story about a problem or an issue, showing different loops, therefore using CLDs as a tool helps to visualise the SD.

The first step is the identification of the main touchpoints and channels in a VJM, together with a list of activities that a user/visitor performs during their journey (Sandler, 2015). At each touchpoint, visitor behaviour and feelings differ with their experiences of the heritage journey. These emotional states need to be understood and applying CLD helps to identify inflow and outflow of a visit later during the developemnt of a SFM. The components in building a CLD are presented in Table 6.3, adopted from Kim, 1992; Forrester, 1961; Kunc, 2016 and Qudrat-Ullah, 2010.

Table 6.3: Component of creating CLD

Step	**Description**	**In this study (constructed sentences)**
Theme Selection	It is pointless to begin creating a causal loop diagram without having selected a theme or issue that you wish to understand better.	'To understand the implications of digital services on visitor behaviour.'
Time Horizon	It is helpful to determine an appropriate time horizon for the issue, one long enough to see the dynamics play out.	Example: - The motivation of visitors decline over time if there are no new digital services and a low quality UX. - The time of change ranges from 10 minutes to a week/month.
Behaviour Over Time Charts	Identifying and drawing out the behaviour over time for the key variables is an important first step towards articulating the current understanding of the system. The diagram should try to capture the structure that will produce the projected behaviour.	Examples: - Visitors will increase if there are new digital services and high quality, and thus will enjoy their journey experience.
Boundary Issue	How do you know when to stop adding to a diagram? Not trying to draw out the whole system, only	Within channels (digital services) recommended from participants in focus group and VJM elements only.

	what is critical to the theme being addressed.	
Level of Aggregation	How detailed should a diagram be? This should be determined by the issue itself and the time horizon. As a rule of thumb, the variables should not describe specific events (a broken pump) but should represent patterns of behaviour (pump breakdowns throughout the plant).	Students change their behaviour if they read a tweet from their teacher which motivates them to visit a place or event. -Persona -Devices (new digital services) -Visit (Journey Phases) -Touchpoints/Interaction -UX Quality
Significant Delays	Make sure to identify which (if any) links have significant delays relative to the rest of the diagram. Delays are important because they are often a source of imbalance that accumulates within the system.	None in this study

Figure 6.2 shows a VJM of a persona (student), whereby the annotation specifies the elements which are used to represent the CLD, and are later utilised in a SFM. The VJM displays key points of the journey and identifies encouragement and decision points. For example, during the navigation, decision and post-visit phases, the persona was happy when interacting with the devices (digital services). In contrast, during the awareness and research phases the persona was not happy about their interaction and touchpoints when using a mobile application and social media. Thus their user experience seems not to be entirely happy (i.e., satisfaction is not achieved).

6.3.3 Stock and Flow Model

Stocks and flows are the accumulation and dispersal of resources, and are central to the dynamics of complex systems (Sterman, 2001). Stocks are entities that represents an accumulation, concrete or abstract, that increases or decreases over time (the nouns in the system). Flow represents actions or processes which transport concrete or abstract stocks, which add to or take away from the accumulation of a stock, and can be an inflow or an outflow (the verbs in the system). In other words, flows are entities that make stocks increase or decrease. It is important to note that the material, either tangible (individuals) or intangible (brand reputation), in the stock and flow network is preserved. For example, in this study a set of stocks and flows describing the dynamics of visitors within a heritage site will only contain visitors and not museum workers, while the feedback links

controlling the flows are derived from the exhibition manager, who uses information about stocks to take action. For example, the required inflow of digital services in a heritage site can be derived from the number of visitors to the heritage site or from the touchpoints or interactions, or other elements from the VJM.

Stocks and flows have a significant role within different areas, and Sterman (2001, p.14) notes that:

It is only in the past decade or so that the strategic management community has begun to consider the role of stocks and flows explicitly, as the resource-based view of the firm has grown in popularity. The resource-based view expanded the definition of a firm's resources beyond tangible stocks such as plant, equipment, cash, and other traditional balance sheet items to include less obvious but more important stocks underlying firm capabilities, such as employee skills, customer loyalty, and other forms of intangible human, social, and political capital.

Using stocks and flows helps to take the next step towards creating a computer model of the system. SD modelling software use these as their fundamental language, where stocks and flows represent integral equations, thus time is continuous and the size of *ds* is presented in the size of time step within the modelling software (e.g., VenSim, iThink) (Kunc, 2016).

$$Stock(t) = \int_{t_0}^{t} [Inflows(s) - Outflow(s)]ds + Stock(t_0)$$

For instance, the number of visitors visiting a heritage site in a museum can be considered as a stock. Stocks increase due to inflows, e.g., visitors arriving at a heritage site, and decrease due to outflows, e.g., visitors leaving a heritage site. When notating the stocks and flows, stocks are represented as rectangles (accumulation), while flows are pipes pointing into or out of stocks (Sterman, 2000; Morecroft, 2015; Kunc, 2016; Binder et al., 2004). Inflows (sources) and outflows (sinks) are represented as clouds at the beginning or end of the pipes, which reflect the limits of the model representation.

After analysing the VJM and considering each element individually and structuring a CLD, the next step in building a SFM is undertaken, which is to generate the relationships between the elements that affect the visitor journey. The CLD artefacts are used to build a SFM to represent the simulated experience and its effects. In this stage the designer can

assess a heritage experience journey by following the proposed methodological framework. Table 6.4 shows the components for creating a SFM.

Table 6.4: Components for creating a SFM

Step	Description	In this study
Stock (box variables/level)	Quantities that can accumulate (all non-stocks are either flows or auxiliaries).	The number of visitor visiting a heritage site in museum (Visit).
Flow (inflow and outflow rates),	Components that illustrate change in quantity over time. Flow dependencies: the variables which represent stock per time unit.	- Inflow: e.g., visitors arriving at the heritage site. - Outflows: e.g., visitors leaving the heritage site.
Connectors	Arrows which illustrate the dependency between variables. Information dependencies: the values which depend on each other.	- Visitor increases due to visitors arriving at the heritage site. - Visitor decreases due to visitors leaving the heritage site.
System boundary	Clouds at the beginning or end of the flow. This reflects the limits of the model representation.	- Within channels (digital services), journey phases extracted from VJM elements only.
Auxiliary	Variables that are constants or parameters that helps to describe the various rates or box variables.	- Journey phases: awareness, research, navigate, decision, post-visit, feedback. - Different Emotions.

From the affected elements designers can analyse and assign relationships, enabling a CLD outcome to be presented in a SFM to characterise a model to simulate the heritage environment. From these structured steps a heritage designer or worker can see the dynamic heritage journey experience and investigate the main touchpoints in order to observe user experience quality or any other aspect which affects the experience journey. The model also depicts a dynamic range of interactions that visitors have across channels (digital services), touchpoints, and time, and try to satisfy their needs. Importantly, understanding visitors' pain points, highlight aspects of their journey where they are not happy, which are opportunities for designing and implementing improvements to the heritage experience journey.

In the following section the instantiation of data transformation process to CLD and then SFM using VenSim software is presented. This research considered a complex system which therefore needs a simulation to be both visualised and investigated, and the application of the proposed techniques enables designers to build heritage experiences and evaluate them with end-users.

6.4 Instantiation of the HUXSIM Framework

The current implementation is focused on modelling visitor interactions with digital services, and the following scenario was chosen to establish the credibility of the framework and to assess user satisfaction. The following scenario is used in this part of the research to represent a museum manager. Their aim is to increase the number of visitors, thus they need to investigate the dynamic behaviour of visitors during their experience journey.

> *"In order to increase the number of visitors to the museum, the manager reduced the cost of the tickets. He also has a plan to re-build the museum and introduce new technologies. Examples of new technologies are; projector, headset guide and documentary films in different sections. He also opened a section for children to attract more visitors and introduced e-games to motivate the younger visitors".*

The HUXSIM framework is followed to investigate visitors' motivations using the VenSim software program to simulate the visitor experience, as real-life observation require more time. Heritage scenarios taken from Dorset County Museum are used for implementing the framework – with different scenarios extracted from earlier interviews and focus group.

6.4.1 Persona Scenario

Visitor (schoolteacher)

This scenario was chosen as the Dorset County Museum workers would like to encourage and motivate teenagers to the site. One way to attract them is through school and collage trips. The following scenario is based on VJM (Figure 6.5); John Brown is an enthusiastic teacher, who each year takes his students on different trips to educate and entertain them. John has high motivation and high ability to deal with the situation. However, this year the manager plans to introduce new digital services to enable John to have more positive experiences. John likes to use the desktop at the school to search about different experiences, and in this scenario, new digital services will be used to encourage him to

take the students to Dorset County Museum and Maiden Castle. The scenario was built using VJM, the output of a focus group (Chapter 5), and takes into consideration the main touchpoints which the participants thought needed improving.

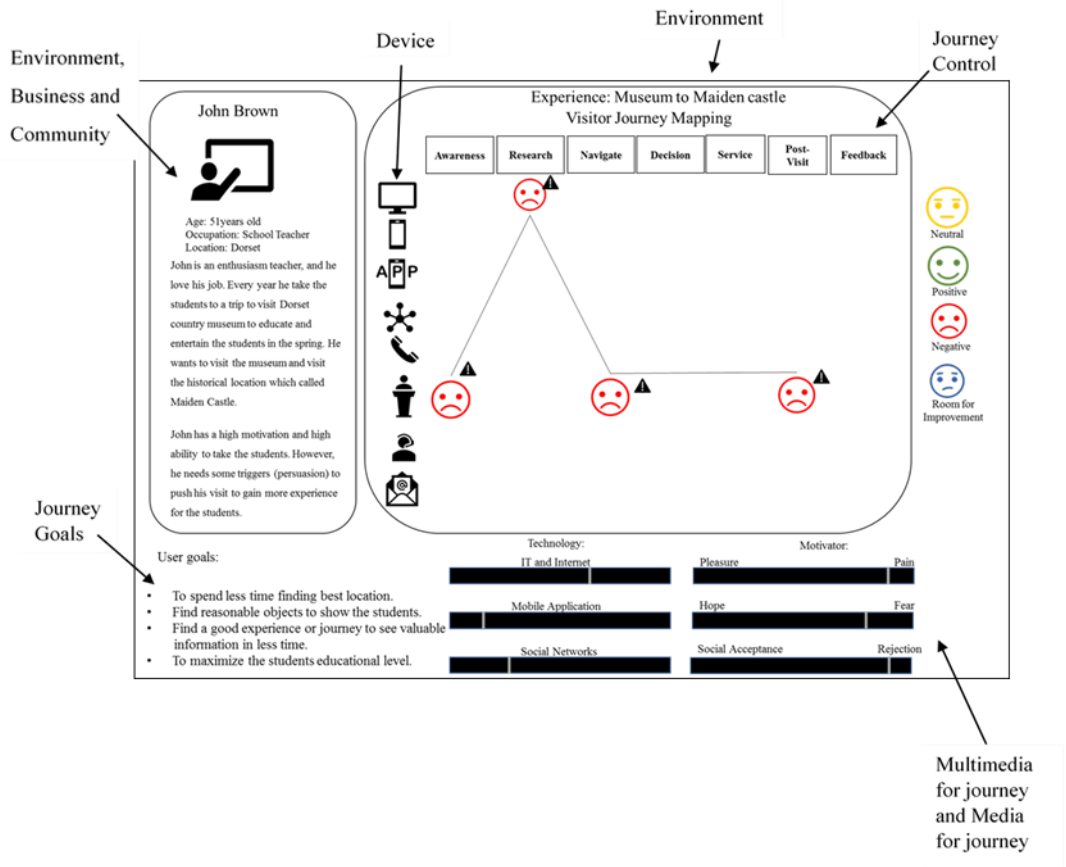


Figure 6.5: VJM experience – schoolteacher

Based on the VJM of John Brown, the museum manager seeks to motivate other teachers to visit the museum, based on negative feedback from the earlier persona. It is April, so it is the time to look for a new trip for the students and a message will be sent by phone to the teacher during the awareness phase (VJM). During the research phase, where the teacher is searching for new experiences, a message will be sent once they open a website via their phone, while in the navigation phase another message will be sent as a video about the history of Maiden Castle. In the post-visit phase an email will be sent to the teacher in order to receive some feedback. This scenario focuses on the main phases (touch points) which were agreed by the participants during the focus group. Table 6.5 shows an example of the data transformation process from VJM to CLD. It represents the annotation of digital services used by the school teacher and the journey phases. An example of annotating elements from VJM to SD model is presented in Appendix G. It also includes the touchpoints statements with identification of the UX quality representing the interaction in each stage.

Table 6.5: Element extraction using the data transformation process (School teacher)

VJM	System Dynamics models		Data Transformation Steps
	CLD	SFM	
Desktop	New Digital service	✓	1) Annotating digital services used
Website in a mobile			
Mobile application			
Social media			
Land phone			
Face to face		✓	
Call centre			
E-mail			
Awareness	Visit	✓	2) Journey phases extraction.
Research		✓	
Navigation		✓	
Decision			
Service			
Post-visit		✓	
Feedback			
Positive (Satisfied)	UX Quality		3) UX quality Extraction
Neutral			
Room for improvement			
Negative (not satisfied)		✓	
In Awareness Phase: the visitor used face to face (Negative (not satisfied)).	Touchpoint/interaction	✓	4) Touchpoints statements 5) Identify relationship statements
In Research Phase: the visitor used Desktop (Negative).		✓	
In Navigation Phase: the visitor used face to face (Negative).		✓	
In Post-visit Phase: the visitor used face to face (Negative).		✓	

6.4.2 Schoolteacher Scenario Elements

This step uses the above scenario model and the extraction of elements shown earlier that can then be utilised to build a CLD and a SFM. From this scenario the issue is what are the barriers to a high quality experience? and what are the main impacts on the visitor

experience? Table 6.6 presents the elements extracted from the scenario VJM to be fed into the CLD.

Table 6.6: Main elements extracted from the scenario and VJM to be fed into the CLD

Scenario	**Schoolteacher**
Extracted elements to be used in CLD	• Desktop • Mobile application • Social media • Face-to-face • Education • Reputation • Awareness • Research • Navigate • ~~Decision~~ • ~~Service~~ • Post-visit • ~~Feedback~~ • UX Quality: Negative
Total elements	11

6.4.3 CLD and SFM for schoolteacher scenario

This step uses the VJM extracted elements to represent CLD elements and then within a SFM. CLD as an analysis tool was used to develop an understanding of the complex system, and after analysing each element in the VJM and scenarios, the next step of building a CLD was undertaken, generating relationships between the representative elements that affect the UX quality within the scenario. Figure 6.6 represents the high-level impacts within the VJM scenario and their relationships to each other; which is a conceptual model for this iteration and one of the research outcomes. An example of model application is shown in Figure 6.7. This model is a base for the dynamic models (Figure 6.8 and Figure 6.10) - a major outcome from this research .

After analysing the initial models, the quality of experience and technology variables are taken forward to the next step of re-building the CLD, focusing on the visit and visitor journey (Figure 6.7). Thus, constructed sentences for visiting Dorset County Museum and Maiden castle are developed. In the schoolteacher scenario there are a number of variables to be tested taking into consideration the UX quality, and the following assumptions, statements, illustrate the relationships that this study is interested in.

- Improvement in quality of UX leads to greater volume of digital services.
- After sometime, the high volume of digital services erodes UX quality.
- Touch points are introduced to improve UX quality.
- The higher the UX quality, the greater the number of touch points.

So in this case, a situation which results in improvements in UX quality will lead to a greater volume of digital services (that make sense). The better the quality of the digital services, the more visitors will want to attend Dorset County Museum (museum/heritage site), and therefore, the volume of digital services grows. After some time the increases in the volume of digital services could potentially erode the UX quality. For example, if this high volume of digital services exceeds the capacity of the service experience, then an intervention or touchpoints can be introduced to improve the UX quality. In addition, the higher the UX quality, the greater the impact of the touchpoints on visitor behaviour.

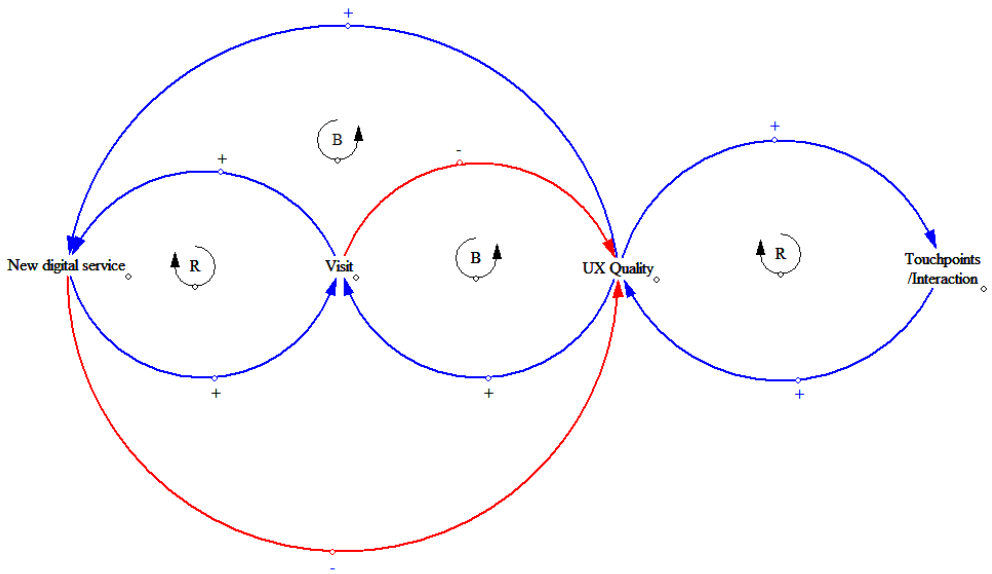


Figure 6.6: CLD model of Journey Experience

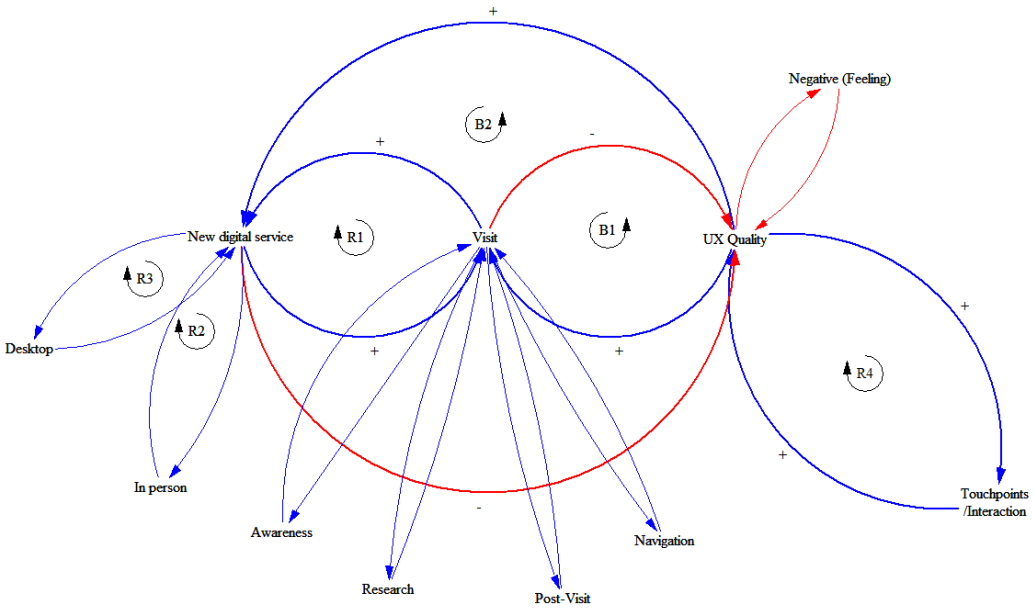


Figure 6.7: CLD uncovering School teacher experience

Figure 6.7 shows that the quality of experience is impacted positively by using technology, which would lead to a higher investment to improve the technology available and hence would eventually be paid back through generating revenue. Similarly, quality of experience impacts positively on visitors' emotions, while in contrast, website quality and an inappropriate reception theme would impact negatively on the number of visitors (See Appendix J for more detail). By positioning the using technology variable within a loop, this acts as a balancing loop to slow down the use of technology. Figure 6.8 presents the development of SFM for school teacher scenario.

This step uses the CLD representation in the SFM, and Table 6.7 presents the variables which are incorporated as it represents the main elements from VJM. Four main stocks are identified, visit, volume of digital services, UX quality, and touchpoints/interactions, while there are four main flows and the remainder are auxiliary or information descriptors.

Table 6.7: Identifying different variables to represent stock and flows

Variables	Stock (Accumulate)	Inflows and Outflows	Descriptors/Auxiliary
1	Visit	Visit/time unit	• Total Visitor • Visit constant • Awareness • Research • Navigate • Post-visit
2	Volume of digital service	Volume of digital service/time unit	• Total Visitor • Desktop • Mobile application • Social media • Face-to-face
3	UX Quality	Quality/time unit	• Total Visitor • Quality constant • UX Quality: Negative
4	Touchpoint/Interaction	Touchpoint/ time unit	• Emotion/Feeling • Reputation

This is the tenth step in the HUXSIM framework, and this outcome is a model which shows four stocks: new digital services, visit, UX quality, and touchpoints/interactions. In addition, the impacts of the effects on the stocks are also shown. The justification for this outcome comes from the VJM and persona, and so each model is different depending on the experience journey of each individual. The previous diagrams helped in collecting and analysing the elements needed to be included in this model and these variable elements are then entered into the VenSim software (Sumari et al., 2013; Juan, Hui, and Pengji, 2018). Figure 6.8 shows the relationships for each variable and then equations are implemented according to these relationships (See Appendix H for the implemented equations). The simulations are run for a few stocks before continuing to the others in order to examine the outcomes of the stock equations separately. Figure 6.8 presents different simulation results, and using these a heritage experience designer can investigate and explore dynamic behaviours according to different VJMs.

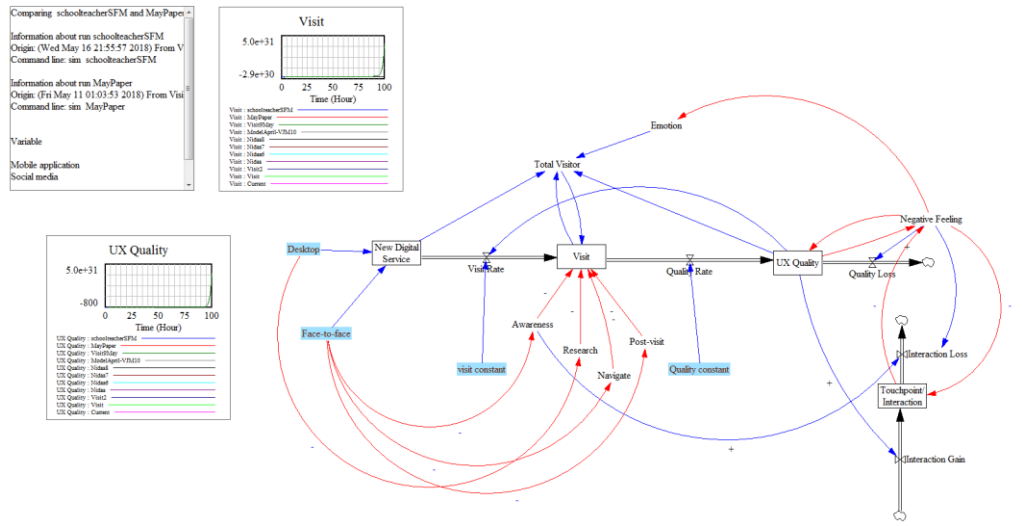


Figure 6.8: SFD exploring the schoolteacher visit

This section instantiated the HUXSIM framework in different scenarios to validate the process. One example is a school teacher, which represents a novel approach to transform and extract data from the VJM. As far as the author is aware there are no studies covering a methodology to design UX using simulations, considering QoE. Thus, in this iteration SD models are typically designed after data exploration and by experts, of which UX is not usually part (Vermeeren et al., 2016 and, Kiourt et al., 2017). CLD and SFM were instantiated for another scenario in the following section.

6.4.4 Exploring College Student visit

The following example CLD highlights the exploration of a college student (Figure 6.9). Then a stock and flow diagram was built which used the same persona to explore the visit (Figure 6.10). Journey mapping provided a set of constructs from which to model, thus VJM constructs are modelled in the following manner (Table 6.8 and 6.9):

Table 6.8: Construct transformation

VJM Construct	SD Model
Devices (New Digital service)	Mobile application, Web or social media opportunities.
Journey Phases (Visit)	Awareness, research, navigate, decision, service, post-visit, feedback in relation to interaction variables.
UX Quality	Outcome variable - Positive, Neutral, Room for improvement and negative feeling of the visitor.
Touchpoints	Visitor interaction variables associated with the experience.

Table 6.9: Element extraction using the data transformation process (College Student)

VJM	System Dynamics models		Data Transformation Steps
	CLD	SFM	
Desktop	New Digital service		1) Annotating digital services used
Website in a mobile			
Mobile application		✓	
Social media		✓	
Land phone			
Face to face		✓	
Call centre			
E-mail			
Awareness	Visit	✓	2) Journey phases extraction.
Research		✓	
Navigation		✓	
Decision		✓	
Service			
Post-visit		✓	
Feedback			
Positive (Satisfied)	UX Quality	✓	3) UX quality Extraction
Neutral		✓	
Room for improvement		✓	
Negative (not satisfied)			
In Awareness Phase: the visitor used Social media (Neutral)	Touchpoint/interaction	✓	4) Touchpoints statements 5) Identify relationship statements
In Research Phase: the visitor used Mobile application (Room for improvement)		✓	
In Navigation Phase: the visitor used Mobile application (Positive Satisfied)		✓	
In Decision Phase: the visitor used face to face (Positive Satisfied)		✓	
In Post-visit Phase: the visitor used Social media (Positive Satisfied)		✓	

The following Figure 6.9 presents the factors that are presented in the VJM scenario and their interrelations. For example, as technology is widely used in museums (apps and digital services), a positive impact on the number of visit would result. Similarly, a bad UX quality has a negative impact on visitor feelings. From the previous phases, it can be observed that the main variables in this problem are the new digital services, the visit and the quality of experience. These variables are grounded in the VJM and their influences emerge from workshop discussion around the journey map.

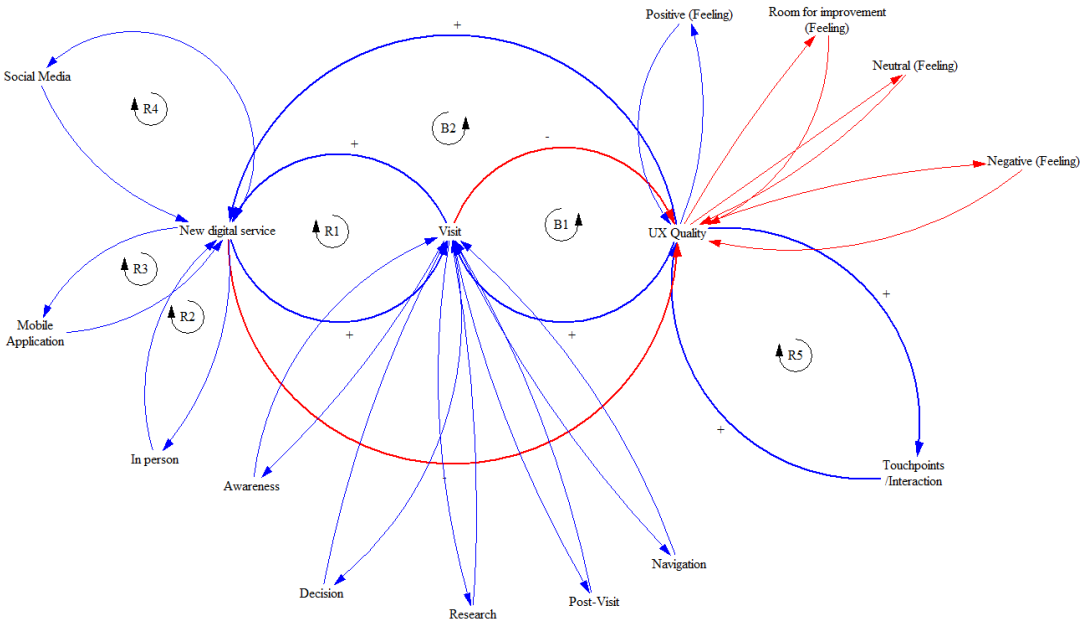


Figure 6.9: CLD model of student visit

Persona CLDs are reviewed for similarity (motivating common experience designs) and then used to build SFM where core VJM variables are examined – specifically new service designs and their potential impact.

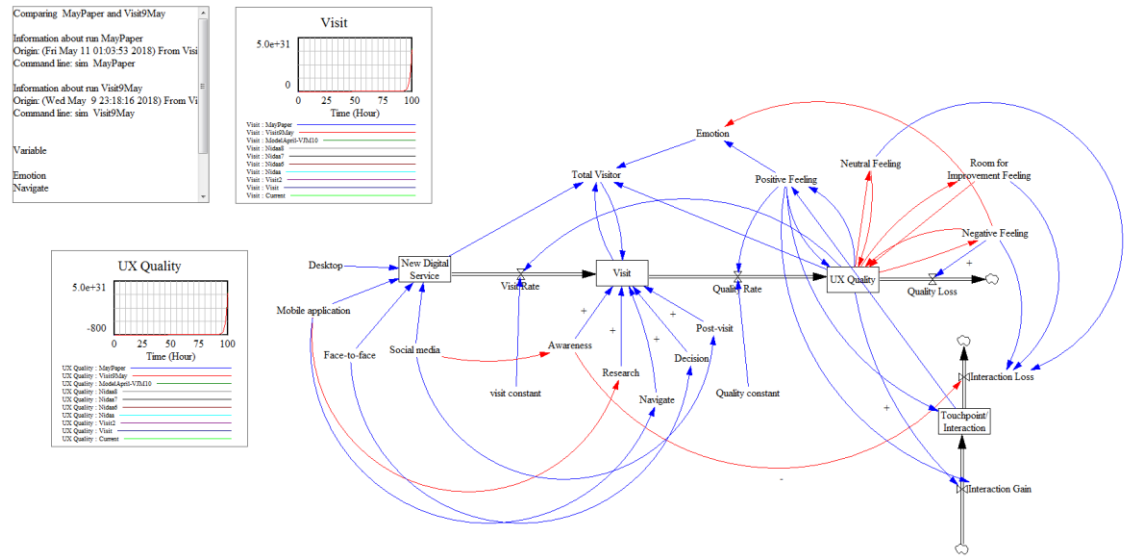


Figure 6.10: SFM exploring the student visit

6.5 Evaluation

The majority of planning models, like SD-type models, are built for the analysis of a plan, the exploration of possible future scenarios, and for management purposes (Gass, 1983; Oliva, 2003; Sterman, 2000; Qudrat-Ullah, 2012). The model here is built for the purpose of exploring the behavioural dynamics of heritage journeys, validating the method of its creation. The evaluation of this iteration asseses the output SD artefacts directly, and the HUXSIM framework is evaluated indirectly using the instantiation of the SFM.

6.5.1 Validity of the HUXSIM Framework

As the aim of this iteration was to extend the HUX framework to include a simulation, it is necessary to evaluate the developed HUXSIM. Table 6.10 compares the requirements with the achieved outcomes.

Table 6.10: Requirements and how they are achieved

Requirements for designing a heritage experience framework	How it is achieved in this iteration
Representation of dynamic journeys	From the structured steps in the HUXSIM framework a heritage designer or worker could design a journey experience and investigate the main touchpoints to assess the UX quality.
Understand visitor's touchpoints and behaviour in different journey phases.	Step (10) in HUXSIM framework.

The designer can investigate the impact of digital services on UX quality by generating more experience visits.	Step (10) in HUXSIM framework.
Straightforwardness, able to be used by non-specialists.	As in Table 6.2 ; Table 6.5 and Figure 6.3 the steps of the methodological framework are easy to use.
Dynamic visualisation to enhance communication inside multidisciplinary teams.	A heritage designer or worker could design a journey experience with a multidisciplinary team (for example, museum manager, web designer, visitor, collection manager)
The evaluation in Chapter 5 showed that different visitors use different digital services; however, dynamic behaviour cannot be shown in a static VJM.	Using stocks and flows to visualise VJM the designer can demonstrate different scenarios representing behavioural dynamics.

6.5.2 Domain Expert Evaluation

The aim of the domain experts evaluation was to validate the effectiveness and practicality of HUXSIM framework in another museum context. Thus, interview questions with three experts who works in the musueum were designed to fulfil this aim.

One of the central evaluation methods in UCD is expert evaluation (Nielsen, 1994). The aim of the review is to validate the main artefacts, the HUX and HUXSIM methodologies and models. The criteria are operationality of artefacts, which is the ability for the method to be re-used, as well as the understandability, efficiency and ease of use of artefacts. The methodology was explained to participants and how the framework was developed and designed. The feedback was generally positive, providing some confirmation of the aforementioned criteria (see Chapter 3, Table 3.2).

Experts were interviewed using semi-structured interviews to uncover their detailed opinions and perspectives (see Section 3.6.3.1 for more detail regarding the selection of the semi-structured interviews). As noted earlier, Hevner et al. (2004) identify most common evaluation criteria to validate the utility, quality, and efficacy of artefacts. Thus the questions were built according to the suggested DSR evaluation criteria (see Table 3.2). Consequently, the methodologies were evaluated in terms of understandability, operationability, ease of use, effectiveness and practicality. The questions were based on Castillo-Montoya's 2016 Interview Protocol Matrix that reflects the research issues (questions) with the interview question (see Appendix F, Table 1 for Expert Interview

Protocol Matrix). The questions were determined from the literature review, significantly based on the evaluation criteria advised by DSR, which this research follows. Interviews took place in the X London Museum at a time and place appropriate for the participants. Each expert interviewed individually and transcribed with varying duration times from 55 to 90 minutes as the maximum time. The questions were divided into three sections; pre-demo, during-demo and post-demo questions (See Appendix F for domain expert evaluation form questions). This structure enabled examination of the current process and then give an opportunity to the experts to express the benefits of using new tools and techniques to design user experiences. The pre-demo questions were designed to warm up the conversation and to investigate the current tools used in the museum to design experiences. It also seeks to know about the process followed to design visitor experience and who is responsible for that. Prior to the second part of the questions, the main characteristics of the HUX and HUXSIM methodologies were explained. It was considered essential that the experts were clear about how the methodologies and tools were intended to work as well as the objectives of the instantiations. During the demo, the experts were asked specific questions regarding the models and tools directly, to get quick and direct feedbacks from each model. This helped in validating and evaluating different steps in the framework. Regarding post-demo questions the experts were asked to evaluate the methodological framework effectiveness as experience design tool in a heritage context. The experts suggested that the framework was unlikely to delay the designer's performance, given that it was evaluated as being easy to use and learn. They also expressed the view that such a tool would be beneficial for the members of the museum workers in terms of efficiency and error reduction, especially when making a large volume of visitors using the SFM simulation. The next section illustrates the findings of experts and a brief discussion of the results.

- **Current design processes**

The experts were asked how they are currently designing new experiences for visitors. In response, he mentioned:

"So in that [new exhibition], we designed new information boards, interpretation boards if you like …. So we didn't do any digital design, we didn't really update the website, and so on, so the only new interpretation in that sense was pre-printed interpretation boards".

"But they don't get updated very often, in fact they tend to get created and designed and then that's it, and they remain static until there's a completely new overhaul and everything changes, and then that will remain static for several years…. And part of the reason for that is it's very expensive …"

A question was then asked to explain the process for designing experiences; and who participates in this activity? The expert pointed out:

"That's hard to answer. It depends upon the nature of the exhibit. …..The guy who did most … and one guy, one of the volunteers did most of the work for that[new exhibition], which in terms of building the stuff, putting it in place, making it ready for exhibition, and also designing the interpretation panels, he did most of that work himself. When the panels were designed, there's a process which means that somebody else will check it… …and they therefore modified the text a little bit, and then the graphic design was created. But in terms of the individuals concerned, it was largely one person who probably had the most knowledge..."

- **HUXSIM framework validity**

In terms of dynamic journeys (including journey maps and simulation), the experts thought that the journey maps are easy to understand and follow by non-specialists. In addition, the touchpoints and behaviour of users in different journey phases are understandable. They also expressed the view that such a framework would be beneficial for the members of the museum workers in terms of efficiency and practicality when designing an experience. In that he stated:

"I think the journey map is the most easy to understand… And the reason for that is it's very clear and uncluttered and … so that makes it all very, very clear and easy to understand straight away."

"Anybody could use that one [Referring to VJM] for sure… Anybody who has basic IT, anyone who uses a mobile phone or a laptop or an iPad or whatever, that's easy"

"I can see how that on its own could add value to a museum, because we want to understand what our visitors think, we want to understand how well our social media is working, and we want to understand how well our website is working, and if people struggle with that … you always get … if we always get negative comments on the website, we know we need to do something about the website."

Regarding the simulation model, they were interested in the idea of assessing journey phases and which mobile phone or device is effective for each visitor group. They stated:

"So we'll be able to see where people are spending their time, in which case we can then focus our marketing more into those specifics. There's no point in putting an effort in marketing on e-mail if everybody is using it… This will be a fantastic tool."

"Well SD models are another way of displaying the VJM information … and it shows you, it's qualitative information…So you can evaluate the different phases of the journey that the visitor brings through. Which is quite interesting actually."

Regarding the effectiveness, operationalability and usefulness of the methodological framework, the experts said that this process covers lots of aspects in a whole journey which is valuable tool for a museums:

"This covers more, this, because this will cover the whole journey from deciding they want to go to the museum, to being in the museum and to what do they think afterwards. And there are different media for providing, to assess that particular journey, and different aspects of the journey. So think this would be a very valuable tool, because people who like to use mobile phones will do it on their phones, people who like to send e-mails will do so, and it can all be captured and all brought in together."

"… I think any museum would benefit from this. I think largely because all museums do this anyway to some extent or another, but this is a way of crossing many different platforms and many different parts of the journey if you like, your visitor journey, and it's all in one place, and it's easy to see."

"… to have a tool, have access to a tool that can give the museum a lot of very specific information about its visitors and the visitor habits and what the visitors like and… that lots and lots of people are, I don't know, nobody uses e-mail or maybe loads and loads of people use social media…It will give you those sorts of feedback as well. So we'll be able to see where people are spending their time, in which case we can then focus our marketing more into those specifics. There's no point in putting an effort in marketing on e-mail if everybody's using social media. So it will help us in those respects. And for a small museum like this, that would be quite valuable. I like it."

The use of the experts' evaluation helped to clarify effectiveness and assess clearly the extent to which the developed methodologies effectively support designers of heritage museum experiences. The experts were positive about the characteristics of the framework. Moreover, experts' evaluation findings provided the researcher with an insight into the designer/museum worker attitude towards using the HUXSIM framework. It also gave a lot of recommendations for further study and future work.

6.5.3 Validity of the System Dynamic Model

The structural verification is of fundamental importance within the overall validation process. For the structural verification of the HUXSIM framework, the approach taken during the construction of the model was to use a focus group workshop (Chapter 5, iteration 2) to collect data about different persona and build heritage journey experiences. The data from the VJM (outcome from iteration 2) were used as knowledge about the real system, and the conceptual model of HUXSIM is represented by a CLD, as in Figure 6.9. To evaluate the structural validity of the SD model, HUXSIM which is a model for understanding the dynamics of VJM, utilised dynamic aspects such as types of visitors (persona), behaviours and UX quality. The purpose of this model is to assess the impact of digital services on creating high UX quality on visitor behaviour.

Table 6.11 compares the characteristics used in this iteration within HUXSIM against the recommended characteristics. It also briefly explains and provides evidence concerning whether the recommended characteristics are present in the HUXSIM model.

Table 6.11: Characteristics of basic SD models

Steps to validate SD modelling (Kunc, 2016)	**Tests for structural validity of SD type model** (Senge and Forrester, 1980 and Qudrat-Ullah, 2012)	**How it is achieved in this iteration** (HUXSIM characteristics)
Defining problems dynamically, in terms of graphs over time.	Boundary adequacy: are the important concepts and structures for addressing the policy issues endogenous to the model?	It can be seen in Table 6.3 that the museum policy is to increase the number of visitors through focusing on the quality of experiences and minimising the cost of new digital services. Furthermore, important concepts are taken from
Striving for an endogenous, behavioural view of the significant dynamics of a system, a focus inward on the characteristics of a system that themselves generate or		

Steps to validate SD modelling (Kunc, 2016)	**Tests for structural validity of SD type model** (Senge and Forrester, 1980 and Qudrat-Ullah, 2012)	**How it is achieved in this iteration** (HUXSIM characteristics)
exacerbate the perceived problem.		early taxonomy work and VJM to present the boundaries of the model.
Thinking of all concepts in the real system as continuous quantities interconnected in loops of information feedback and circular causality.	Structure verification: is the model structure consistent with relevant descriptive knowledge of the system being modelled?	As presented in Figure 6.9 CLD of visit
Identifying independent stocks or accumulations (levels) in the system and their inflows and outflows (rates).	Dimensional consistency: does each equation in the model dimensionally correspond to the real system? Parameter verification: are the parameters in the model consistent with relevant knowledge of the system?	As presented in Table 6.4, components for creating SFM and in Table 6.7, which identifies different variables that represent stocks and flows. Figure 6.10 presents different simulation results. From the dynamic elements designers can analyse and determine relationships in a CLD (Figure 6.9) and use SFM to characterise a model to simulate the heritage environment. The visualisation of the dynamic VJM in Figure 6.8 shows elements that are significant to capture emotions.
Formulating a behavioural model capable of reproducing, by itself, the dynamic problem of concern. The model is usually a computer simulation model expressed in nonlinear equations, but is occasionally left without quantities as a diagram capturing the stock-and-flow/causal feedback structure of the system.		
Deriving understandings and applicable policy insights from the resulting model.		
Implementing changes resulting from model-based understandings and insights.	Extreme conditions: does the model exhibit logical behaviour when selected parameters are assigned extreme values?	Representation of extreme conditions by changing the value of the parameters exhibits logical behaviour (See Appendix H)

By investigating the output of this iteration, the diagrams and models reveal some motivating conclusions. The extracted elements, which are presented in the CLD and SFM, indicate significant heritage domain concepts that would be hard to investigate and evaluate using simple tools or conversations. In addition, elements from VJM appear

differently in the SFM and result in different models according to the elements and the quality of experience. It is clear that models can be created for various visitors and the channels they used. At the end of the process it is interesting to note that the VJM produced significant elements which can be used to represent dynamic behaviours. Thus, using design thinking together with system thinking techniques yields improvements that leads to a high quality of experience. This should also reduce the effort of the experience designers and museum workers when designing heritage journeys and allow curators to manage experience more easily. Evidence for that; are extracted from the experts' evaluation interviews :

"I can see how that on its own could add value to a museum, because we want to understand what our visitors think, we want to understand how well our social media is working, and we want to understand how well our website is working, and if people struggle with that … you always get … if we always get negative comments on the website, we know we need to do something about the website."

"… I think any museum would benefit from this. I think largely because all museums do this anyway to some extent or another, but this is a way of crossing many different platforms and many different parts of the journey if you like, your visitor journey, and it's all in one place, and it's easy to see."

"… to have a tool, have access to a tool that can give the museum a lot of very specific information about its visitors and the visitor habits and what the visitors like… So we'll be able to see where people are spending their time, in which case we can then focus our marketing more into those specifics. There's no point in putting an effort in marketing on e-mail if everybody's using social media. So it will help us in those respects. And for a small museum like this, that would be quite valuable. I like it."

"This covers more, …. So I think this would be a very valuable tool, because people who like to use mobile phones will do it on their phones, people who like to send e-mails will do so, and it can all be captured and all brought in together."

6.6 Summary

This chapter concludes all practical activities, and results in a methodological framework to help experience designers to design heritage experiences. This iteration has yielded an improved HUX framework synthesising design and syetm thinking, and a formal definition of outputs from each of the phases. This methodological framework guides the development of a dynamic journey experience utilising three design thinking tools (persona, scenario modelling, and VJM), and two systems thinking tools (CLD and SFM) – with steps describing how to construct a high-quality visitor experience. To develop a successful heritage experience, the framework proposed allows designers to simulate visitors' journeys in a system dynamic visualisation, while SD show the impact on the number of visitors. Thus, the transformation process from VJM to the simulation demonstrates the practicality of using this framework as an effective tool for the targeted stakeholders. Furthermore, such simulations serve as an appropriate approach to analyse visitors' experiences, which are highly diverse and complex in nature. This study demonstrated for the first time how VJM can be used alongside simulation – directing the use of CLD and SFM.

CHAPTER 7 Conclusions and Future Research Directions

7.1 Introduction

This chapter summarises the research and outlines the research contributions and findings. Study limitations are discussed, providing insights for further research. The remaining sections are structured as follows: Section 7.2 summarises the rationale for each chapter; Section 7.3 highlights research contributions and summarises design artefacts resulting from this study; Section 7.4 focuses on the limitations of the study and suggests future research that will underpin developments in heritage experience design; and, finally, Section 7.5 concludes the thesis.

7.2 Research Summary

This thesis contributes to the knowledge by investigating tools and techniques for designing UX in a heritage domain – synthesing design and system thinking. Many approaches have been proposed for designing user experiences over the past few years, however the focus has tended towards static modelling of experiences (or experience snapshots). Moreover, most studies in the heritage domain have been carried out in tourist cities. Little attention has been paid to developing integrated approaches for heritage sites, e.g., museums and surrounding landscapes, to leverage the socio-economic benefits of cultural heritage for regions and towns (Marty, 2008; Arnold and Geser, 2008; Parry, 2005). Thus, it is critical for designers to broaden their understanding on how to utilise digital services and techniques, to increase QoE and in turn, improve visitor experiences at heritage locations. The aim of this research was to design effective approaches for heritage stakeholders to collaboratively design interactions that motivate visitor engagement. The approach focussed on a methodological framework for journey-based experience design.

In term of contributions, the research developed a methodological heritage framework for designing user experiences. To meet the research aims, DSR was adopted from Vaishnavi & Kuechler (2004), as an overarching research methodology. Research was achieved using DSR processes via: (1) An awareness of the problems presented in Chapters One and Two; (2) Suggestions articulated in Chapters Three and Four; (3) Study development, expressed in Chapters Four, Five and Six; (4) Applied evaluations in Chapters Four, Five and Six; and (5) Conclusions.

March and Smith's (1995) research product (artefact) classifications were adopted to illustrate research output. Research products were identified in the form of constructs, models, methods and instantiations. The DSR methodology employed for developing artefacts was an iterative design cycle (design, build and evaluate). The build component was concerned with the development of the artefact, and evaluation was concerned with the development of an assessment method or metric, to assess the quality and effectiveness of the artefact (March and Smith, 1995).

Grounded theory techniques were applied to build the heritage taxonomy in the first iteration. In the second iteration, design thinking tools and techniques, including CJM, were used in the design of experience models (termed Visitor Journey Maps - VJM). Thirdly, a novel approach explored visitor behaviours using SD tools to simulate specific persona behaviours. This iteration presented the methodological framework, which introduced a structured process to guide designers in building a high-quality heritage experience. The objectives are summarised below:

Objective 1: Investigate state-of-the-art design experience techniques for visitors in the heritage domain, highlighting their capabilities and limitations in designing heritage experiences. (Chapter 2)

Objective 2: Investigate the need for innovative technologies and tools to design experiences with the aim of building a structured framework, to help categorise visitor experiences. (Chapters 3 and 4)

Objective 3: Design and develop a process to represent a visitor experience model for personas, and to capture their behaviours and emotions during heritage experiences. (Chapter 5).

Objective 4: Develop a methodological framework that considers the findings of objective 3, to provide a novel approach in exploring visitor behaviours. (Chapter 6)

Objective 5: Evaluate the utility and efficiency of the framework by developing a simulation model to generalise and confirm findings. (Chapter 6).

In outlining the aims, Chapter 2 reviewed the state-of-the-art, specifically: Museum digital experiences, QoE models, design thinking and system dynamics. Recent research has tended to either: 1) Focus on the abstract modelling of heritage artefacts (Dragoni et

al., 2017), 2) Encourage participation in the modelling and simulation (Tako and Kotiadis, 2015) or 3) Provided the designer with a palette of practical UX elements (Vermeeren et al., 2016). Therefore, a gap existed requiring exploration into how the creativity of design thinking can be utilised alongside system thinking early in the design process. In response, Chapter 2 critically reviewed heritage challenges in terms of experience design. In addition, the chapter discussed QoE models (Marcus, 2006; Hartson and Pyla, 2012; Möller et al., 2009; Laghari, and Connelly 2012; and Perkis, 2013 and Floris et al., 2014) and recommended a heritage taxonomy for the development of an experience design. Design thinking techniques, more specifically on CJM and persona, were selected. System thinking techniques were proposed as a dynamic addition to UX modelling for the heritage design process.

Chapter 3 established DSR as a viable approach in this study. The methodology engaged with the design research problem by providing learning from each phase, each addressing a specific problem. The main design artefacts created in this study are: a heritage taxonomy detailing visitor experiences (HUX) and a methodological framework (HUXSIM) for designing heritage journeys and exploring visitor behaviours. Following design research guidelines, this thesis adopted an iterative strategy. The knowledge gained from each iteration was used to facilitate the next. The overall research methodology was executed as design research incremental iterations, where each iteration formed a design problem, that executed the 'build and evaluate' design activities (Vaishnavi & Kuechler, 2004).

Chapter 4 described the first iteration and concentrated on developing a taxonomy for heritage experiences. Ten interviews with heritage stakeholders (including collection managers, archaeologists, curators and fundraisers) were conducted, with data analysed using GT techniques. The resulting taxonomy provided scaffolding for the later heritage experience design. Artefacts built in this iteration guided heritage designers on choices to initiate heritage journeys. The heritage taxonomy was developed to help designers specify the scope of digital experiences. The artefact was evaluated by comparing it with experience elements (Stokes, 2015, Floris et al., 2014, Kuniavsky, 2010, Garrett 2010, Schmidt and Etches, 2012, Hassenzahl, 2008) to validate its use in heritage experiences. The taxonomy itself can be used to: 1) identify relevant design tactics, given a specific experience context, (2) allow the design of an experience or techniques for a particular experience and (3) provid an overview of the heritage domain of experience quality.

Chapter 5 presented the first HUX framework, where heritage journeys were constructed using UCD techniques. Two focus groups used in the design process - consisting of three heritage workers and three visitors - were encouraged with discussions about experiences, feelings and participant perceptions (Porcellato et al., 2002). Despite there being many existing applications within the museum, robust processes for heritage experience design was a new phenomenon, which required the gathering of ideas from users.

The second iteration contributed another set of design research products, facilitating the customer journey mapping to map the visitor journey. Customer journey maps, persona concepts and focus groups were used as design thinking tools to facilitate the design of a heritage experience. The term 'customer journey map' (CJM) was extended as 'visitor journey map' (VJM) for this research study. Applying design thinking tools and techniques helped in identifying experience models for specific visitors. Steps in the design of experiences were identified after comparing results from two focus group meetings (Dorset County Museum employees and visitors).Based on these analyses, an initial HUX framework was developed and instantiated via another focus groups, consisting of visitors and workers at Dorset County Museum.

Taxonomy elements were applied to understanding visitor characteristics and to model heritage experiences. Focus groups were used in building a set of VJMs. Developing different VJMs as model artefacts was used to recognise visitor interactions with heritage digital services. Development of an experience design method (HUX) was a key research contribution in this chapter. It extended the framework developed in iteration 1, Chapter 4. From the VJM artefacts, a designer can identify and extract touch points which are used in subsequent iterations. Based on results and evaluations from focus groups, areas for further development of the HUX are proposed for the next iteration.

Chapter 6 described the final iteration of this research. The HUXSIM methodological framework is a novel framework for designing experience models. This iteration proposed the addition of a simulation model to explore visitor behaviours and introduced system thinking tools as simulation techniques to represent the effectiveness and quality of the experience journey. This iteration extended the HUX framework, developed in Chapter 5, to build system models, including causal loop diagrams and stock and flow diagrams, to simulate the use and impact of new digital services. Thus, this iteration focused on providing an effective tool for stakeholders to design high-quality heritage experiences. The proposed methodological framework guided the development of a

journey experience design, by using design and system thinking tools. Learning that emerged from the third iteration highlighted a number of issues and challenges that could be used to direct future research. Table 7.1 represents how the chapters of this thesis addressed the objectives of the research.

Table 7.1: How the objectives of the study were addressed (outcomes)

Objective	Chapter	Outcome
Objective 1: To investigate state-of-the-art design experience techniques for visitors in heritage domains, highlighting capabilities and limitations in designing heritage experiences.	Chapter 2	Providing contextual backgrounds to digital experiences in museums; studying different models of QoE and analysing the main elements. In addition, studying design and system thinking tools and techniques. Also, modelling frameworks for heritage digital experiences and reviewing challenges in heritage experience design. These models, tools and techniques were used for building and constructing the taxonomy (Iteration1) and the methodological framework (Iteration2 and Iteration3).
Objective 2: To investigate the need for innovative technologies and tools to design experiences with the aim of building a structured framework, to help categorise visitor experiences.	Chapters 3 and 4	This objective was fulfilled by interviewing experts in heritage museums. Outcome included the development of a heritage taxonomy and utilising design visitor experience models. Utilising DSR methodology processes is aimed at designing different artefacts – e.g. models (VJM,SD) and method (HUXSIM).
Objective 3: To design and develop a process representing a visitor experience model for different personas, and to capture behaviours and emotions during a heritage experience.	Chapter 5	A novel approach was proposed in designing visitor experiences and to build a framework (HUX) for heritage experience journeys, based on an experience models.
Objective 4: To develop a methodological framework that considers the findings of objective 3, to provide a novel approach to explore visitor dynamic behaviours.	Chapter 6	Develop a novel approach; the HUXSIM methodological framework for describing a step by step process of designing heritage experiences. Develop an SFM to explore visitor dynamic behaviours.

Objective	Chapter	Outcome
Objective 5: To evaluate the utility and efficiency of the framework by developing simulation models to generalise and confirm findings.	Chapter 6	Validated the efficiency of the framework in a simulation environment, using SD models. Demonstrated to experts.

7.3 Research Contributions and Conclusions

This research followed DSR guidelines (March and Smith 1995, Vaishnavi and Kuechler 2004, Hevner et al. 2004, Peffers et al. 2007), thus it was essential to make a new contribution to a domain of study. According to DSR, contributions are in the form of artefacts, i.e. constructs, methods, models and instantiations (March and Smith 1995). The artefacts derived from this research are summarised in Table 7.2. The main research contributions are outlined below.

Table 7.2: Design research artefacts and activities

Research Activities					
		Design Science		**Natural Science**	
Research Artefacts		**Build**	**Evaluate**	**Theorise**	**Justify**
	Constructs	Heritage Taxonomy	Completeness Simplicity Ease of use Understand-ability	Explain why and how constructs work by using them to describe real case scenarios (addressed in Ch.4, Ch.5, 6)	Prove that constructs work scientifically by applying to models and methods (Ch.4, 5, 6)
	Model	-Taxonomy scenario -VJM -HUX -CLD. -SFM. -HUXSIM	-Fidelity with real world phenomena. -Completeness -Level of detail -Internal consistency	Adapting current CJM theories and hypothesising those models are true (achieved by theorising VJM in Ch. 5 and 6)	Test models in a real-life example (addressed in Ch. 5 and 6)

	Methods	-VJM Process. -Heritage Taxonomy Development process. -HUX Framework. -CLD process -SFM process -HUXSIM Framework.	-Operationally (ability of others to efficiently use the method). -Efficiency. Generalisability -Ease of use	Explain why and how methods are applied (achieved in Ch. 4, 5 and 6)	Prove the methods work by instantiating using real examples (achieved in Ch. 5 and 6)
	Instantiation	-HUX application. -SFM application -HUXSIM application	-Effectiveness -Efficiency -Impact on environment and users.	Understanding how and why applications work in heritage domains (achieved in Ch. 5 and 6)	Prove that HUX and HUXSIM works by testing in the domain (achieved in Ch. 5 and 6)

7.3.1 Contribution 1: HUXSIM Framework

The HUXSIM methodological framework (design method), as far as the author is aware, is the first simulation modelling approach derived from journey maps. Therefore, the development process of HUX and HUXSIM frameworks is a contribution to both DSR and simulation communities (Figure 7.1). The HUXSIM framework was designed to better represent heritage experience journeys and key touchpoints in a systems environment. Importantly, it was the translation of VJM constructs into SD models that enabled the exploration of visitor behaviour and new digital interactions. Furthermore, the approach was applied in a number of visitor scenarios (see section 6.4.4). VenSim software was used to represent visitor behaviour (a design instantiation, see Appendix I) Thus, designers can evaluate and investigate the quality of an experience and make better decisions on the technologies, digital services or/and channels offered by a museum. The simulation also provided useful insights on the impact and technological influences at heritage sites. Applications of HUXSIM methodological frameworks supported the exploration of QoE in heritage digital services and utilisation in the design of visitor journeys.

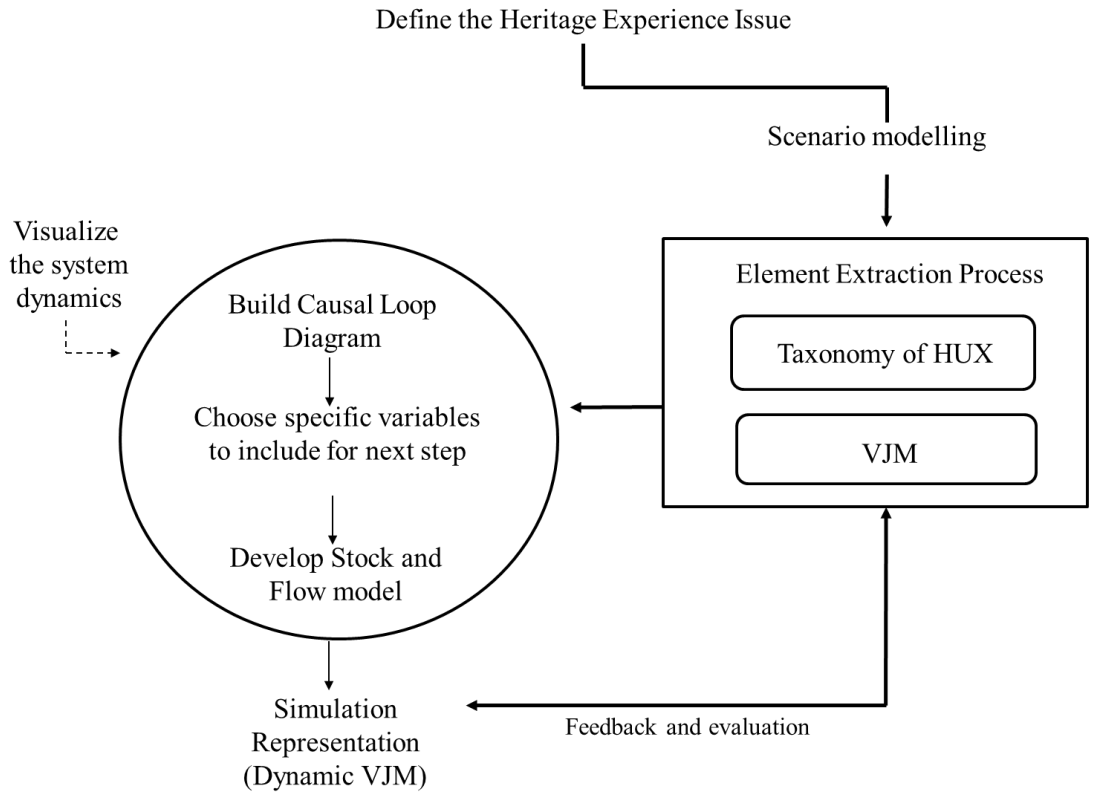


Figure 7.1: HUXSIM framework

State-of-the-art research has tended to either: 1) Focus on the abstract modelling of heritage artefacts (Dragoni et al., 2017), 2) Encourage participation in the modelling and simulation (Tako and Kotiadis, 2015) or 3) Provided the designer with a palette of practical UX elements (Vermeeren et al., 2016). This framework is a novel approach in terms of exploring how the creativity of design thinking can be utilised alongside system thinking early in the design process.

7.3.2 Contribution 2: HUX Taxonomy

The taxonomy artefact was a novel design model enabling element extraction from subsequent VJM modelling. This method contributed a broad structured interpretation extraction process that can be effectively applied to heritage experience models to map heritage journeys and touchpoints (see section 5.4.2). It employed design thinking tools to present a heritage experience model. The translation itself is a method aimed at extracting experience elements using personas and focus groups to understand specific visitor characteristics.

7.3.3 Contribution 3: VJM based Simulation

The data transformation process from VJM to SD models is another supporting contribution. The VJM model depicts relationships between basic elements of heritage experiences. The process helped in designing and annotating digital services in heritage journey experiences to visualise experience factors in a simulation model (see section 6.4.1). The process presented a set of variables from VJM, easily applied to Vensim software in order to build the SD models. The data transformation process is a novel artefact specifically tailored to map elements to the heritage SD models served as map-driven element. Applications were demonstrated in chapter 6, which is part of the HXDSIM framework. It presented proof-of-concept and the significant relationships between digital services, visits, UX quality and touchpoints/interaction in heritage domains.

7.4 Research Limitations and Future Work

Although this research has made valuable contributions to the process of heritage experience design, some challenges and limitations were catalogued during the process:

Iteration 1. It was observed that primary data collected from interviews (Dorset County Museum workers) would be of more interest if collected from visitors as well to develop the taxonomy. Different ideas from different visitors could bring a different taxonomy, or add to it. In addition, comparing results with other museums may add different elements to the taxonomy. Moreover, it would be interesting to extract and analyse data from social media websites such as Instagram, Twitter or Snapchat. Thus, a major limitation of this research is the limited visitor information and museums used to carry out the analyses.

Iteration 2. In partial response to a lack of visitor involvement, both visitors and museum workers were engaged in building and developing the HUX framework. However, there were limitations to the number of workshop participants. Greater visitor numbers and experts could help build a variety of personae; thus extracting a variety of different elements. It was hoped to conduct more focus groups to build more VJMs, however this was difficult due to other duties and lack of time.

Another limitation concerned focus groups; the allocation of a facilitator could have helped during these sessions. Arranging sessions was both time-consuming and required considerable effort. Making use of a facilitator would have helped discussions and

improved interactions with participants. Although the researcher encouraged participants to contribute more, each participant answered briefly.

In terms of building the VJM during the focus group (instantiation of the HUX framework), the data were collected from participants in the workshop, at one place. The researcher was lucky to find this number of people. Also there was no chance to sit individually with participants and physically walk them through the process. For future studies, it is recommended that this be carried out as it will help the process from the user's point of view (Marquez, Downey and Clement, 2015).

Iteration 3. The HUXSIM methodological framework was presented and uses system dynamics to simulate heritage experiences. In this research, the dynamics of experience were shown briefly, as the aim was to develop a process guiding heritage designers. Therefore, in future work, it would be useful to explore and investigate additional personas to generalise these findings. Moreover, it would be useful to apply other simulation methods and techniques, such as agent, discrete event or hybrid, to extend the work.

This research has, for the first time, demonstrated how a VJM could be transferred into a simulation model using CLD and SFD tools. Future work will focus on moving the simulation into the real world to compare it with steps proposed during the simulation phase. This will offer more refined conclusions on the methodological framework.

Regarding generalisation, the HUXSIM framework can be implemented in different domains of study. It could be applied to education domains, where school managers can make decisions on the quality of education based on simulating student behaviours toward digital services. It could also be applied in health domains, the banking sector and services sectors.

During framework evaluation and validation, different limitations and recommendations came to light. As North and Macal (2007) emphasised, no computational modelling approach will ever be fully validated. In addition, North et al. (2010, p.44) cited that "George Box mentioned: All models are wrong, but some models are useful"; this is certainly applicable to SFM. This work experienced this limitation, and came with two consequences: firstly, lowering the fidelity of problem representation and secondly, limiting validation options. For future work, it will be important to investigate the

framework using other validity tests and methods recommended by Qudrat-Ullah, (2012), Kunc, (2016) and Senge and Forrester, (1980).

Another recommendation from the evaluation was to have a user friendly interface. However, having such an interface was not a study objective. Nonetheless, the researcher received recommendations on making the interface easy for designers. In the future, it will be beneficial to implement a user friendly interface and test its usability with designers and end users.

7.5 Concluding Remarks

This research investigated the combined use of CJM and SD tools to explore visitor behaviours. A comprehensive framework (HUXSIM) was developed to support the collaborative design of more efftective visitor experience models. Although with limitations, it has proven useful in visitor behaviour analysis and exploration.

From the SD perspective, decision-making occurs continuously and is driven by habits, routines and rules of thumb and not in discrete events (Kunc, 2016). Journey map based models were constructed in order to develop dynamic models for a number of visitor groups (persona). SD is beneficial for Heritage experience designers, as it provides useful insights on the impact of digital services on user experience quality at heritage sites.

References

Abras, C., Maloney-Krichmar, D. and Preece, J. (2004) 'User-centered design', *Bainbridge, W.Encyclopedia of Human-Computer Interaction.Thousand Oaks: Sage Publications,* 37(4), pp. 445-456.

Agboma, F. and Liotta, A., (2012) Quality of experience management in mobile content delivery systems. *Telecommunication Systems*, *49*(1), pp.85-98.

Al Subhi, N.N., Bell, D. and Lashmar, P. (2016) 'User Experience (UX) of Heritage Journeys: Design Taxonomy for Quality Measurement', *International Conference on Human-Computer Interaction.* Springer, pp. 247-256.

Al Subhi, N., Bell, D. and Lashmar, P. (2015) 'Location based modelling for Heritage Mobile Applications', UKAIS Conference 2015.

Alves, R. and Nunes, N.J. (2013) 'Towards a Taxonomy of Service Design Methods and Tools.', *IESS.* Springer, pp. 215-229.

Ambrose, T. and Paine, C. (2018) *Museum Basics: The International Handbook*. Routledge.

Andolina, S., Pirrone, D., Russo, G., Sorce, S. and Gentile, A. (2012) 'Exploitation of mobile access to context-based information in cultural heritage fruition', *Broadband, Wireless Computing, Communication and Applications (BWCCA), 2012 Seventh International Conference on.* IEEE, pp. 322-328.

Andrews, J. and Eade, E. (2013) 'Listening to students: Customer journey mapping at Birmingham City University Library and learning resources', *New Review of Academic Librarianship,* 19(2), pp. 161-177.

Ardito, C., Buono, P., Costabile, M. F., Lanzilotti, R., and Piccinno, A. (2009). Enabling interactive exploration of cultural heritage: an experience of designing systems for mobile devices. Knowledge, Technology and Policy, 22(1), pp. 79-86.

Ardito, C., Costabile, M.F., De Angeli, A. and Lanzilotti, R. (2012) 'Enriching archaeological parks with contextual sounds and mobile technology', ACM Transactions on Computer-Human Interaction (TOCHI), 19(4), pp. 29.

Arnold, D. and Geser, G. (2008) 'EPOCH research agenda for the applications of ICT to cultural heritage', *EPOCH Project*.

Asquith, J.A.L. (1997) 'The effects of group size on the outcome of focus group sessions', *Management Research News,* 20(12), pp. 1-15.

Bae, K. M., Lee, K. S., & Kim, Y. S. (2014). Relationship between service design tools and service innovation-focused on Korean healthcare cases. Asia Pac. J. Multimedia Serv. Convergent Art Humanit. Sociol, 4(2), pp. 63-70.

Bainbridge, W. Encyclopedia of Human-Computer Interaction. Thousand Oaks: Sage Publications

Bakhshi, H. (2013) Digital culture report: How arts and cultural organizations in England use technology. In: NATIVE magazine, Digital R&D fund for the Arts. Available at: http://artsdigitalrnd.org.uk/digitalcultureresearch/ (Accessed: Dec/15 2014).

Baskerville, R. L., and Myers, M. D. (2002) Information systems as a reference discipline. Mis Quarterly, pp.1-14.

Bell, F., Fletcher, G., Greenhill, A., Griffiths, M. & McLean, R. (2013) Science fiction prototypes: Visionary technology narratives between futures, Futures, 50, pp.5–14.

Binder, T., Vox, A., Belyazid, S., Haraldsson, H. and Svensson, M. (2004) Developing system dynamics models from causal loop diagrams. In: Proceedings of the 22nd International Conference of the System Dynamic Society.

Bitner, M. J. (1992). Servicescapes: The impact of physical surroundings on customers and employees. the Journal of Marketing, pp. 57-71.

Bishai, D., Paina, L., Li, Q., Peters, D.H. and Hyder, A.A. (2014) 'Advancing the application of systems thinking in health: why cure crowds out prevention', *Health research policy and systems*, 12(1), pp. 28.

Blake, S. P. (1978). Managing for responsive research and development. WH Freeman.

Bleecker, J. (2009). Design fiction. A short essay on design, science, fact and fiction. Near Future Laboratory.

Boca, S., Gentile, A., Ruggieri, S., & Sorce, S. (2013, July). An evaluation of HCI and CMC in information systems within Highly Crowded Large Events. In Complex, Intelligent, and Software Intensive Systems (CISIS), 2013 Seventh International Conference on (pp. 600-604). IEEE.

Brown, A.L. (1992) 'Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings', *The journal of the learning sciences*, 2(2), pp. 141-178.

Brown, T. (2009) Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business, New York, USA.

Buisine, S., Guegan, J., Barré, J., Segonds, F. and Aoussat, A. (2016) 'Using avatars to tailor ideation process to innovation strategy', *Cognition, Technology & Work*, 18(3), pp. 583-594.

Castillo-Montoya, M. (2016) Preparing for interview research: The interview protocol refinement framework. *The Qualitative Report*, *21*(5), pp.811-831.

Chan, S. and Cope, A. (2015) 'Strategies against Architecture: Interactive Media and Transformative Technology at the Cooper Hewitt, Smithsonian Design Museum', *Curator: The Museum Journal*, 58(3), pp. 352-368.

Checkland, P. (1981) 'Systems Thinking, Systems Practice: Includes a 30-Year Retrospective'.

Chasanidou, D., Gasparini, A. and Lee, E. (2014) 'Design Thinking Methods and Tools for Innovation in Multidisciplinary Teams', *Workshop Innovation in HCI. Helsinki, Finland: NordiCHI.* , 27-30.

Chasanidou, D., Gasparini, A.A. and Lee, E. (2015) 'Design thinking methods and tools for innovation', *International Conference of Design, User Experience, and Usability.* Springer, 12-23.

Cope, D. G. (2014, January) 'Methods and meanings: credibility and trustworthiness of qualitative research.' In *Oncology nursing forum* (Vol. 41, No. 1).

Cooper, A. (1999). The inmates are running the asylum:[Why high-tech products drive us crazy and how to restore the sanity](Vol. 261). *Sams Indianapolis*.

Creswell, J. W. (2007) *Qualitative inquiry and research design: Choosing among five approaches* (2nd ed.). Thousand Oaks, CA: Sage.

Crosier, A. and Handford, A. (2012) 'Customer Journey Mapping as an Advocacy Tool for Disabled People A Case Study', *Social Marketing Quarterly,* 18(1), pp. 67-76.

Cross, N. (2007). From a design science to a design discipline: Understanding designerly ways of knowing and thinking. *Design research now*, 41-54.

Coyle, G. and Exelby, D. (2000) 'The validation of commercial system dynamics models', *System Dynamics Review,* 16(1), pp. 27-41.

Dahl, K., Chattopadhyay A. and Gorn, G.J. (2001) The importance of visualization in concept design. *Design Studies*, 22(1), pp.5-26.

D'Ambra, A., Amenta, P. and Lucadamo, A. (2018) Analyzing Customer Requirements to Select a Suitable Service Configuration Both for Users and for Company Provider. *Social Indicators Research*, pp.1-12.

Della Spina, L. (2018) The integrated evaluation as a driving tool for cultural-heritage enhancement strategies. In *Smart and Sustainable Planning for Cities and Regions: Results of SSPCR 2017 2* (pp. 589-600). Springer International Publishing.

Denardo, A.M., 2002. Using Nvivo to analyze qualitative data.

Derby Museums (2014) Derby-Museums-HCDHandbook.pdf [Online]. Derby Museum. Available from: https://www.derbymuseums.org/wpcontent/uploads/2016/01/Derby-Museums-HCDHandbook.pdf [Accessed 25 September 2018].

Dix, A., Finlay, J., Abowd, G. & Beale, R. (1997). *Human-Computer Interaction*, (2nd Ed.). New York: Prentice Hall.

Dragoni, M., Tonelli, S. and Moretti, G. (2017) 'A Knowledge Management Architecture for Digital Cultural Heritage', *Journal on Computing and Cultural Heritage (JOCCH)*, 10(3), pp. 15.

Drury-Grogan, M.L., Conboy, K. and Acton, T. (2017) 'Examining decision characteristics and challenges for agile software development', Journal of Systems and Software, 131, pp.248-265.

Dubberly, H. (2008). ON MODELING Design in the age of biology: shifting from a mechanical-object ethos to an organic-systems ethos. *interactions*, *15*(5), pp.35-41.

Edelson, D.C. (2002) 'Design research: What we learn when we engage in design', *The Journal of the Learning sciences*, 11(1), pp. 105-121.

Elliott, N. and Lazenbatt, A. (2005) How to recognise a 'quality' grounded theory research study. Australian Journal of Advanced Nursing, 22(3), pp.48.

Evans, G. (2013) Cuts survey 2013, In: Museums association. Available at: www.museumsassociation.org (Accessed: Jan/13 2015).

Falk, J.H. and Dierking, L.D. (2016) *The museum experience revisited*. Routledge.

Fern, E.F. (2001) *Advanced Focus Group Research.* SAGE Publications.

Fichter, D. and Wisniewski, J. (2015) 'Customer Journey Mapping', *Online Searcher*, 39(4), pp. 74.

Floris, A., Atzori, L. and Ginesu, G. (2014) 'Addressing un-interoperability issues in QoE models: Is a layered modelling effective?', *Communications Workshops (ICC), 2014 IEEE International Conference on.* IEEE, pp. 563-568.

Forlizzi, J., & Battarbee, K. (2004, August). Understanding experience in interactive systems. In *Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques* ACM, pp. 261-268.

Fors, V. (2013). Teenagers' Multisensory Routes for Learning in the Museum: Pedagogical Affordances and Constraints for Dwelling in the Museum. *The Senses and Society*, *8*(3), pp. 268-289.

Forrester, J. (1961) 'Industrial Dynamics', Cambridge, MA: MIT Press .

Forrester, J.W. (1997) 'Industrial dynamics', *Journal of the Operational Research Society*, 48(10), pp. 1037-1041.

Forrester, J.W. and Senge, P.M. (1996) Tests for building confidence in system dynamics models. *Modelling for Management: Simulation in Support of Systems Thinking*, 2, 414-434.

Freeman, T. (2006) 'Best practice'in focus group research: making sense of different views. *Journal of advanced nursing*, *56*(5), pp.491-497.

García, L. M., Deserti, A., & Teixeira, C. (2013, December) Service design tools as frameworks in the generation of business ideas an action research case study. In *Design Management Symposium (TIDMS), 2013 IEEE Tsinghua International* (pp. 338-344). IEEE.

Garrett, J.J., Street, N.R.E., Straiger, A.H. and Scott, K., (2010) The Elements of User Experience: User-Centered Design for the Web and Beyond.

Garrett, J.J. (2010) The elements of user experience: user-centered design for the web and beyond. Pearson Education.

Gass, S.I. (1983) 'Decision-Aiding Models: Validation, Assessment, and Related Issues for Policy Analysis', *Operations research*, 31(4), pp. 603-631.

Gentile, A., Andolina, S., Massara, A., Pirrone, D., Russo, G., Santangelo, A., and Sorce, S. (2011, October). A multichannel information system to build and deliver rich user-experiences in exhibits and museums. In *Broadband and Wireless Computing, Communication and Applications (BWCCA), 2011 International Conference on* IEEE, (pp. 57-64).

Glaser, B.G. and Strauss, A.L. (1967) 'The discovery of grounded theory: strategies for qualitative theory', *New Brunswick: Aldine Transaction*.

Gurteen, D. (1998) 'Knowledge, creativity and innovation. Journal of knowledge Management', 2(1), pp.5-13.

Gregor, S. (2006) The nature of theory in information systems. MIS quarterly, pp. 611-642.

Gregor, S. & Hevner, A.R. (2013) Positioning and presenting design science research for maximum impact. MIS Quarterly: Management Information Systems, 37(2), pp. 337-355.

Gronemann, S. T. (2017). Portable Tablets in Science Museum Learning: Options and Obstacles. *Journal of Science Education and Technology*, *26*(3), 309-321.

Hartson, R. and Pyla, P.S. (2012) *The UX Book: Process and guidelines for ensuring a quality user experience.* Elsevier.

Hassenzahl, M. (2008) 'User experience (UX): towards an experiential perspective on product quality', *Proceedings of the 20th Conference on l'Interaction Homme-Machine.* ACM, pp.11-15.

Hauan, N. P., DeWitt, J., & Kolstø, S. D. (2017). Proposing an evaluation framework for interventions: focusing on students' behaviours in interactive science exhibitions. *International Journal of Science Education, Part B, 7*(2), 103-120.

Heath, H. and Cowley, S. (2004) 'Developing a grounded theory approach: a comparison of Glaser and Strauss', *International journal of nursing studies*, 41(2), pp. 141-150.

Hegeman, J. (2012) *Mapping the Journey*. UX Lisbon, Lisbon.

Hekkert, P. (2006) Design aesthetics: principles of pleasure in design. *Psychology science*, *48*(2), 157.

Hevner, A.R. (2007) A three cycle view of design science research. *Scandinavian Journal of Information Systems*, 19(2), p.4.

Hevner, A., & Chatterjee, S. (2010). *Design research in information systems: theory and practice* (Vol. 22). Springer Science & Business Media.

Hevner, A.R., March, S.T., Park, J. and Ram, S. (2004) 'DESIGN SCIENCE IN INFORMATION SYSTEMS RESEARCH.', *MIS Quarterly*, 28(1), pp.75-105.

Hinrichs, U., Schmidt, H. and Carpendale, S. (2008) 'EMDialog: Bringing information visualization into the museum', *IEEE Transactions on Visualization and Computer Graphics,* 14(6), pp. 1181-1188.

Hughes, K. and Moscardo, G. (2017) 'Connecting with New Audiences: Exploring the Impact of Mobile Communication Devices on the Experiences of Young Adults in Museums', *Visitor Studies,* 20(1), pp. 33-55.

Ives, B. and Olson, M.H. (1984) User involvement and MIS success: A review of research. *Management science*, *30*(5), pp.586-603.

Juan, S., Hui, D. and Pengji, H. (2018) Simulation on College Students Crisis Behavior Intervention Model on SD. *Journal of Tianjin University (Social Sciences)*, (1), p.16.

Junior, P. T. A., and Filgueiras, L. V. L. (2005, October) 'User modelling with personas'. In *Proceedings of the 2005 Latin American conference on Human-computer interaction* ACM, (pp. 277-282).

Karat, J. (1997) 'Evolving the scope of user-centered design', *Communications of the ACM,* 40(7), pp. 33-38.

Kelly, A.E. and Lesh, R.A. (2000) 'Handbook of Research Design in Mathematics and Science Education.'

Kemp, S. (2017) 'Design museum futures: Catalysts for education', *Futures,* 94, pp. 59-75.

Kim, D.H. (1993) 'Guidelines for drawing causal loop diagrams', *The Systems Thinker,* 3(1), pp. 2.

Kiourt, C., Pavlidis, G., Koutsoudis, A. and Kalles, D. (2017) 'Realistic Simulation of Cultural Heritage', *International Journal of Computational Methods in Heritage Science (IJCMHS),* 1(1), pp. 10-40.

Kitzinger, J. (1995) 'Qualitative research. Introducing focus groups', *BMJ: British Medical Journal (Clinical research ed.),* 311(7000), pp. 299-302.

Kleindorfer, G.B., O'Neill, L. and Ganeshan, R. (1998) Validation in simulations: Various positions in the philosophy of science. *Management Science,* 44(8), pp.1087–1099.

Kocsis, A., Barnes, C., and Kenderdine, S. (2012) Digital Mediation and Museum Space. *Interiors*, *3*(1-2), pp.107-125.

Krueger, R. A., and Casey, M. A. (2009) Developing a questioning route. In *Focus groups: A practical guide for applied research* (pp. 35-60). Thousand Oaks, CA: Sage.

Krippendorff, K. (2006). The Semantic Turn, a new foundation for design, 2006. *New York*.

Kunc, M. (2016) 'System dynamics: a behavioral modeling method', Proceedings of the 2016 Winter Simulation Conference. IEEE Press, pp. 53-64.

Kuechler, B. and Vaishnavi, V. (2008) 'On theory development in design science research: anatomy of a research project'. *European Journal of Information Systems*, 17(5), pp.489-504.

Kuniavsky, M. (2010) *Smart things: ubiquitous computing user experience design.* Elsevier.

Laghari, K.U.R. and Connelly, K. (2012) 'Toward total quality of experience: A QoE model in a communication ecosystem', *Communications Magazine, IEEE*, 50(4), pp. 58-65.

Laker, L.F., Torabi, E., France, D.J., Froehle, C.M., Goldlust, E.J., Hoot, N.R., Kasaie, P., Lyons, M.S., Barg-Walkow, L.H. and Ward, M.J. (2018) 'Understanding emergency care delivery through computer simulation modeling', *Academic Emergency Medicine*, 25(2), pp. 116-127.

Lankshear, A.J. (1993) 'The use of focus groups in a study of attitudes to student nurse assessment', *Journal of advanced nursing*, 18(12), pp. 1986-1989.

Lee, N., Saunders, J. and Goulding, C. (2005) 'Grounded theory, ethnography and phenomenology: A comparative analysis of three qualitative strategies for marketing research', *European journal of Marketing*, 39(3/4), pp. 294-308.

Lemon, K.N. and Verhoef, P.C. (2016) 'Understanding customer experience throughout the customer journey', *Journal of Marketing*, *80*(6), pp.69-96.

Leung, L. (Ed.). (2008) *Digital Experience Design: ideas, industries, interaction*. Intellect Books.

Macdonald, S. (2011) Leveraging heritage: public-private, and third-sector partnerships for the conservation of the historic urban environment. *ICOMOS 17th General Assembly, Paris, France*.

Maiden Castle. (2015) History of Maiden Castle, English Heritage [Online] Available at: http://www.english-heritage.org.uk/visit/places/maiden-castle/history/ (Last Accessed 10 April. 2018)

Maguire, M. (2001) Methods to support human-centred design. *International Journal of Human-Computer Studies*, 55(4), pp.587-634.

March, S.T. and Smith, G.F. (1995) 'Design and natural science research on information technology', Decision Support Systems, 15(4), pp. 251-266.

Marcus, A. (2006) 'Cross-cultural user-experience design', in Diagrammatic representation and inference. Springer, pp. 16-24.

Marcus, A. and Baradit, S. (2015) 'Chinese user-experience design: an initial analysis', in *Design, User Experience, and Usability: Users and Interactions.* Springer, pp. 107-117.

Marty, P.F. (2008) 'Museum websites and museum visitors: digital museum resources and their use', *Museum Management and Curatorship*, 23(1), pp. 81-99.

Mason, M. (2016) 'The MIT Museum Glassware Prototype: Visitor Experience Exploration for Designing Smart Glasses', *Journal on Computing and Cultural Heritage (JOCCH)*, 9(3), pp. 12.

Maxwell, J. (2013) *Qualitative research design: An interactive approach* (3rd ed.). Thousand Oaks, CA: Sage.

Mayhew, D (1999) *The Usability Engineering Lifecycle.* Morgan Kaufmann.

Marquez, J.J., Downey, A. and Clement, R. (2015) 'Walking a mile in the user's shoes: Customer journey mapping as a method to understanding the user experience', *Internet Reference Services Quarterly*, 20(3-4), pp. 135-150.

McDermott, F., Clarke, L., Hornecker, E., and Avram, G. (2013) Challenges and opportunities faced by cultural heritage professionals in designing interactive exhibits. *Proceedings of NODEM*, pp. 19-26.

McKercher, B., Ho, P.S. and Du Cros, H. (2005) Relationship between tourism and cultural heritage management: evidence from Hong Kong. *Tourism management*, *26*(4), pp.539-548.

Meroni, A. and Sangiorgi, D. (2016) *Design for services*. Routledge.

Merriam, S. B. (2009) *Qualitative research: A guide to design and implementation*. San Francisco, CA: Jossey-Bass.

Mgbemena, C., Bell, D. and Saleh, N. (2016) A Data-driven Methodology for Agent Based Exploration of Customer Retention. In *Distributed Simulation and Real Time Applications (DS-RT), 2016 IEEE/ACM 20th International Symposium on* (pp. 108-111). IEEE.

Miles, M.B. and Huberman, A.M. (1994) 'Qualitative data analysis: An expanded sourcebook'.

Möller, S., Engelbrecht, K., Kühnel, C., Wechsung, I. and Weiss, B. (2009) 'A taxonomy of quality of service and quality of experience of multimodal human-machine interaction', *Quality of Multimedia Experience, 2009. QoMEx 2009. International Workshop on.* IEEE, pp.7-12.

Moore, C. (2015) Embracing Change: Museum Educators in the Digital Age. *Journal of Museum Education*, *40*(2), 141-146.

Morecroft, J.D. (2015) *Strategic modelling and business dynamics: a feedback systems approach.* John Wiley & Sons.

Morgan, D. L. (1996) *Focus groups as qualitative research* (Vol. 16). Sage publications.

Mortara, M., Catalano, C.E., Bellotti, F., Fiucci, G., Houry-Panchetti, M. and Petridis, P. (2014) Learning cultural heritage by serious games. *Journal of Cultural Heritage*, *15*(3), pp.318-325.

Nenonen, S., Rasila, H., Junnonen, J.M. and Kärnä, S. (2008) Customer Journey–a method to investigate user experience. In *Proceedings of the Euro FM Conference Manchester*, pp.54-63.

Neumann, A. (2008, Fall) The craft of interview research. Graduate course at Teachers College, Columbia University, New York, NY.

Newell, A. and Simon, H.A. (1976) 'Computer Science as Empirical Inquiry: Symbols and Search', *Communications*. Nielsen, J. (1994, April) Usability inspection methods. In *Conference companion on Human factors in computing systems* (pp. 413-414). ACM.

North, M.J. and Macal, C.M. (2007) *Managing business complexity: discovering strategic solutions with agent-based modeling and simulation.* Oxford University Press.

North, M.J., Macal, C.M., Aubin, J.S., Thimmapuram, P., Bragen, M., Hahn, J., Karr, J., Brigham, N., Lacy, M.E. and Hampton, D. (2010) 'Multiscale agent-based consumer market modeling', *Complexity,* 15(5), pp. 37-47.

Noble, H. and Smith, J. (2015) 'Issues of validity and reliability in qualitative research', *Evidence-based nursing,* 18(2), pp. 34-35.

Nunamaker Jr, J.F., Chen, M. and Purdin, T.D. (1990) 'Systems development in information systems research', *Journal of Management Information Systems,* 7(3), pp. 89-106.

Oates, B.J. (2005) *Researching information systems and computing.* Sage.

Oliva, R. (2003) 'Model calibration as a testing strategy for system dynamics models', *European Journal of Operational Research,* 151(3), pp. 552-568.

Ortbal, K., Frazzette, N. and Mehta, K. (2016) 'Stakeholder Journey Mapping: An Educational Tool for Social Entrepreneurs', *Procedia engineering,* 159, pp. 249-258.

Owen, C.L. (1998) 'Design research: Building the knowledge base', *Design Studies,* 19(1), pp. 9-20.

Pallud, J. (2017) 'Impact of interactive technologies on stimulating learning experiences in a museum', *Information & Management,* 54(4), pp. 465-478.

Pallud, J. and Straub, D.W. (2014) 'Effective website design for experience-influenced environments: The case of high culture museums', *Information & Management,* 51(3), pp. 359-373.

Parry, R. (2005) 'Digital heritage and the rise of theory in museum computing', *Museum Management and Curatorship,* 20(4), pp. 333-348.

Parry, R. (2010) Museums in a Digital Age. Leicester Readers in Museum Studies. *UK, USA, Canada: Routledge*.

Pedersen, I., Gale, N., Mirza-Babaei, P. and Reid, S. (2017) 'More than Meets the Eye: The Benefits of Augmented Reality and Holographic Displays for Digital Cultural Heritage', *Journal on Computing and Cultural Heritage (JOCCH),* 10(2), pp. 11.

Peffers, K., Tuunanen, T., Rothenberger, M.A. and Chatterjee, S. (2007) 'A design science research methodology for information systems research', *Journal of Management Information Systems,* 24(3), pp. 45-77.

Perkis, A. (2013) 'A QoE cross layer approach to model media experiences', *IEEE COMSOC MMTC E-Letter,* 8(2), pp. 6-8.

Peters, D.H. (2014) 'The application of systems thinking in health: why use systems thinking?', *Health Research Policy and Systems,* 12(1), pp. 51.

Pine, B. J., and Gilmore, J. H. (1998) Welcome to the experience economy. Harvard business review, 76, pp. 97-105.

Porcellato, L., Dughill, L. and Springett, J. (2002) 'Using focus groups to explore children's perceptions of smoking: reflections on practice', Health Education, 102(6), pp. 310-320.

Preece, J., Rogers, Y. and Sharp, H. (2002) *Interaction design: beyond human-computer interaction,* J. Wiley & Sons, New York, NY

Price, S., Sakr, M., and Jewitt, C. (2016) Exploring whole-body interaction and design for museums. *Interacting with Computers*, *28*(5), pp. 569-583.

Pruitt, J., and Adlin, T. (2006) The persona lifecycle: Keeping people in mind throughout the design process.

Pruitt, J. and Grundin, J. (2003) Personas: Practice and Theory. In: *Proceedings of the 2003 Conference on Designing for User Experiences*, pp. 1-15.

Purao, S. (2002) Design research in the technology of information systems: Truth or dare. *GSU Department of CIS Working Paper*, pp. 45-77.

Qudrat-Ullah, H. (2012) 'On the validation of system dynamics type simulation models', *Telecommunication Systems*, 51(2-3), pp. 159-166.

Qudrat-Ullah, H. (2010) 'Perceptions of the effectiveness of system dynamics-based interactive learning environments: An empirical study', *Computers & Education,* 55(3), pp. 1277-1286.

Rawson, A., Duncan, E. and Jones, C. (2013) The truth about customer experience. *Harvard Business Review*, *91*(9), pp.90-98.

Razzouk, R. and Shute, V. (2012) What is design thinking and why is it important?. *Review of Educational Research*, *82*(3), pp.330-348.

Richards, T. (2002) An intellectual history of NUD* IST and NVivo. *International journal of social research methodology*, *5*(3), pp.199-214.

Rizzo, F. (2011) '12. Co-design versus User Centred Design: Framing the differences', *Notes on Doctoral Research in Design. Contributions from the Politecnico di Milano: Contributions from the Politecnico di Milano,* pp. 125.

Rubin, H. J., and Rubin, I. S. (2012) *Qualitative interviewing: The art of hearing data* (3rd ed.). Thousand Oaks, CA: Sage.

Rubino, I., Barberis, C., Xhembulla, J. and Malnati, G. (2015) 'Integrating a location-based mobile game in the museum visit: Evaluating visitors' behaviour and learning', *Journal on Computing and Cultural Heritage (JOCCH)*, 8(3), pp. 15.

Rwashana, A. S., Nakubulwa, S., Nakakeeto-Kijjambu, M., and Adam, T. (2014)Advancing the application of systems thinking in health: understanding the dynamics of neonatal mortality in Uganda. *Health research policy and systems*, *12*(1), 36.

Sandler, J. (2015) 'What users want: Functional user experience', *Interactive Collaborative Learning (ICL), 2015 International Conference on.* IEEE, pp.355-360.

Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M. and Oliveira, A. (2011, May) Smart cities and the future internet: Towards cooperation frameworks for open innovation. In *The future internet assembly* (pp. 431-446). Springer, Berlin, Heidelberg.

Schmidt, A. and Etches, A. (2012) *User experience (UX) design for libraries.* American Library Association,18.

Senge, P.M. (2006) *Learning for sustainability.* SoL (The Society for Organizational Learning, Incorporated).

Senge, P.M. and Forrester, J.W. (1980) 'Tests for building confidence in system dynamics models', *System dynamics, TIMS studies in management sciences*, 14, pp. 209-228. Shin, D. (2017) *Conceptualizing and measuring quality of experience of the internet of things: Exploring how quality is perceived by users*.

Shostack, G.L. (1984) Designing services that deliver. *Harvard Business Review*, 62(1), pp. 133-139.

Simon, H. (1996) *The Sciences of Artificial*, (3rd Ed.) MIT Press, Cambridge, MA.

Soldani, D., Li, M., and Cuny, R. (2006) QoS and QoE management in UMTS cellular systems. New York: Wiley.

Sonnenberg, C. and Brocke, J. (2012) Evaluation Patterns for Design Science Research Artefacts. *Practical Aspects of Design Science*, pp.71-83.

Smolentsev, A., Cornick, J.E. and Blascovich, J. (2017) 'Using a preamble to increase presence in digital virtual environments', *Virtual Reality*, 21(3), pp. 153-164.

Steel, P. (2013) *english-museums-falling-behind-in-the-digital-revolution*. Available at: http://www.museumsassociation.org/museums-journal/news/03122013-english-museums-falling-behind-in-the-digital-revolution (Accessed: Dec/3 2013).

Sterman, J.D. (2001) 'System dynamics modelling: tools for learning in a complex world', *California management review*, 43(4), pp. 8-25.

Sterman, J.D. (2000) *Business dynamics: systems thinking and modelling for a complex world.*

Stewart, D.W. and Shamdasani, P.N. (2014) *Focus groups: Theory and practice* (Vol. 20). Sage publications.

Stickdorn, M., Schneider, J., Andrews, K., and Lawrence, A. (2011) *This is service design thinking: Basics, tools, cases* (Vol. 1). Hoboken, NJ: Wiley.

Stickdorn, M., and Schneider, J. (2010) The Iterative Process. *This Is Service Design Thinking*, 126.

Stickdorn, M., 2013. a. How does Service Design work. *Stickdorn, M. & Schneider, J.(Eds.)*, pp.120-143.

Stoica, A., and Avouris, N. (2010) An architecture to support personalized interaction across multiple digitally augmented spaces. *International Journal on Artificial Intelligence Tools*, *19*(02), 137-158.

Stokes, R. (2015) *E-marketing: the essential guide to marketing in a digital world.* Fifth edn. Quirk eMarketing (Pty).

Strauss, A. and Corbin, J.M. (1997) *Grounded theory in practice.* Sage.

Strauss, A. and Corbin, J. (1998) 'Basics of qualitative research: Procedures and techniques for developing grounded theory'.

Sumari, S., Ibrahim, R., Zakaria, N.H. and Ab Hamid, A.H. (2013) Comparing three simulation model using taxonomy: System dynamic simulation, discrete event simulation and agent based simulation. *International Journal of Management Excellence*, *1*(3), pp.54-59.

Sweeney, L.B. and Sterman, J.D. (2000) 'Bathtub dynamics: initial results of a systems thinking inventory', *System Dynamics Review*, 16(4), pp. 249-286.

Tako, A.A. and Kotiadis, K. (2015) 'PartiSim: A multi-methodology framework to support facilitated simulation modelling in healthcare', *European Journal of Operational Research*, 244(2), pp. 555-564.

Takeda, H., Veerkamp, P. and Yoshikawa, H. (1990) 'Modeling design process', *AI magazine*, 11(4), pp. 37.

Thomas, S., and Mintz, A. (1998) *Virtual and the Real: Media in the Museum*. American Association of Museums.

Temkin, B. D. (2010). Mapping The Customer Journey. *Forrester Research*.

Vaishnavi, V. and Kuechler, W. (2004) 'Design research in information systems'.

Varvin, G., Fauskerud, H., Klingvall, I., Stafne-Pfisterer, L., Hansen, I.S. and Johansen, M.R. (2014) 'The journey as concept for digital museum design', *Digital Creativity*, 25(3), pp. 275-282.

Venable, J.R. (2015) 'Five and Ten Years on: Have DSR Standards Changed?', *International Conference on Design Science Research in Information Systems.* Springer, pp.264-279.

Venable, J., Pries-Heje, J. and Baskerville, R. (2016) FEDS: a framework for evaluation in design science research. European Journal of Information Systems, 25(1), 77-89.

Venable, J., Pries-Heje, J. and Baskerville, R. (2012, May) A comprehensive framework for evaluation in design science research. In *International Conference on Design Science Research in Information Systems* (pp. 423-438). Springer, Berlin, Heidelberg.

Vermeeren, A.P., Roto, V. and Väänänen, K. (2016) 'Design-inclusive UX research: design as a part of doing user experience research', *Behaviour and Information Technology,* 35(1), pp. 21-37.

Vosinakis, S. and Tsakonas, Y. (2016) 'Visitor experience in google art project and in second life-based virtual museums: a comparative study.', *Mediterranean Archaeology and Archaeometry,* 16(5).

Wang, Y., Stash, N., Sambeek, R., Schuurmans, Y., Aroyo, L., Schreiber, G. and Gorgels, P. (2009) 'Cultivating personalized museum tours online and on-site', *Interdisciplinary Science Reviews,* 34(2-3), pp. 139-153.

Weber, R.P. (1990) *Basic content analysis.* Sage.

West, M. A., Borrill, C. S., Dawson, J. F., Brodbeck, F., Shapiro, D. A., and Haward, B. (2003) Leadership clarity and team innovation in health care. *The Leadership Quarterly*, *14*(4-5), 393-410.

Willcock, I. (2017, July) Tools for Designing Experience: Repurposing Design Resources for the Emerging Experience Economy. In *Proceedings of the conference on Electronic Visualisation and the Arts* (pp. 219-226). BCS Learning and Development Ltd.

Wiliam, D. and Black, P. (1996) 'Meanings and consequences: a basis for distinguishing formative and summative functions of assessment?', *British Educational Research Journal,* 22(5), pp. 537-548.

Williams, B. and Hummelbrunner, R. (2010) *Systems concepts in action: a practitioner's toolkit.* Stanford University Press.

Winter, R. (2008) 'Design science research in Europe', *European Journal of Information Systems,* 17(5), pp. 470-475.

Wolstenholme, E.F. (1990) *System enquiry: a system dynamics approach.* John Wiley & Sons, Inc.

Zikmund, W.G. (1997) Exploring marketing research, 6th edn, Dryden Press, London; Fort Worth.

Appendix A - Ethics Approval

School of Information Systems, Computing and Mathematics
David Gilbert, Head of School, Professor of Computing
Martin Shepperd, Head of Information Systems and Computing
Steven Noble, Head of Mathematical Science, Professor of Mathematics

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Date: 08/04/2014

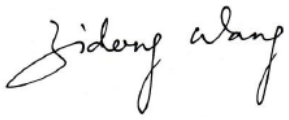
STATEMENT OF ETHICS APPROVAL

Proposer: Nada Nasser Al-Subhi

Title: Mobile Human-Data Interaction within a Historical Landscape

The school's research ethics committee has considered the proposal recently submitted by you. Acting under delegated authority, the committee is satisfied that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that you will adhere to the terms agreed with participants and to inform the committee of any change of plans in relations to the information provided in the application form.

Yours sincerely,



Professor Zidong Wang
Chair of the Research Ethics Committee
SISCM

Appendix B - Participants Information Sheet

Information Sheet

Introduction:

My name is Nada Nasser Al-Subhi. I am a Ph.D. candidate studying at Brunel University. I am looking at the effectiveness of using Media elements technologies in digital services to enhance heritage and cultural experience. I have selected you to speak with me today because you have been identified as someone who has a great deal to share about the experience of the museum, the experience of the visitors and the availability of media to the visitors during their visit or journey. My research project as a whole attempts to explore and analyse how design and system thinking tools can re-shape the role and mission of museums and historic locations. Importantly, my study does not aim to evaluate your techniques or profession. Rather, I'm trying to learn more about currently employed media technology and the visitor overall experience, and hopefully learn about your experience and how best can we enhance the visitors experience using digital services and simulation tools.

Introductory Protocol:

To facilitate note-taking, the researcher would like to use audio recording of our conversations today. I would kindly request you to sign the release form. Please note that, only researchers on the project will be privy to the recordings which will be eventually destroyed after they are transcribed. In addition, you will be required to sign a form devised to meet our ethic approval form. Principally, this document states that: (1) all information will be held in a confidential manner and (2) your participation is voluntary and you may stop at any time if you feel uncomfortable. Thank you for your agreeing to participate. I have planned for this interview to last no longer than an hour. During this time, I have several questions that I would like to cover. In the case where time begins to run short, I may have to interrupt you in order to push ahead and complete this line of questioning.

If you have any concerns or complaints regarding this project please contact siscm.srec@brunel.ac.uk or Professor Zidong Wang, Tel. No. 01895 266021.

Appendix C - Consent Form

Brunel UNIVERSITY LONDON

CONSENT FORM

The participant should complete the whole of this sheet him/herself

Please tick the appropriate box

	YES	*NO*
Have you read the Research Participant Information Sheet?	☐	☐
Have you had an opportunity to ask questions and discuss this study?	☐	☐
Have you received satisfactory answers to all your questions?	☐	☐
Who have you spoken to?		
Do you understand that you will not be referred to by name in any report concerning the study?	☐	☐
Do you understand that you are free to withdraw from the study:		
• at any time	☐	☐
• without having to give a reason for withdrawing?	☐	☐
I agree to my interview being recorded.	☐	☐
I agree to the use of non-attributable direct quotes when the study is written up or published.	☐	☐
Do you agree to take part in this study?	☐	☐

Signature of Research Participant:

Name in capitals: Date:

Witness statement

I am satisfied that the above-named has given informed consent.

Witnessed by:

Name in capitals: Date:

Appendix D - Intreview Protocol

iSEE Stakeholder Interview Questions (Recorded interview – Open Questions)

Interviewee: _____

Interviewer: _____

Interviewee role: _____

Date/Time of interview: _____

Place of interview: _____

Part 1- Interviewee Background

1.1 How long have you been in your present position?

1.2 Do you work at the Dorset County Museum?

1.3 What is your educational background/field of study?

1.4 Briefly describe your role and how it relates to visitors' experience (if appropriate).

Part 2- Museum Connected Interviewees – Aim: Context

2.1 How is the museum trying to improve visitors' experience? Is it working?

2.2 What resources are available to the museum for improving visitor's experience?

2.3 What technologies could improve visitor experience?

Part 3- Museum Workers – Aim: Media use in the museum

3.1 What is the most attractive part of the museum for the visitor?

3.2 What are the ages (and numbers) of people visiting the museum (or your part of the museum)?

3.3 What kind of multimedia do you offer to visitors? Where is this media stored?

3.4 What kinds of multimedia are used as visitors journey around the museum?

3.5 Is there any specific links (using technology) to the history of Maiden castle? If yes, elaborate more.

3.6 Do you see any opportunities for further use of technology or multimedia for visitors?

3.7 It has been highlighted in the news that the UK is lacking museums and culture heritage related technologies. What is your view?

3.8 What types of multimedia are most likely to interest visitors (e.g. video on screens, mobile content or other)?

3.9 If you could develop a mobile application for use at Maiden Castle, what would your preference be for its look and feel, features, content?

Part 4- All - Aim: Experience Description

4.1 What challenges does the cultural sector face when adopting new technologies?

4.2 Does the sector attempt to personalise multimedia to specific visitor groups?

4.3What specific stories about Maiden Castle need to be told?

4.4 How would you present these stories to the visitor on a mobile device?

4.5 How would you like to design such a mobile interface (if working with a designer, computer programmer etc.)?

4.6 How would you link your story to the physical environment (e.g. if I was walking on Maiden Castle)

Table 1: Interview Protocol Matrix

		Background Information: (The history and background of the research context)	Research Issue 2: (The motivation for considering technologies in the historical landscape)	Research Issue 3: (How users will benefit from the technology and its efficiency and effectiveness	Research Issue 4: (How users interpret experience and journey)	Research Issue 5: (How users collect and save objects, e.g. database strategies)	Research Issue 6: (The organisational context, e.g. structure, users' jobs and autonomy)
Interview Questions Part 1	Q 1.1 How long have you been in your present position?	X					
	Q 1.2 Do you work at the Dorset County Museum?	X					
	Q 1.3 What is your educational background/field of study?	X					X
	Q 1.4 Briefly describes your role and how it relates to visitors' experience (if	X					X

	appropriate).						
Interview Questions Part 2	Q2.1 How is the museum trying to improve visitors' experience? Is it working?	X	X	X	X		
	Q2.2 What resources are available to the museum for improving visitor's experience?		X		X		
	Q2.3 What technologies could improve visitor experience?		X	X	X		
Interview Questions Part 3	Q3.1 What is the most attractive part of the museum for the visitor?	X	X				
	Q3.2 What are the ages (and numbers) of people visiting the museum (or your part of the museum)?	X				X	X
	Q3.3 What kind of multimedia do you offer to visitors? Where is this media stored?			X		X	
	Q3.4 What kinds of multimedia are used as visitors' journey around the museum?		X		X	X	

	Q3.5 Is there any specific links (using technology) to the history of Maiden castle? If yes, elaborate more.		X	X			
	Q3.6 Do you see any opportunities for further use of technology or multimedia for visitors?		X	X			
	Q3.7 It has been highlighted in the news that the UK is lacking museums and culture heritage related technologies. What is your view?	X	X				
	Q3.8 What types of multimedia are most likely to interest visitors (e.g. video on screens, mobile content or other)?		X	X			
	Q3.9 If you could develop a mobile application for use at Maiden Castle, what would your preference be for its look and feel, features, content?		X	X			
Interview Questions Part 4	Q4.1 What challenges does the cultural sector face when adopting new technologies?	X	X	X			

	Q4.2 Does the sector attempt to personalise multimedia to specific visitor groups?		**X**	**X**		**X**	**X**
	Q4.3 What specific stories about Maiden Castle need to be told?	**X**		**X**		**X**	
	Q4.4 How would you present these stories to the visitor on a mobile device?		**X**	**X**	**X**	**X**	
	Q4.5 How would you like to design such a mobile interface (if working with a designer, computer programmer etc.)?		**X**	**X**	**X**	**X**	
	Q4.6 How would you link your story to the physical environment (e.g. if I was walking on Maiden Castle)		**X**	**X**	**X**	**X**	

Appendix E - Sample of Interview Transcription

Project: **UX Museum Research**

Code: **PC3**

Interviewer: **Nidaa Al Subhi**

Length of interview: **40 minutes**

1.1 I joined the museum last July and have been here two days a week since then.

1.2 Yeah, I fundraise for the museum which means I look at all avenues regarding fundraising options for the museum to pursue to help with various projects that we are embarking on at the moment.

1.3 I have been studying fundraising for the last 25 years and I have been a fundraiser for lots of organisations within the Dorchester field. Dorset County Hospital, basically high valued fundraising options; the last big one was the mammography appeal for which we raised £1 million for the new mammography scanner.

1.4 I also do a lot of volunteer... which means when visitors come into the museum and want a tour I can take them round and guide them through the various collections that we hold within the museum. I have been a member here for the last 18 years and I've also a keen interest in Roman history and archaeology.

2.1 We have 200 volunteers within the museum and we've engaged in a series of volunteers who are eminent in a field of study relevant to the various parts of the museum being given tours within the museum and being available for guidance and information at all times or online or by mail or by contact.

2.2 We currently hold in the exhibition room various exhibitions booked out to 2018 now. Within the museum also we have leaflets and pamphlets and information online regarding all projects and the collections within the museum and outside the museum which currently we only exhibit 3% of the entire collection we own.

2.3 We looked at various... for the future for multimedia visual aids, tactile aids basically like things you can actually touch and feel and watch and magnify so they can actually see the article without just wondering what it looks like.

3.1 The building itself is a design by the Crickmay architects, the front of the building is iconic design, within the museum we have the Victorian gallery which is a copy of the Paris exhibition of I think it was 1846 and the Crystal Palace exhibition was a copy of that hall and we are the only one in I think Europe that's got it.

3.2 We currently engage a lot with schools, colleges, universities and world events, so basically our age group is from four to old. I can't say a final age because there isn't one because that is like our current, in one of our rooms Norrie was the last Hardy Player of Thomas Hardy who unfortunately passed away two years ago and she was 102, so that means, you know, we can't really say what age to finish at because they all come to the museum.

3.3 The multimedia we've got in the Jurassic gallery is where the... skull is, it is a TV interaction for younger people and older people. There is also currently... is some visual aids, as in screens to show the Jurassic coast and basically shows where items within the collections came from. Also there is as I said the pamphlets, leaflets and also verbal information from all the guides working at the museum.

3.4 There is a museum guide leaflet because the museum itself is very big, a lot of people think it's tiny at the front because you go into a TARDIS basically and because of that there is a guided plan, floor plans of the museum to take the visitor around so they don't miss any of it and on top of that we've got connecting leaflets to connect with the various parts of the museum that we're showing off. Like, for example, at the moment we've got the history of women at war down in the big exhibition hall, so we've got the Mabel Stobart leaflets to indicate why she is here, why we've put on the exhibition and of what importance it is to Dorset relevant to its history. We do have an audio facility as well which we use.

3.5 Our link to Maiden Castle is that we've got a lot of visual things within the museum i.e. the skeletons which were found on Maiden Castle. We also indicate the fact that the importance of Maiden Castle is the fact it was the first ever proper research... done and the procedure was invented on Maiden Castle to use throughout the world regarding investigating historical sites or archaeology or surveyance.

3.6 Absolutely. Multimedia, TV screens, interactive video, even interactive goggles that we use now, google glasses and that means you can actually walk around, apps on mobiles, headphones with speaking like the British Museum does but the encouraging thing that I'm interested in at the moment is google glass which means that while you're walking around you can actually have something shown on your glasses which you can see and relate to as in a multimedia centre.

3.7 That's not going on here. We have a huge centre of resources here, all of the people within the museum, who volunteer in the museum, working within the museum have a huge interest in the collections and its collections, so that means it basically knows partly about it, if not we have relevant bodies throughout the museum where we can go to on any of the collections and pieces to find information out or help somebody if they need information back.

3.8 Video, mobile phone, headphone sets, international language sets. Again video glass, you've got actually the objects themselves, you can actually see what you're looking at, ...cases, the fact that people can actually see something for what it really is not dark in a room and also the fact that personal contact with people i.e. stages in the rooms so that means if anything is needed to be discussed any further or is needing more information on there is someone there to contact at the same time.

3.9 Something light, wearable and easy to manage. It's all very well walking around with these sets and headphones but they're quite bulky so you want something that's a bit lighter, something like round your wrist which means you can connect can be Wi-Fi... handsets or earphones and also we did mention google glass. I know it's a... thing but something of that technology so it can actually be Wi-Fi fed, so when you're walking about around the museum there are Wi-Fi throughout the museum to interact you with whatever you're looking at, at the same time.

4.1 I don't ever say the word challenge. I say, how can we do it? I always look at this and say there are so many people in thought process regarding these things that if there is a person found for these of interest to the subject then it will be thought through and basically solved, so the fact that I think challenge is a bit of a strong word. I would look at it as, how can we solve it.

4.2 The sector I take it you mean is the cultural sector. If it is the cultural sector then the entire museum is the cultural body and its collections, so does it personalise itself to specific

groups. Not really because if you can read and write you can actually understand what's going on and also the fact that the museum is so diverse in its collection i.e. fossils or literature or birds and insects or grasses, fabrics, there is so much diverse collections within the museum and you can basically go towards anybody within the sector.

4.3 The principle thing about Maiden Castle is it was actually built and maintained by the... tribe of Dorset native to the county and the area and then they were of course invaded by the Romans and basically integrated within the Roman society and then the majority of the stories about Maiden Castle then go from the Roman period to the present day. The present day is being left out a bit because there seems to be vague knowledge about what the Maiden Castle really looked like before the Romans got here, so I think that's the sort of area because of the importance of Maiden Castle being one of the biggest castles in Europe it could be looked at the fact that, how was it built – well we know that, but what did it really look like. Some of the buildings as well on the castle after the invasion from the Romans, like there was a Roman temple, very vague description of the temple and very vague about the buildings again being on the Maiden Castle considering the historical importance of Maiden Castle I think that could be opened up far more. Also the fact that in relation to Maiden Castle – why was it put there, a lot of people never seem to get that question asked. Why was Maiden Castle put where it was? They could have gone to the hill next door to it and built it up there but they specifically put it where it is, and they built it there. That's a hell of a task to build what they've got there and that's where my questions would be. I look at it often and have walked up there many, many times but why is it here. I don't know.

4.4 Developing our own app to put it on there so they can link in and link to other areas of the county i.e. the Dorset County Museum, basically where we hold the collections and also the relevance of these around the county which hold association with Maiden Castle itself i.e. the long barrows and places like that across Long Bredy barrow that are all connected in some way, shape or form with the Maiden Castle route.

4.5 Very much so, I'd like to be really involved with it, given the fact my passion for the museum is quite evident and the fact is that I do know a lot and the fact that if I don't know I will find out and I have various sources where I can actually go and get the information which I need.

4.6 Previously said that Maiden Castle to walk round is quite a structure, it really is quite something. When you're up there on your own on the top of the wall looking across Dorset then you can see how far they could see, they were well advised when anything was going to happen or invade them, they had full information of what was going on at all times. A full view and great security system when you're going into Maiden Castle itself with the runs that it has, so it could be, you could attack people coming in without being attacked yourself. It's quite interesting and very advanced for its day.

Appendix F - Domain Expert Evaluation Form

Purpose of Domain Expert Evaluation:

- To validate the process framework.
- Evaluate main artefacts.
  - Methods and Models
    - Operationally: ability for the method to be re-used.
    - Generality.
    - Efficiency.
    - Ease of use.

Expert Information	
Date:	
Name (Optional):	
Organization/Institute:	
Position:	
Email:	
Criteria	**Pre-demo questions:**
	1. How do you currently design new experiences for your visitors?
	2. Could you please explain your process for designing experiences? Who participates in this activity?
	During demo questions:
Understand ability	3. Are dynamic journeys (including both journey maps and simulation) understandable?
Understand ability	4. Using the model, can you understand visitor touchpoints and behaviour in different journey phases?
Ease of Use	5. Is the framework easy to use and learn by non-specialists?
	Post demo-questions:
Ease of Use	6. Do you consider the process is easy to use? Why?
Effectiveness	7. Do you think the framework could be used at this museum? Would you explain that further?
Operation ability, usefulness and Practicality	8. Is the HUXSIM framework practical for use across different museums?
	9. Would you add any processes or practices? If so, please explain what and why?

Closing question: Is there anything more you would like to add?

Thank you for your time.

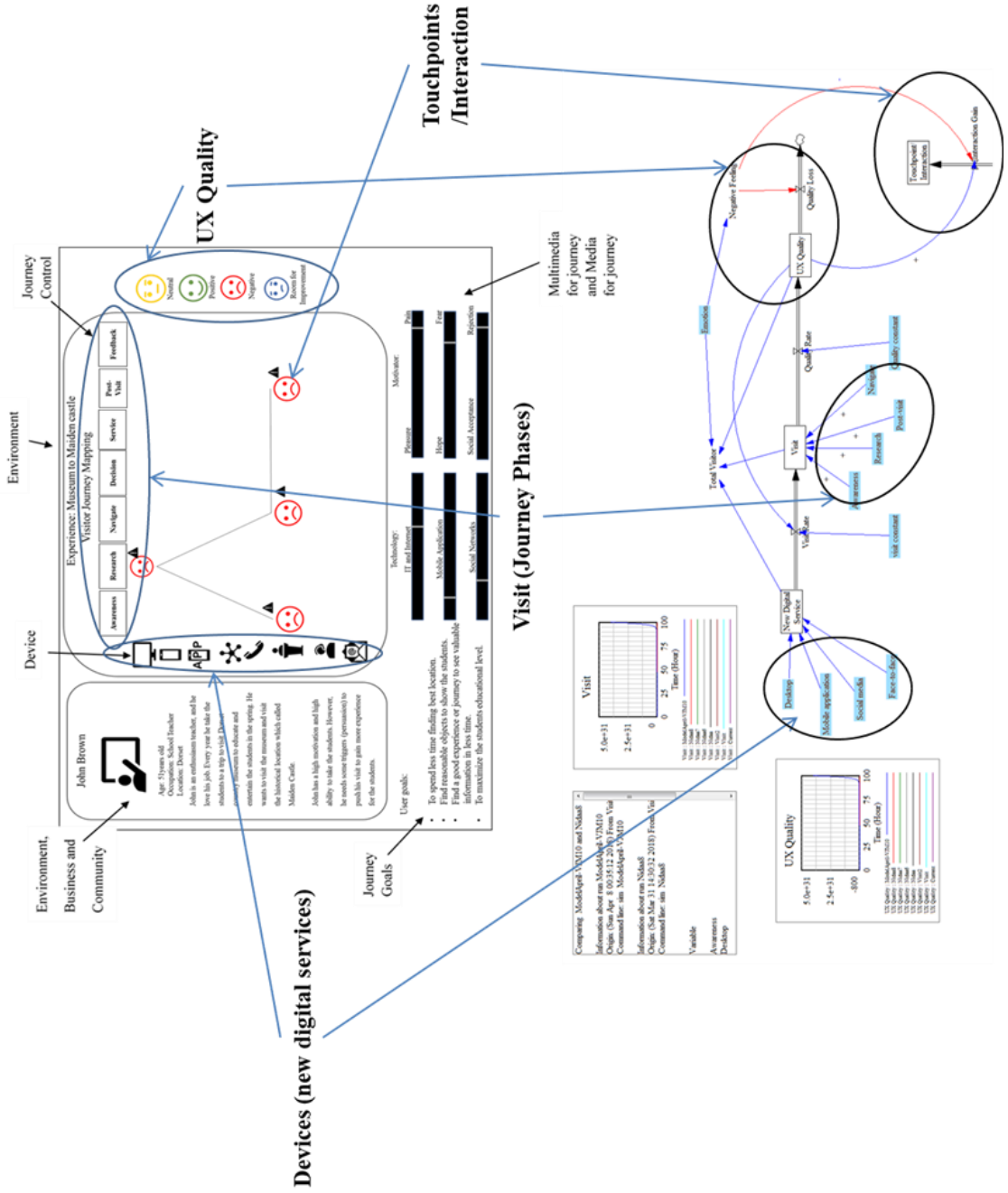
Nidaa Nasser AlSubhi, Ph.D. candidate

Table 1: Expert Interview Protocol Matrix

		Background Information	Understand ability	Operationally	Generality	Efficiency	Ease of Use
Pre-demo questions	Q 1 How do you currently design new experiences for your visitors?	X					
	Q 2 Could you please explain your process for designing experiences? Who participates in this activity?	X					
During Demo questions	Q3 Are dynamic journeys (including both journey maps and simulation) understandable?		X				X
	Q4 Using the model, can you understand visitor touchpoints and behaviour in different journey phases?		X	X		X	X
	Q5 Is the framework easy to use and learn by non-specialists?		X	X	X		X

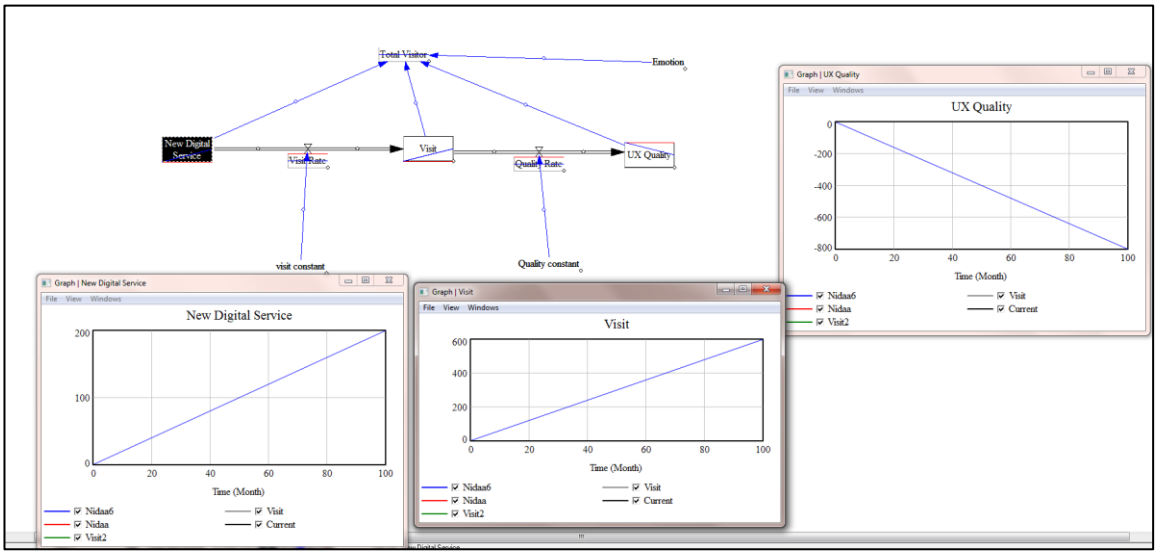
Post Demo questions	**Q6 Do you consider the process is easy to use? Why?**		**X**	**X**			**X**
	Q7 Do you think the framework could be used at this museum? Would you explain that further?		**X**	**X**	**X**	**X**	
	Q8 Is the HUXSIM framework practical for use across different museums?			**X**	**X**		**X**
	Q9 Would you add any processes or practices? If so, please explain what and why?	**X**					

Appendix G - Data Transformation Process



Appendix H - SFM Equations

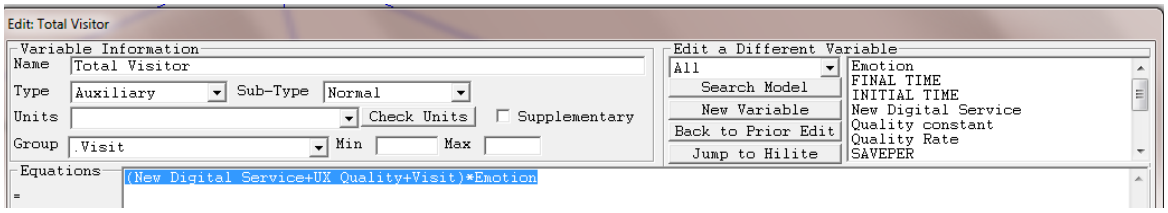
The following output shows that there are three stocks (New digital services, visit and ux quality), two flows (visit rate and quality rate) and four constants (visit constant, quality constant, emotion and total visitor).



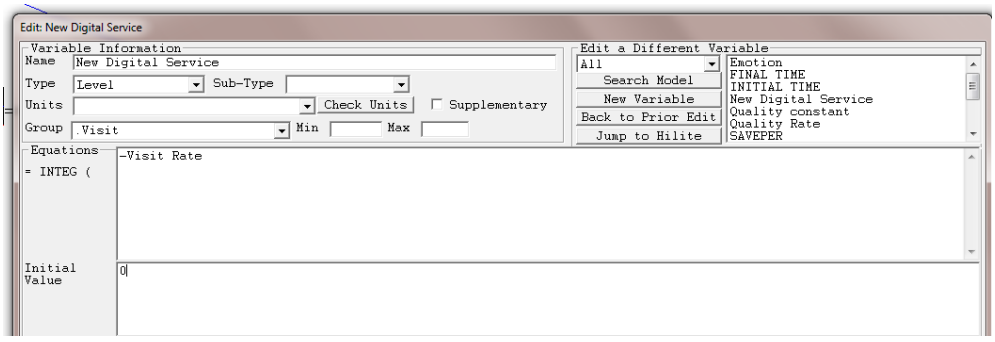
Example of SFM representation

The equations for each are:

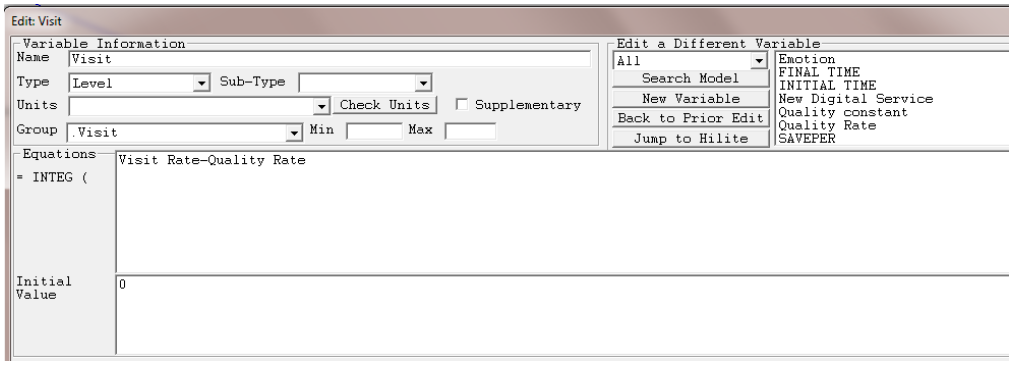
*Total Visitor = (New Digital Service + UX Quality + Visit)*Emotion



New Digital Service = INTEG (-Visit Rate), where the initial value =0, (∫-Visit Rate)



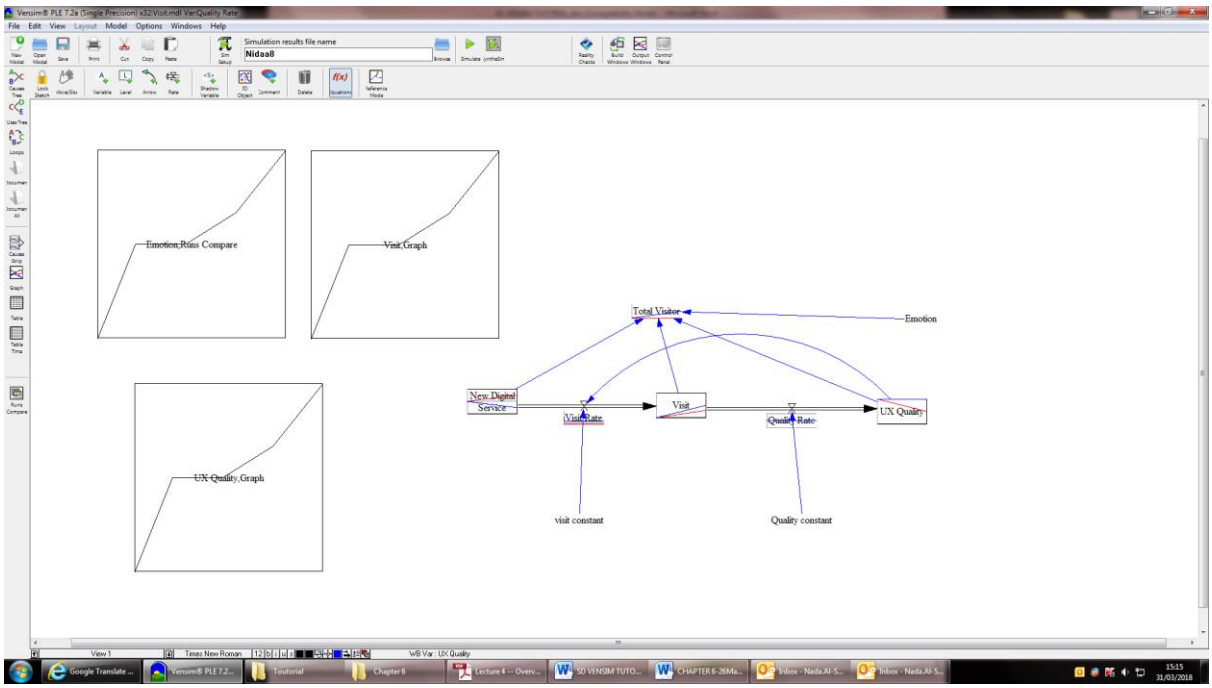
Visit = INTEG (Visit Rate-Quality Rate), where the initial value =0, (∫Visit Rate - Quality Rate).



UX Quality: INTEG (Quality Rate), where the initial value = 0, (∫Quality Rate)
Visit rate: - visit constant
Quality Rate: - quality constant

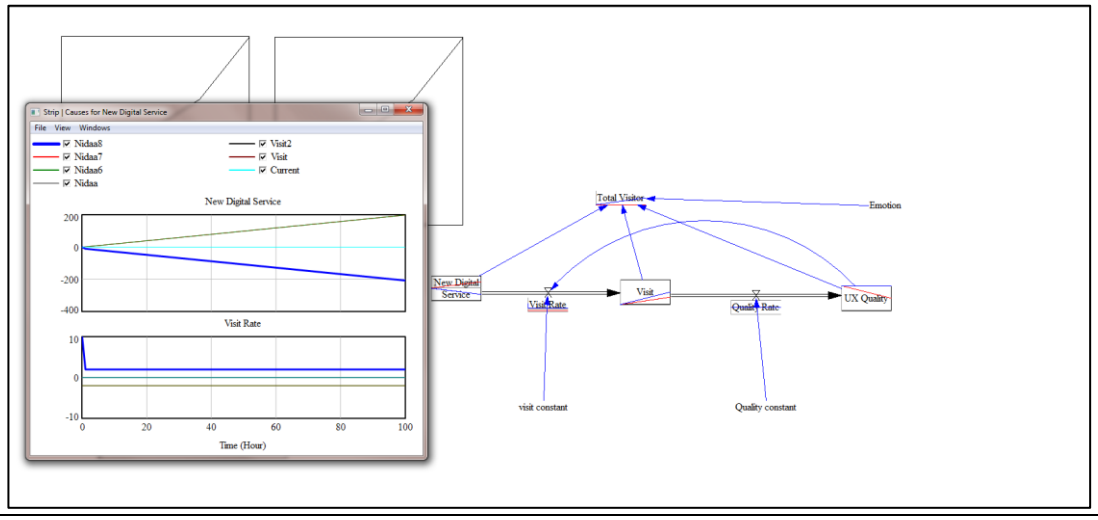
If the equations are changed, then this gives different results, and the equations for each are then:

- Total Visitor = (New Digital Service + UX Quality + Visit)*Emotion
- New Digital Service = INTEG (-Visit Rate), where the initial value =0, (∫-Visit Rate)
- Visit = INTEG (Visit Rate-Quality Rate), where the initial value =0, (∫Visit Rate - Quality Rate)
- UX Quality: INTEG (Quality Rate-UX Quality), where the initial value =0, (∫Quality Rate-UX Quality)
- Visit rate= visit constant + UX Quality
- Quality Rate: - Quality constant

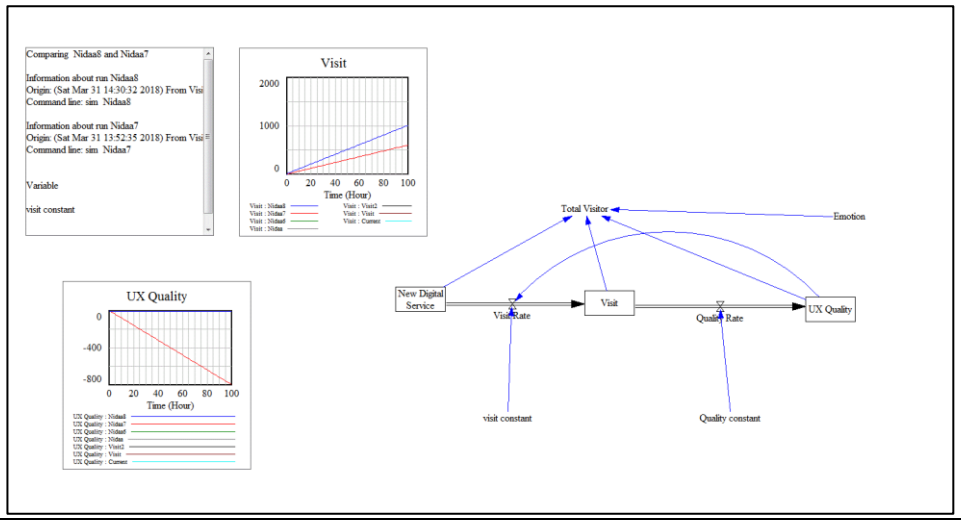


Results after changing the equations

Representations of extreme conditions after changing the value of the parameters exhibit logical behaviour, and are shown.



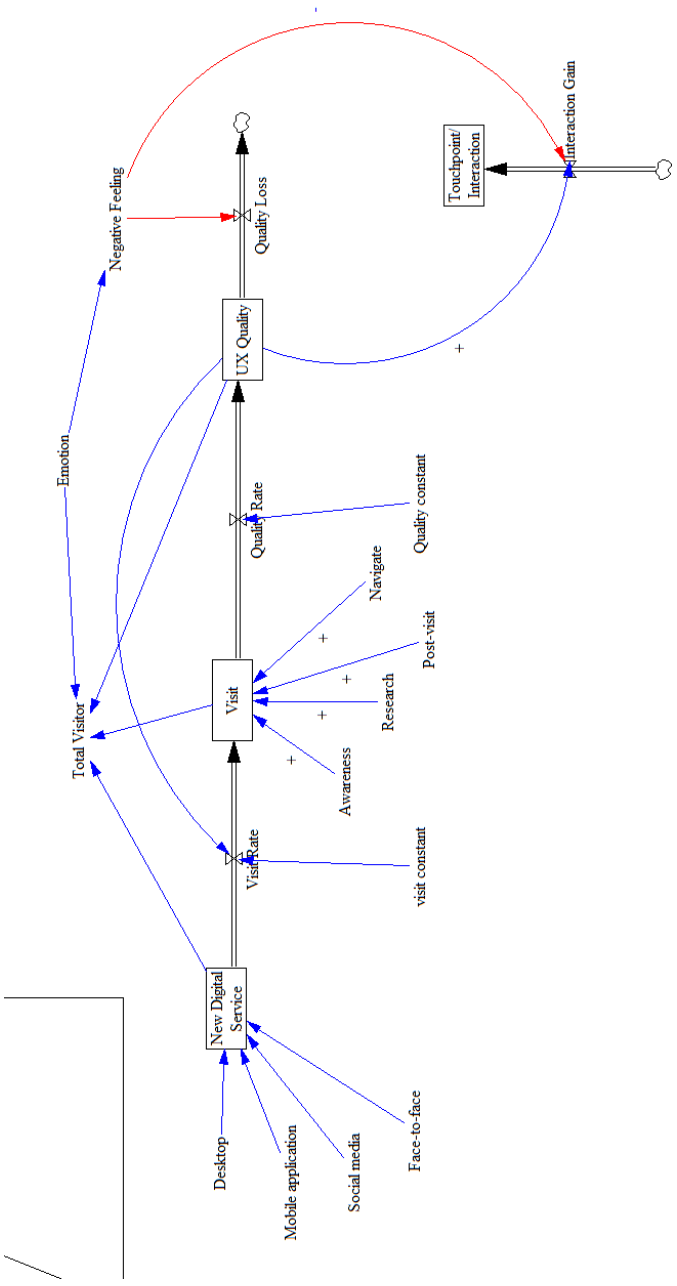
Extreme condition validity 1



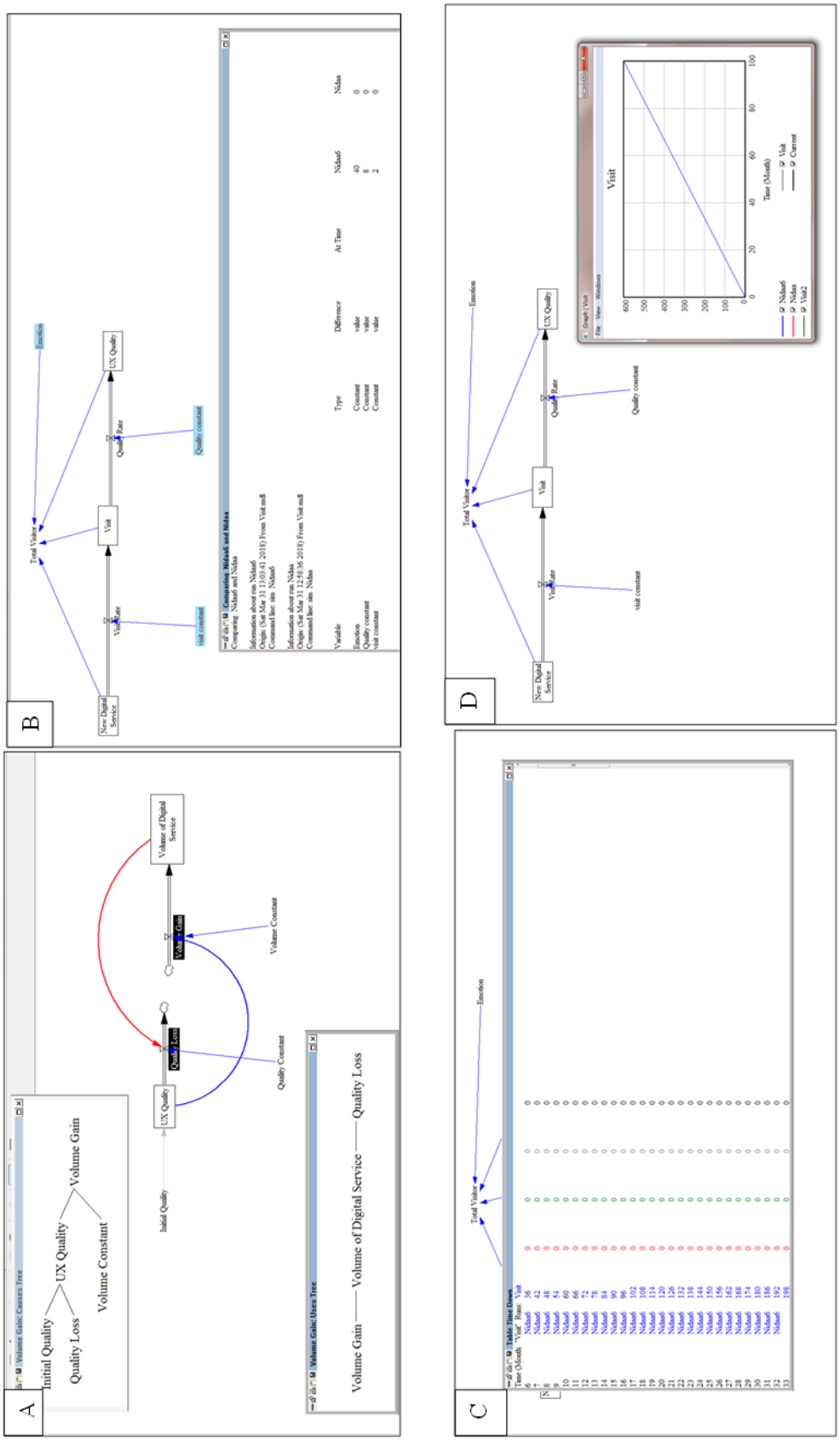
Extreme condition validity 2

To summarise, from the affected elements heritage experience designers can analyse and determine the relationships using a CLD and then utilise the CLD outcomes in a SFM to characterise a model to simulate the heritage environment Using these structured steps a heritage designer or worker can design a journey experience and investigate the main touchpoints in order to assess the UX quality.

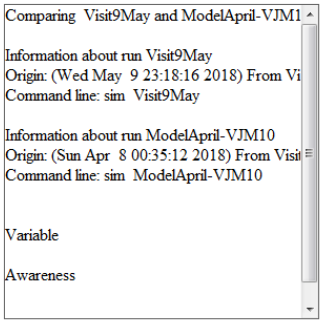
Appendix I – SFM simulation

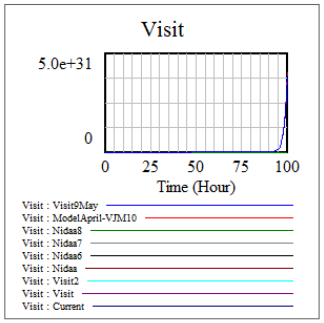


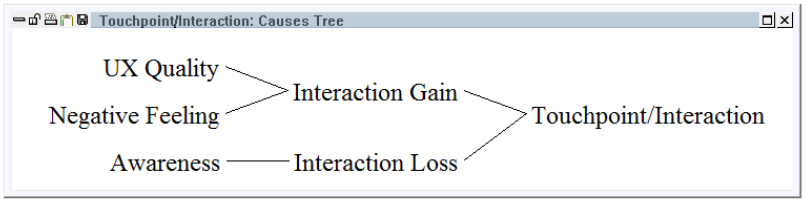
SFM showing the relationships between variables

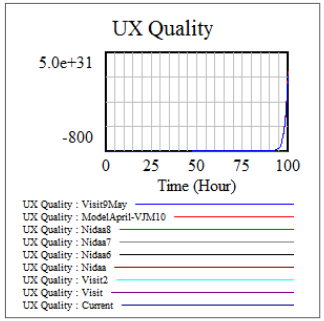


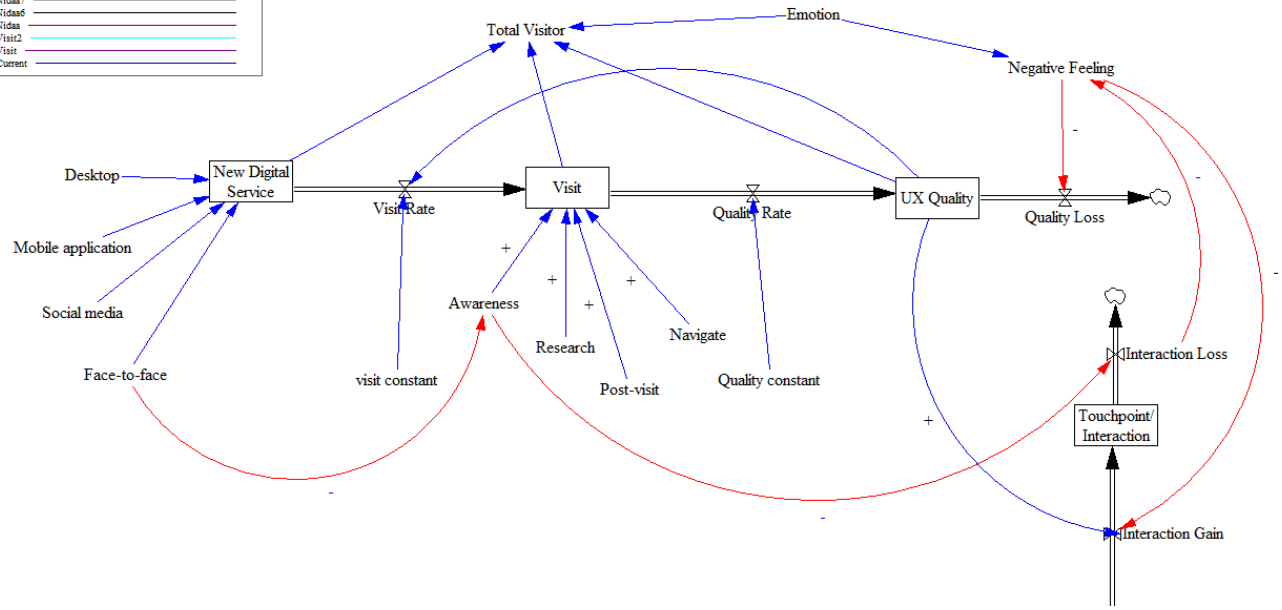
Initial implementation and simulation test


Comparing Visit9May and ModelApril-VJM1
Information about run Visit9May
Origin: (Wed May 9 23:18:16 2018) From Vi
Command line: sim Visit9May
Information about run ModelApril-VJM10
Origin: (Sun Apr 8 00:35:12 2018) From Visit
Command line: sim ModelApril-VJM10
Variable
Awareness


Visit
5.0e+31
0
0 25 50 75 100
Time (Hour)
Visit : Visit9May
Visit : ModelApril-VJM10
Visit : Nidaa8
Visit : Nidaa7
Visit : Nidaa6
Visit : Nidaa
Visit : Visit2
Visit : Visit
Visit : Current


Touchpoint/Interaction: Causes Tree
UX Quality
Negative Feeling
Awareness
Interaction Gain
Interaction Loss
Touchpoint/Interaction


UX Quality
5.0e+31
-800
0 25 50 75 100
Time (Hour)
UX Quality : Visit9May
UX Quality : ModelApril-VJM10
UX Quality : Nidaa8
UX Quality : Nidaa7
UX Quality : Nidaa6
UX Quality : Nidaa
UX Quality : Visit2
UX Quality : Visit
UX Quality : Current

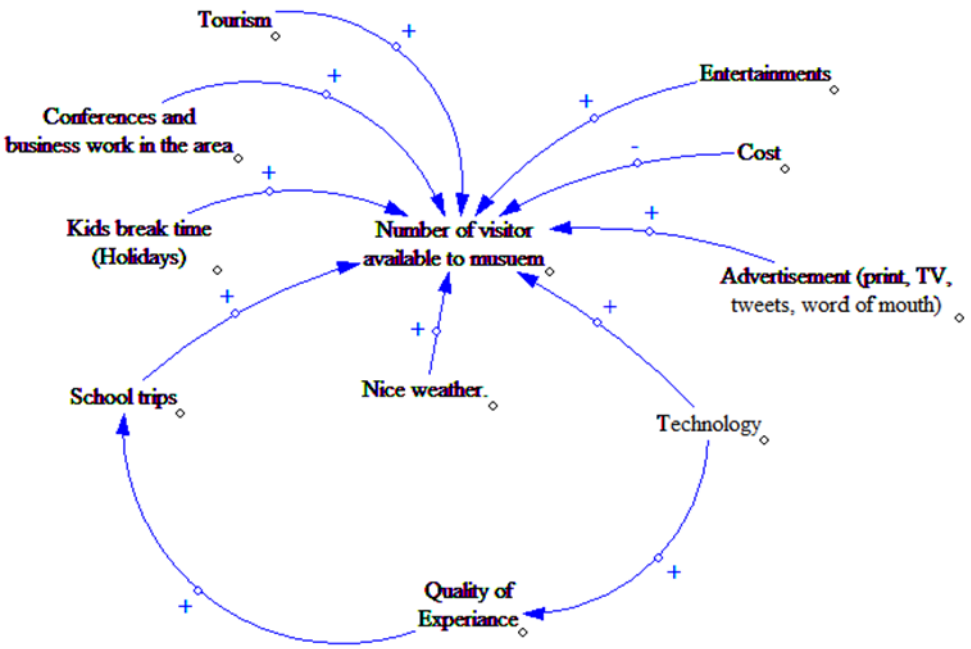

Total Visitor
Emotion
Negative Feeling
Desktop
New Digital Service
Visit Rate
Visit
Quality Rate
UX Quality
Quality Loss
Mobile application
Social media
Face-to-face
visit constant
Awareness
Research
Post-visit
Navigate
Quality constant
Interaction Loss
Touchpoint/ Interaction
Interaction Gain

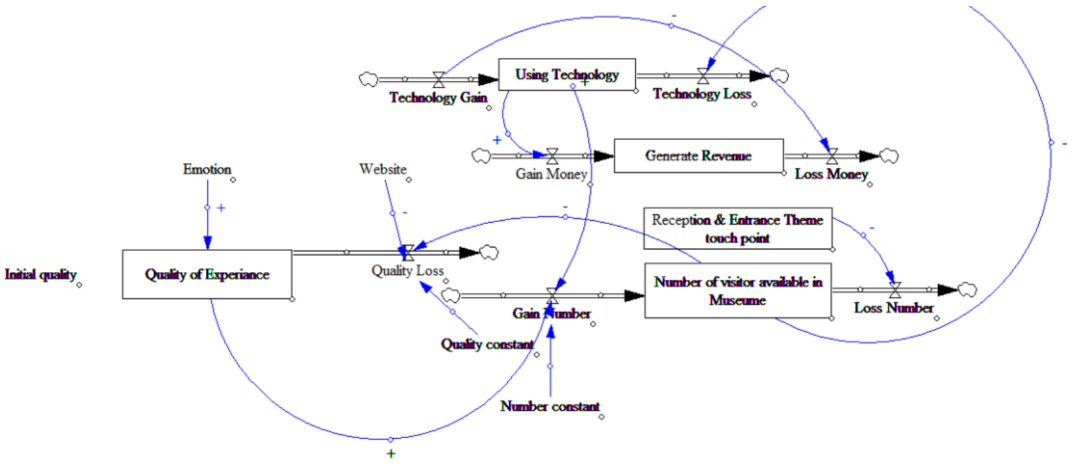
Appendix J – Initial System Dynamics

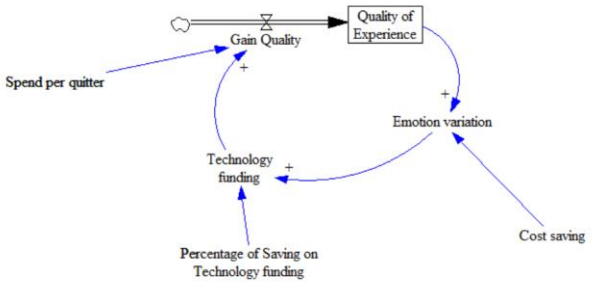
For example, ticket cost has a negative relationship with an increase in visitors, in other words, if the ticket cost is more expensive then less visitors would come to the museum. Similarly, as technology (digital service) is widely used in museums, this would impact positively on the number of visitors. From the previous phases, it can be observed that one of the main variables in this setting is the quality of experience which will be used as a main element in the SFM presented later.

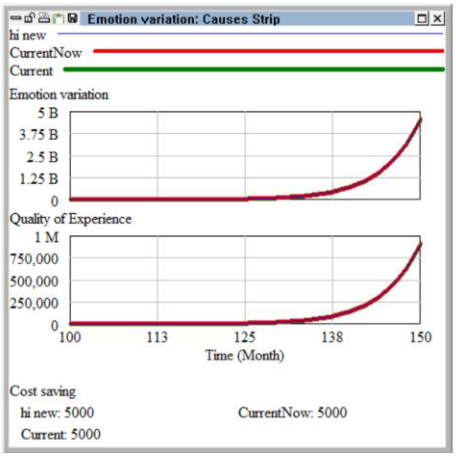
Table 7.3: Main elements extracted from scenario to be fed into the CLD

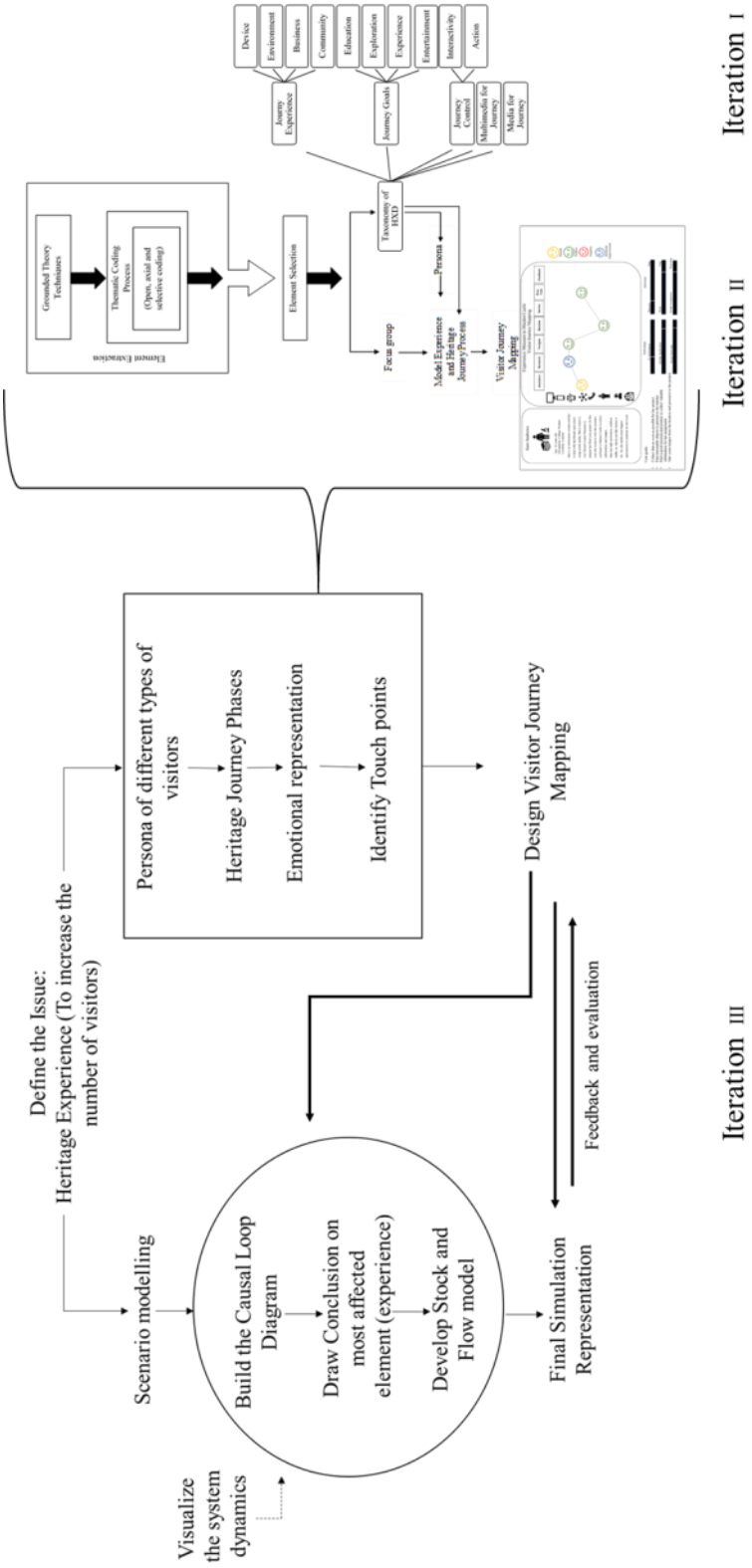
Scenario	**Museum Manager**
Extracted elements to be used in CLD	• Kids break time (holidays) • Advertisement (print, TV, tweets, word of mouth) • Cost • Entertainments • Technology
Total elements	5




Using Technology
Technology Gain
Technology Loss
Generate Revenue
Gain Money
Loss Money
Emotion
Website
Reception & Entrance Theme touch point
Initial quality
Quality of Experiance
Quality Loss
Number of visitor available in Museume
Gain Number
Loss Number
Quality constant
Number constant


Quality of Experience
Gain Quality
Spend per quitter
Emotion variation
Technology funding
Cost saving
Percentage of Saving on Technology funding


Emotion variation: Causes Strip
hi new
CurrentNow
Current
Emotion variation
5 B
3.75 B
2.5 B
1.25 B
0
Quality of Experience
1 M
750,000
500,000
250,000
0
100
113
125
138
150
Time (Month)
Cost saving
hi new: 5000
CurrentNow: 5000
Current: 5000



High level framework implementation