DESIGN PREFERENCES FOR TOUCH SCREENS IN MUSEUM GALLERIES

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DECLARATION

I hereby declare that the work has been done by myself and no portion of the work contained in this thesis has been submitted in support of any application for any other degree or qualification of this or any other university or institution of learning.

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ABSTRACT

The rapid development of digital technologies has made digital media widely available to everyone. Some galleries or museums in Malaysia, such as the National Museum, have made use of interactive multimedia, which provides interaction between the users and the items being displayed. Regardless of the presence and accessibility of interactive multimedia, few studies have indicated that research on museum visitors in Malaysia, especially museums with interactive multimedia display, are still lacking.

The purpose of this study is to explore the current scenario of interactive multimedia usage among visitors, to investigate visitor's perceptions and preferences on current interactive multimedia applications in National Museum and to evaluate the interactive multimedia application based on design criteria and visitors' experience. With the usage of the Norman's Emotional Design Model as the conceptual theory and the adaption of the Simple Interaction Design Lifecycle Model for full development process, four stages of studies were conducted to gain insights of interactive multimedia usage and visitors' perceptions and preferences. The first stage or the study is conducted with the purpose of having an overall understanding of visitors' perceptions and preferences on the current interactive multimedia in the National Museum of Malaysia. For that, the researcher had conducted two preliminary studies, which were direct observation and interview. Next, the researcher studied the selected interactive multimedia application and analysed the necessary design criteria to further develop or modify it. In the last stages, evaluation of the modified interactive multimedia was conducted to examine whether visitors' experience have improved due to the design criteria.

The outcome of this study will provide designers and developers the option of considering work closely in order to deliver the best interface design for interactive multimedia. This research will also benefit the museums in Malaysia as it is able to provide an insight into the awareness of interactive multimedia and touch screens

usage for more engaging experience. It also encourages visitors to educate and entertain themselves with interactive and multi-sensory contents. Overall, the results provide directions for curatorial and design criteria issues for interactive multimedia in informal learning institution such as galleries in museums.

The results of the research provided suggestion for the use of Norman's Emotional Design Model, design elements and design principles when developing interactive multimedia in order to enhance user experience in museum gallery.

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CHAPTER 1

INTRODUCTION

1.1 Overview

Over the recent years, the rapid evolution of digital technologies has changed our way of life. These technologies are appearing in various digital media, such as smartphones, PCs, laptops and touch screen displays.

For galleries and museums to survive in this digital age, they have to overcome many challenges. Interactive multimedia, which can apply information, is increasingly employed by galleries or museums across all fields to support learning (Dribin & Rickhoff, 2010). In order to remain relevant in a rapidly evolving society, it is important to understand the roles of interactive multimedia usage and apply them in this informal learning environment.

On the other hand, research over the recent years has raised the awareness and potential of interactive multimedia in galleries and museums, and the significant effect it has on a visitor's preference and experience (Kusunoki, Yamaguti, Nishimura, Yatani & Sugimoto, 2005; Birchfield, Mechtley, Hatton & Thornburg, 2008; Ng, Hoo & Jantan, 2013). Nonetheless, there have not been many attempts to evaluate whether the adaption of visual design elements into interactive multimedia can enhance the experience among visitors in museums.

This study examines the current usage of interactive multimedia among visitors in galleries belonging to Malaysia's National Museum. Visitors' design preferences of interactive multimedia design were also investigated. In this case, a

prototype was developed by adapting the Norman's Emotional Design Model and Simple Interaction Design Lifecycle Model, followed by an evaluation of the efficacy of the prototype to improve or enhance visitors' experience.

1.2 Background of the Research

A museum is an institution which enables people to explore interesting and valuable collections for inspiration, learning and enjoyment. Most important, it provides visitors the opportunity to access knowledge and objects not otherwise reachable on a daily basis. "Museums need to be transformed through the process of rebranding so that they do not merely store and preserve historical items, but also adopt a high-technology approach to displaying artefacts, -" said Sultan Ahmad Shah (New Straits Times, 2012). For instance, digital technologies are now widespread in our daily lives. Museums which do not upgrade their technologies may find themselves receding into non-relevance. The Minister of Rural and Regional Development, Datuk Seri Mohd Shafie Apdal also challenges museums to be more creative and innovative in attracting the young market segment as well (Mokhtar & Kasim, 2011).

In this research, the researcher focuses on the visual design of interactive multimedia. For instance, visitors feel the lack of visual and interface design in the preliminary studies during the visitation on October 2013. They did try to interact with touch screens applications, yet the overall design does not hold their attention for too long. People make snap judgements about everything they see and try to rationalize it later, and so it is essential to get a positive first impression (Lindgaard, Fernandes, Dudek & Brown, 2006).

This study adapted the concept of Norman's Emotional Design Model (Partners, 2004), which was also adapted in other studies such as game design process study (Baharom, Tan & Idris, 2014). The Norman's Emotional Design Model

has three layers, visceral, behavioural and reflective. He explains how emotion and behaviour are determined by different levels of the brain. It plays an important part in shaping one's experience. He argues that our emotional attachment and involvement with products are as important as how easy we find them to use. If users find the look and feel of a product pleasing, they are likely to have a more positive experience.

In the first layer which is known as the visceral level, physical features including the visual, tactile and aural aspects of an object are more dominant. Norman mentions that the interaction at the visceral level of emotional design is instinctive. The visceral is an initial level, but it is the most direct and irresistible level. Great visual design and aesthetic will give more credibility too. For example, aesthetically pleasing application appeared to be more effective due to the emotional connection with the application. Products will look, feel, and sound good with visual design.

Use and performance are the important aspect of behavioural design. This is the level where most human activities occur (Ortony, Norman & Revelle, 2005). This level stresses on the functionalities and ease of use. Measurement of effectiveness of the interactive multimedia is normally reflected by the satisfaction level of the users' expectations.

Reflective level defines the long term impact of the product. This is the least immediate level of processing, which involves conscious thought where people generalize and reflect on past experience (Sharp, Rogers & Preece 2011). It can enhance behavioural processing thought, but it has no direct access to visceral reactions. According to Wroblewski (2004), reflective design is rarely integrated with interface design of an application as it is often the responsibility of brand and marketing organizations.

For this research, the researcher focuses more on visceral and behavioural levels, as these two levels are the part of subconscious human thought that is hardly overrule by conscious thinking (Norman, 2012; Kahneman, 2011). Design criteria, which include the design elements of content (layout, typography, colour, imagery, and also controls) and design principles, simplicity and consistency (Ng et al., 2013) are applied for this study.

1.3 Problem Statement

According to Azizah Aminah Maimunah, museums should be competitive and innovative in attracting the interest of the public especially in the digital age (Ong, 2012). Furthermore, the former Minister for Information, Communications and Culture, Rais Yatim claims that allocation has been given to enable the museums to play their roles in channelling information on a wider scale including in improving their quality of displays (Bernama, 2012). In this case, museums in Malaysia have made efforts in incorporating interactive multimedia in their galleries, such as touch screens that also function as an interactive form of information provider.

Still, there are not many studies have been conducted to investigate the interactive multimedia usage in museum context (Ng et al., 2013). Apart from that, no further data has been collected to gain more insight into visitors' perceptions and design preference of touch screens application in museum.

The researcher only studies the touch screen applications in galleries of the National Museum Malaysia. The National Museum or *Muzium Negara* provides a good overview of the country's cultural heritage (Elottol & Bahauddin, 2011). Hasan (2006) mention in his study that the National Museum is one of the nation's prides. The National Museum is three storied structure with an exterior that is decorated with various motifs that represent the diverse culture in Malaysia. In addition to that, the National Museum is still a part of the government institution, under the Ministry

of Culture, Arts and Heritage Malaysia. Nowadays, the galleries of the National Museum are administered by the Department of Museums Malaysia Ministry of Tourism and Culture.

Figure 1.1: Visitors were Interacting with Touch Screens in Gallery B and Gallery D, on October 2013

From the preliminary studies of this research, most visitors do approach and interact with touch screens in the National Museum. While the museum curators hope that the interactive multimedia can provide an alternative option to visitors (Appendix 2), it does not hold their attention. Additionally, there is still lack of visual design to attract visitors as visual attractiveness was often mentioned as a reason to start using an application (Chang, Kaasinen & Kaipainen, 2012). The existing touch screen applications need to deliver professional and completed look in order to engage visitors in museum.

"Engagement" is taken here to mean a combination of attention, interest, enjoyment and implied learning (Elliston & FitzGerald, 2012). Successful application not only motivates the users to use it but also users will spend time, pay attention and relate emotion as well. Visitors should actively interact and engage with

the exhibits in order to maximize informal learning experience. Badly designed application frustrates users and causes them to leave.

The visual design of touch screen application is the main focus in this study. According to Galitz (2007), a person will be distracted from performing a task if the interface is distracting. In conclusion, all distractions must be eliminated in design. For museums, their main function is to collect and display the collections. Compared to other private galleries, they are forced to face many challenges such as minimal funding and limited access to technology or other sources (Hasan, 2006). To avoid unnecessary spending on expensive novel technologies that do not guarantee success, the study could allow both curators and designers an insight into the visitors benefit from interactive multimedia integration with design suggestion. The researcher will focus and study the design preferences for touch screens applications in galleries of museum, enhance visual design criteria, and induce positive experience in visitors to encourage engagement with interactive multimedia.

1.4 Objective

The aim of this research is to enhance visitors' touch screens experience. In order to achieve that, users' perception and preference of touch screens design in local museum are the most important driving force of this study.

Firstly, the objective of this research is to identify visitors' perception and preference on current touch screens in museum galleries. Secondly, the objective is to evaluate whether modified touch screen application with selected design criteria improve visitors' experience. The research motivation is to come out with a suggestion of suitable design criteria for creating a touch screen application that enhances visitors' experience.

1.5 Research Gap

There is still a lack of interaction and engagement using touch screens in local museum. To bridge the gap between museum collection information and visitors' engagement, the researcher will study the design preferences of visitors in galleries in museum through observation and interview. In doing so, the researcher has proposed a prototype to be tested and feedback is then collected.

1.6 Research Question

The two main research questions that the study will serve to address are:

1) What are the perceptions and preferences of visitors on the current interactive multimedia in museum?

2) Does touch screen application which meets the design criteria enhance visitors' museum engagement experience?

1.7 Significance of the Study

The success of the interactive multimedia design is not only judged by aesthetic values, but also on its ability to provide positive experience for visitors (Chang et al., 2012). This study will justify whether the combination of visual design criteria can improve the quality of interactive multimedia in museums. The outcome of this study will provide a platform for designers and developers to consider working close together and in order to deliver the best interface design for interactive multimedia.

This research will also benefit to the museums in Malaysia as it provides an insight into the awareness of interactive multimedia and touch screens usage for more engaging experience. Besides that, it is hoped that the outcome of this research

will enable museum to develop interactive multimedia based on the design suggestion and avoid unnecessary fund usage.

1.8 Research Design

For the overall research workflow, the researcher adapted the Simple Interaction Design Lifecycle Model (refer to Figure 3.2). The model captures a set of interaction design activities such as establishing requirements, designing alternatives, prototyping and evaluating (Sharp et al., 2011). This study started with literature review on the research design related to interactive multimedia usage in museums. After gaining some insight into the research, the study is separated into four stages. The first stage is separated into two preliminary studies which includes direct observation and interview. This is crucial in an attempt to understand the usage of interactive multimedia in museums and also the visitors' preference. The literature review indicates that the main deterrent in the usage of interactive multimedia revolves around design elements and interactivity aspects. For that reason, in the second stage of the study, the researcher identifies suitable design elements and design principles (Norman, 2012; Ng et al., 2013) and subsequently develops a prototype in the third stage. Evaluation was conducted to collect user feedback in fourth stage. More details about method of this study can be found in Chapter 3. The data collected from all stages are analyzed and presented in Chapter 4. The findings and conclusions are discussed in Chapter 5.

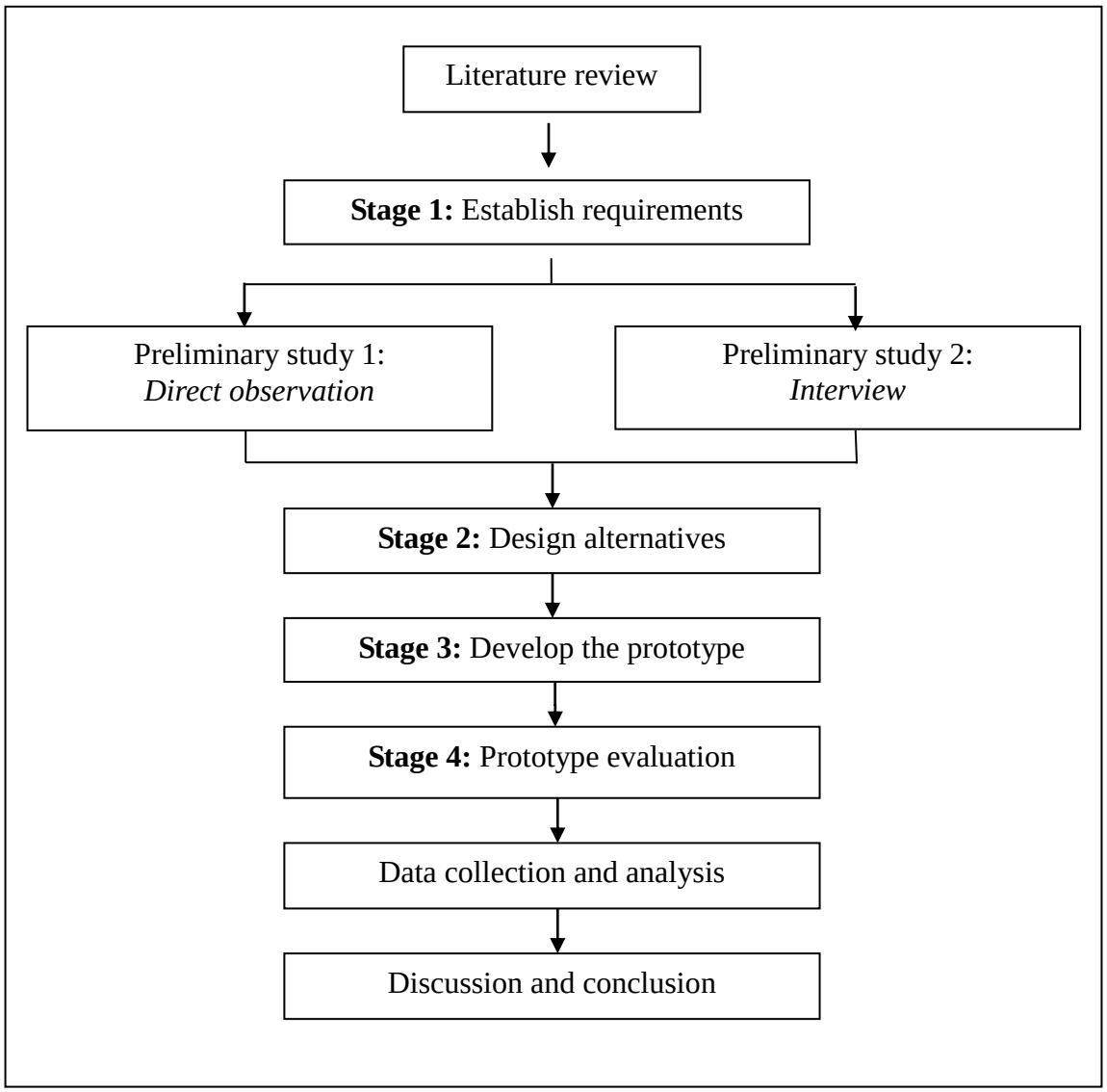

Figure 1.2: Research Workflow

1.9 Definition of Terms

Some terms that used throughout the study are listed in Table 1.1.

Table 1.1: Definition of Terms

Term	Definition
Visual Design	The aesthetics of a user interface, ensuring that it looks good, communicate the right image to users, and conforms to any brand guidelines (Macefield, 2012).
Engagement	A combination of attention, interest, enjoyment and implied learning (Elliston & FitzGerald, 2012).

1.10 Thesis Outline

The thesis is divided into five chapters. Chapter One has a brief introduction to this research study which includes background of the research, problem statement, aim and objectives, research gap, research question, contribution to knowledge, justification for the research and methodology.

Chapter Two presents the literature review about touch screens usage in local museums and also research studies on the design preferences of visitors for touch screens design. The relevant theory and models that are useful in data analysis procedure are included as well.

Chapter Three details the methodologies used in this research. The study is divided into four stages. Firstly, in preliminary study 1 and 2, interview with visitors and observation in National Museum are conducted. The location of the touch

screens and overall content of applications are studied. This will help the researcher choose one of the touch screen applications to be redesigned according to the data collected later on. The research design, data collection method and data analysis procedure are also explained in this chapter.

The results of the study are discussed in Chapter Four. All the statistic and data will be analysed and combined with the design preference study. Based on the results, the researcher will proceed to design and develop the touch screen design prototype to be tested and the feedback to be collected accordingly.

The final chapter, Chapter Five is the conclusion of the research. The summary based on the findings is discussed. Other than that, this chapter has included the limitation of research and suggestion for future studies.

1.11 Summary

This chapter presents the background of research and the research questions that frame the whole structure of this study. It is hoped that this research will answer questions related to perception and preferences of visitors in the development of interactive multimedia application. The justifications from the research problems and the contribution to knowledge are discussed in order to support the key purpose of this study. Definitions of terms are defined in this chapter as guidance to the readers. Justifications from the literature review to support the findings of this study are presented in the next chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

The researcher discusses the areas which are related to this study in this chapter. It includes readings and overviews of museums and galleries which act as the informal learning environment (Lin, Fernandez & Gregor, 2012). Besides, the researcher discusses current interactive multimedia usage and development in the museum scenario. Norman's Emotional Design Model, which is the conceptual theory of the study, will be discussed in more detail in this chapter as well. Last but not least, the researcher reviews relevant research work on the design issues related to interactive multimedia such as design elements and design principles, as well as the touch screen strengths and limitations.

2.2 Museums and Galleries

According to the International Council of Museums (ICOM) Statutes:

A museum is a non-profit making and lasting institution in the service of society and of its development, and open to the public, which acquires, conserves, researchers, communicates and exhibits, for purposes of study, education and enjoyment, material evidence of people and their environment (ICOM, 2010). Every museum which reaches the goals of its formation is successful (UK Standard, 2010). In addition, Camenson (2007) divides museums into 10 types which include history museums, natural history museums, living history museums, art galleries, art museums, science museums, national historic sites, discovery centers, archives and genealogy, planetariums, and others like botanic gardens, arboreta, zoos and aquariums.

In Malaysia, there are 185 museums and galleries (Bernama, 2012). The Federal Government's Department of Museums Malaysia manages 21 museums. Others are run by local governments and private bodies (Department of Museums Malaysia, 2011). Museums and galleries industry has begun since 19th century in Malaysia (Hasan, 2006). The first museum in Malaysia was opened in 1883 by the British in Taiping, Perak. The purpose for all museums to exist in Malaysia is to defend the national uniqueness and heritage. There are thirteen states in Malaysia. According to Taha (2008), each of the states has its own museums or galleries that reveal and exhibit the local uniqueness culture and historical. The only authorities that sustain the national history and cultural heritage in Malaysia are the ministry of culture, arts and heritage of Malaysia and the department of museums Malaysia. Malaysia government had invested millions of cash into museums (Bernama, 2012). Nevertheless, a museum is an institution that needs high maintenance fees to maintain and service their displays. In order to help keeping the existence of museums while contribute to the society, effective designs of interactive multimedia is considered necessary.

The Malaysian government considers museums as the society which combined intellectual and learning. According to Elottol & Bahauddin (2011), among all of the museums, the Islamic Art Museum, Rice Museum and National Museum are three samples that have give greatly to the achievement of the tourism industry, both locally and globally. All in all, museums in Malaysia need to be relevant and this can be done by organizing activities and programs to work for the educational drive and source of information for visitors. Thus, it can be said that the strong point of a museum still rely greatly on its part in learning development.

2.3 Museum as Informal Learning Environment

Learning is generally expected to be greatly personal, firmly influenced by the individual's past knowledge, interests and beliefs, where one should also anticipate learning to be shaped by an individual's desire to select and control their own learning (Falk, Dierking & Adams, 2008). Museum has become a common setting for many researchers to study learning experiences (Hawkey, 2006; Lin et al., 2012). Museums deliver and fulfil needs of enjoyment and education to visitors, motivate and encourage visitors to engage in exhibition and activities (De Backer et. al, 2014). Learning in museums does not involve formal lecture, schools and classrooms. Moreover, learning is voluntary and self-directed in such informal setting. It is driven by curiosity, free exploration and sharing of experience. It can often fill the gap where formal learning institution cannot provide, and creating the potential for lifelong learning. Thus, great observation opportunity for in depth study of informal learning experiences can be found in museums.

There are numerous studies that relate informal learning with new technology,, and these support that the majority of museums are increasingly implement digital media across all fields to support learning (Richards & Tangney, 2007; Dribin and Rickhoff, 2010; Lin et al., 2012). These studies show that different types of demographics include young children and elderly have been using new technology in order to learn new knowledge. Some studies have also observed the importance of characteristics in new technology like "play", "interactivity" and "design" that contributes to attracting interest and sparking motivation (Cranmer, 2006). All these studies implies the underlying potential of informal learning in the digital age and the overall positive effect that is more likely connected with the learning experience

2.4 Engaging Visitors in Informal Learning Experience

Engagement plays an important role in the informal learning setting, as visitors have to actively engage with the content of the museum exhibits in order to make the most out of the learning process (Ng et al., 2013). The experience of "engagement" is defined here as a combination of interest, attention, enjoyment and implied learning (Falk et al., 2008; Vavoula & Sharples 2009, Elliston & FitzGerald, 2012). Learning can be designed to be exciting and fun. This could incite visitors' interest and motivation to learn and hold their attention on the content itself. Eventually, getting visitors to enjoy their visit is of utmost importance. To define the relationship between informal learning experience and engaging experience is an ongoing research area. Many museums continue to explore ways to apply new digital media in order to engage museum visitors and build a relationship with them (Dribin and Rickhoff, 2010). Technology or digital media can assist in running the museum independently (Bertacchini & Morando, 2014).

Visitors often enjoy museum visits in hands-on and interactive exhibits. One of the researches on learning experience of visitors in museums implies that interactivity encourages engagement, improves understanding and recall of exhibits (Allen, 2004). This is substantiated by Vom Lehn (2006) who also describes the importance of interaction between the exhibits and the visitors, especially among children. Kusunoki et al., (2005) had developed a learning prototype with the intention to motivate the visitors' participation. It provides a more interactive and enjoyable visual interface and the user testing outcome shows that putting interactive multimedia into practice can effectively motivate the visitors to engage with the exhibits. Besides, a study by Birchfield et al., (2008) shows that the implementation of interactive multimedia helps to motivate the visitors into active participation along with increasing audience attendance and appreciation of museum exhibits. According to Brian & Elizabeth (2012), exhibit that implements interaction enable visitors to be more engaged and not just passively observing the exhibit, this stimulate affective learning which will result in attitude change, increase of interest and more. In

conclusion, iinteractive multimedia promotes in shaping of knowledge to the museum visitors (Abbas, Taib & Masri, 2014). All these studies indicate that actively engaging with interactive multimedia was acknowledged to be more effective way for learning process, as visitors' knowledge will be extended through the interaction. To sum up, visitors will recall better by engaging and experiencing with interactive multimedia. The implementation of digital technology, especially interactive multimedia allows the information of exhibition to be presented in an interactive way to engage visitors.

2.5 Interactive Multimedia

Interactive multimedia or "rich media" is the combination of several types of media, such as text, graphics, video, animation and sound, into a structured digital medium that allows users to interact with the content data for both educational and entertainment purposes (Bakave, Lee & Cheng, 2007; Chrysostomou, Chen & Liu, 2008; Phillips & Chaparro, 2014). Contrary to traditional learning styles, an interactive multimedia uses various media to create a rich environment and provides advanced interface features, and encourages users to have the flexibility in learning (Phillips & Chaparro, 2014). In other words, interactive multimedia has the potential to offer expanded engagement with content stories and deeper experiences, for instance collections can be more widely covered, and can offer a more interesting story-telling learning process.

One of the major feature of well-designed interactive multimedia application is user interactivity. The "interactivity" component refers to the process of allowing the user to control and interact with the content usually by a computer (Phillips & Chaparro, 2014). Furthermore, researchers have proven that by providing an interactive learning environment can actually create effective instruction and learning system (Kusunoki et al, 2005; Ng et al., 2013).

Since museums are considered to be informal learning institutions, as they focus on free exploration and self-motivation learning style. The way a visitor chooses to explore a museum depends on the knowledge and availability of the guide that shows them the way around in the past. In order to be a modern museum, it can not only preserve heritage, it must also provide information and entertainment. Recently, both visitors and museum staffs expect a seamless experience across digital devices (Johnson and Witchey, 2011). In relation to this, interactive multimedia works well with the informal learning style in this context. Interactive multimedia application has been verified to promote dynamic participation of the visitors as it allows them to look for the necessary information at their own pace, which increases the desire and motivation to learn (Vavoula and Sharples, 2009). This is especially true as interactive touch screen kiosks which have been widely implemented in museums are often used for a dual purpose: to both educate and entertain visitors.

Usage of touch screens interactive multimedia application found in museums is widespread, ranging from museum directory to interpretive audio guide. The wide usages of these touch screen applications in museums and galleries nowadays are able to bring exhibits to life through the mixture of sounds, pictures, maps and narration. Touch screen application is an effective communication tool because it has provided large amount information in an attractive way and made the experience flexible for everyone. In addition to that, touch screen interface features allow users to navigate freely, locate necessary information easily and holding their attention (Hong, 2003). Employ engaging interactive is often the way to attract more visitors. Touch screen make interactions more efficient and customized, and is a tool for getting visitor interest. User experience design principles help to consider the relationship between digital and physical space, and restore context. Touch screens allow visitors to be actively engaged with the knowledge and enhance the overall user experience if their needs on visual, usability are met.

Many museums have made use of the touch screen application. On the local front, the newly refurbished museum, the Sultan Abu Bakar Museum in Pahang, has

introduced the use of modern technology, such as touch screen displays, at its exhibition halls (New Straits Times, 2012). An interactive touch screen, One Road was installed in an exhibition at the Australian Museum to enhance and empower visitor' experiences (Touw & Miller, 2012). Other than that, the Cleveland Museum of Art also recently installed a wide multi touch screen that displays a collection of images. Each image is attached with information and visitors can customize and personalize their own museum tour by sending their favorite image of the museum's collection to an iPad (Bernstein, 2013). This enhances visitors' experience, as visitors can choose a less linear tour and at the same time, connect with friends or other visitors who share the same interest.

However, there is a minimal published research or study about the satisfaction of museum visitors in Malaysia towards the current museum interactive multimedia application (Ng et al., 2013). One of the visitors who had visited National Museum mentioned that some of the touch screens were not usable because of system freeze, or insensitive touch point (Anonymous, 2011). This had formed a bad experience for the visitors as the touch screens did not fulfil the users' expectation and needs.

Consequently, it is important to study the visitors' needs from the exhibit, perceiving the current performance of the exhibits and understanding their expectation to enhance the exhibits. The data will contribute to the decision in selecting the appropriate design criteria of its content in creating a prototype. Furthermore, the researcher will evaluate the prototype to understand the impact of design criteria for interactive multimedia application in learning and engaging experience.

2.6 Norman's Emotional Design Model in Interactive Multimedia Design

At the present time, people are spending most of the time navigating throughout web and interactive multimedia applications, thus provided that an

experience that engages and guides users is vital for the accomplishment of the application design. The contemporary design practices might have the similar fundamental design characteristics with Norman's Emotional Design Model to include in design. Nevertheless, in creating outstanding user experience, emotional design has become influential instrument. Emotional design turns casual users into fanatics, ready to tell others about their positive experience. According to Walter & Spool (2011), emotional experiences are important because they can make insightful imprint to users' memory and form humanizes connection type of experience for users. Therefore, the main difference between these two is that Norman's Emotional Design Model is user-centered in creating positive experience, whereas contemporary design reflects the possible range of design suggestion which might not fulfil the users' needs. Emotions are the key to the full potential of contemporary.

Norman's Emotional Design Model is chosen as the conceptual theory of this research because it describes different aspects of emotion, its potential importance to design, and bringing these aspects together into a satisfying user experience. According to Norman (2004), "attractive things work better". He thinks that eye-catching application affects emotion and mental process, with ends up making the users extra open-minded of slight problems. Therefore, the shortest way to manipulate a choice or view is through the emotions. Tractinsky, Shoval-Katz & Ikar (2000) also agree that "perceptions of interface aesthetic are closely related to apparent usability and thus increase the likelihood that aesthetics may considerably affect system acceptability." Thus, a key concern here is to strike a balance between designing aesthetic and usable interfaces.

There are three different levels of design that are connected to each levels of psychological processing according to the Norman's Emotional Design Model (2004). These levels consist of the visceral level, behavioural level, and also reflective level (See Figure 2.1).

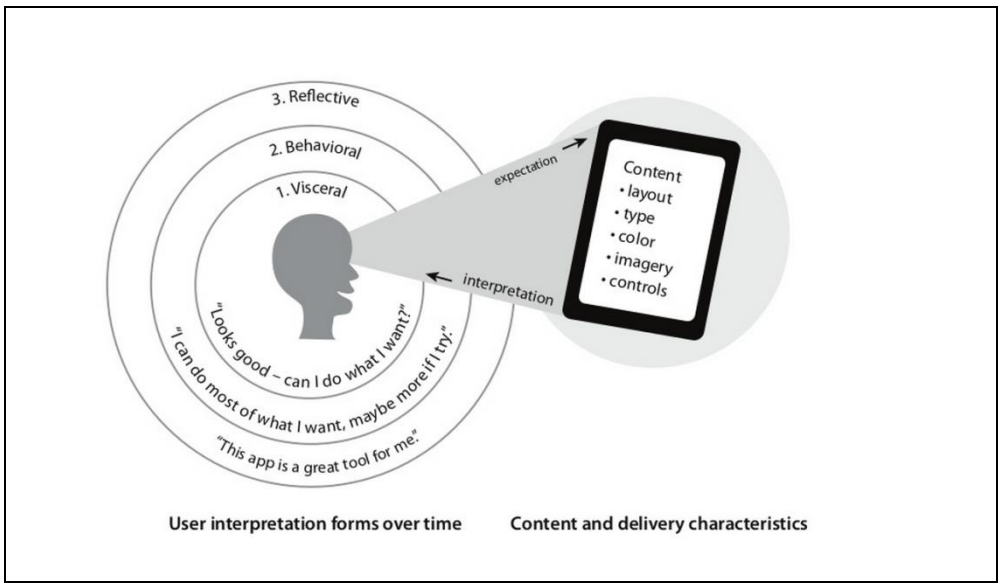

Figure 2.1: Norman's Emotional Design Model (Partners, 2013)

Kahneman (2011) on the other hand suggests that human thought can be separated into two: fast or subconscious system, and slow or conscious system. The two systems function according to dissimilar values and frequently arrive at contrary conclusion. The fast system is based ahead of experience, the slow system based upon aware way of thinking and assumption. In this case, Norman (2012) has a finer level of study for the fast system which is the visceral and behavioural, and slow, conscious system is the reflective level. On overall, it can be very hard for the reflective level to claim superiority of the visceral and behavioural level, which so raise many human idiosyncrasies. The researcher decided to research more on the fast thinking levels, which are the visceral and behavioural levels in this study.

2.6.1 Visceral Level

The first level, visceral level is the level of subconscious or fast system. It means that this level is where the emotional signals of the initial impact of the appearance, touch and feel from the surroundings are occupied automatically. It responds quickly, makes judgements, and triggers the emotional responses to stimuli that are expressed through a combination of physiological and behavioural response

(Ortony, Norman & Revelle, 2005). A good quality of visceral design often leaves users with good first impression. This level works intuitively, and both users' cultural and personalities principles can also affect how they classify or take in the experience. So, a good visceral design is attractive and makes users feel happy and positive (Idler, 2012).

2.6.2 Behavioural Level

The behavioural level is regarding the how effective and usable an application is during interaction. This is the level where most human activities occur (Ortony et al., 2005). For the most part, usability subject are connected to this behavioural level. The behavioural design must take account of related features that accomplish the users' requirements. Despite the facts that interface interruption direct to negative emotion, effectiveness and ease of use trigger positive emotion (Idler, 2012).

Historically, usability was viewed as the most important subject for drawing and keeping visitors. However, the research in user centered design has exposed that pragmatic qualities alone cannot make the user experience that will influence customers' preferences. Nevertheless, this certainly not the reason to exclude the influence of usability from the design process or the user experience. The ISO (1998) defined usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" (ISO 9241-11, 1998). Most studies agree that the measurement of application effectiveness reflected by the satisfaction level of the user expectations.

According to Cyr & Trevor-Smith (2004), language is one of the significant features of design that needs consideration in an intellectual background. Language is a characteristic side of each different culture, which when moved to the interactive multimedia application and presented on its own, challenges the quality of translation, symbol and modern elements. In Malaysia, the three main languages used by the

visitors are English, Bahasa Malaysia and Chinese (Ng et al., 2013). Therefore, there is a need to fulfil the users' expectation and needs in term of language in order to understand the content.

2.6.3 Reflective Level

Finally the third level, the reflective level defines long term impact of the product. This level involves mindful thought where people simplify and mirror on past experiences, and work as the least immediate level of processing (Sharp et al., 2011). Reflective processing can improve behavioural processing, except straight way in to visceral reactions. This level of cognitive processing is accessible only via memory, not through direct interaction or perception. The most interesting aspect of reflective processing is that it relates to design. Users are able to mix their experiences with designed interactive multimedia into their life experiences and eventually, connect meaning and value with the application itself. The third aspect of visual design is frequently absent from the design process. This level is all about the culture, message and meaning of a product and its use. It is often influenced by knowledge, learning process, and culture. Reflective design is the duty of brand and marketing organizations in large companies. It is hardly ever incorporated with the interface design of a product (Wroblewski, 2004).

2.7 Visual Design

Norman's Emotional Design Model (2004) will be the main conceptual model for this study as the researcher would like to discover the visitors' design preferences towards touch screen applications in museum. In recent studies, the attractiveness, visual appeal, aesthetics or beauty of user interfaces have turn out to be a subject matter of major attention (Tuch et al., 2012). Visual appealing is shaped largely by visual stimulation. For a great user experience, it is important to make use of the power of visual appeal. Visual aesthetics is concerned with anything that appeals to

the five senses of human, which includes what users see, hear, smell, taste, and feel. In order to create positive user experience, every stimulus that might influence interactions must be considered. Perhaps more importantly, aesthetics examines users' affective domain response to an object or phenomenon and communicates function. In other words, aesthetics is not just about the artistic of other visual effects, but about how users respond to these elements.

Visual design has been defined as the aesthetics of an interface. A group of suitable elements that look good, using appropriate images for users, and match to any design guidelines are helping to build an attractive interface (Macefield, 2012). Based on the findings from Kelly (2008) study, there are overwhelming interest towards the museum content, and the sensory engagement primarily through touch interface, and also the visual aesthetic. This shows that visual attractiveness is often a reason to start using an application, as mentioned quite frequently both in positive and negative comments during studies conducted by Chang, Kaasinen & Kaipainen (2012) as well.

Moreover, numerous studies show that visual design impacts greatly on the ease of use, credibility and overall impression (Hassenzahl & Monk, 2010; Tuch et al., 2012). Users prefer a beautiful look and feel over an ugly or dull one. Aesthetic designs are perceived as easier to use, whether they are or not. Design of a product needs extra thought to detail and additional care while it is planned to be used under hectic and stressful condition (Norman, 2004). Basically, when users are relaxed and happy, their brains are more flexible and are more likely to work around and find solutions to solve difficult problems. In contrast, when users are frustrated and tense, their brains get a sort of tunnel vision where they can only see the problem in front of them. To put it briefly, badly designed applications distract users to find required information, frustrate users and cause them to leave. Hassenzahl (2004) supported this statement by showing visual design is a necessity to create loyalty and preference towards the product. Lindgaard et al. (2011) also suggest that visual appeal is important in which largely driven users' judgments on usability and

trustworthiness.

To put it briefly, user's insight and views are important on visual design for interactive multimedia design. Designers have to focus on the environment and the tasks of an application it is being used for (Norman, 2004). As a result, the application will be able to guide users on what to do at first, how to interact with it, and also leave users a positive feeling at the end. The application should be more standout and special from the mass variety and to present in a complete look. Designers ought to adapt essential components of visual design with the intention of developing a fine visual appealing interface. The design criteria can be grouped into two main categories which are the design elements and the design principles throughout design development (Yamin & Jaafar, 2013; Bakar & Long, 2013).

2.8 Design Elements

Based on the adaption of Norman's Emotional Design Model (2004) from Partners (2013), the content design elements is made up of layout, typography, colour, imagery, and controls. According to Fogg et al. (2003), the visual appeal elements of the overall interface design is made up of font size, typography, layout, and colour schemes. There are similar studies dealing with multimedia and web site design, such as the work of Park, Choi & Kim (2004) and Bakaev, Lee & Cheng (2007). Although there are various design factors proposed by different studies, only five of the general design elements were considered and used. The factors considered are layout, typography, colour, imagery and controls which help to deliver content of interactive multimedia.

2.8.1 Layout

Layout is a communication bridge between the user and the interface. It includes menu items, orientation and placement of the elements. The layout factors

design has been researched by Bauerly and Liu (2006). The layout factors that are proposed are some of the design principles such as balance, homogeneity, equilibrium, symmetry, cohesion, proportion, simplicity, rhythm, economy, density, unity, regularity and sequence.

Layout involves further more than just how the look of the elements applies on the interface. Layout designs show the users which part is important, what choices they have, and also how all the elements on screen are related. According to Partners (2013), the position or location of elements needs to match the flow. Although interface standards offer familiarity, it might not suitable with the flow of interaction. Interface layout has to guide users through step by step to avoid confusion.

One of the tips by iOS Human Interface Guidelines (2014) is to make use of the grid design principles to create an area of focus for the layout of application. The design of an application is to encourage using alignment in order to ease scanning and communicate groupings or hierarchy. Alignment tends to make an application look tidy and arrange in ordered. It gives users centre of attention too while they read throughout the content. Alignment makes the layout easier for users to discover particular items as well. In addition, if each interactive element is given plenty of spacing, it will be easier for users to interact with the content and controls.

The IOS Human Interface Guidelines (2014) also suggest that the designers have to make certain that users can read and view the most important information at its default size. For instance, users should not zoom in to view main images or have to scroll horizontally to read key images. They should be able to understand what the overall context is about at first glance. Therefore, it is important to present the important content or functionality at first for users as this would allow them to easily focus on the main task.

2.8.2 Typography

Typography is how the text looks, and it includes the selection of typeface, the placement of text in relation to the whole interface to other text, and the use of signals such as the titles or headings (Lee & Boiling, 1999; Bringhurst, 2005). Ivory and Hearst (2002) collected a number of text-related factors, such as the amount of text on a page, font styles and size, the number of times text is re-aligned, and the number of text colours (Bakaev et al., 2007). Texts should be informative but not include too much reading. Useful information should be provided in few words with an option for users to read for more information.

In addition to that, text should always be legible. "The legibility of a typeface is related to the characteristics inherent in its design, which is related to the ability to distinguish one letter from the other" (Ilene, 2010). If users could not read the words in the application, having beautiful typography would not matter (iOS Human Interface Guidelines, 2014). All styles of fonts have to be legible at different sizes. Texts should never be smaller than 11 points. In contrast, the body style use font size 17, which is the default text-size setting. Text always uses either regular or medium weight; it doesn't use light or bold.

Visual weight and balance if used properly can illustrate the importance of screen components to users (iOS Human Interface Guidelines, 2014). In general, font size and leading values differ by one point per text-size setting. It is therefore advisable to use a single font throughout the application. Mixing too many different fonts can make the application seem disjointed and messy. Using one font and a few styles and sizes will be more appropriate.

2.8.3 Colour

Colour is the most sophisticated visual language components for interface design (Lee & Boiling, 1999; Bakaev et al., 2007). Colour enhances communication, helps indicate interactivity, and provides visual continuity (iOS Human Interface Guidelines, 2014). It draws the eyes of users, adds aesthetic appeal as well as conveys personality. Colour is visually important to make a design more attractive, legible and viewer-friendly (Lim & Woods, 2010). Papachristos, Tselios & Avouris (2005) have identified influential colour factors which are brightness of the dominant colour, brightness of the secondary colour, the number of colours, and contrast between hues. However, colours may vary depending on cultural differences and how they assign meanings to colours. This would subsequently have an effect on the users' expectations. Therefore, the designer has to spend some time to select and assign correct colours for the application and ensure that the colours send the appropriate message.

Colour is one of the ways that an interface element indicates its interactivity. The designer should think about selecting a type of colour to signify interactivity, and pay attention to colour contrasts in different contexts (iOS Human Interface Guidelines, 2014). It is important to keep away from using the identical colour in designing interactive and non-interactive components, as it will be hard for users to know where to tap if both elements have the same colour. In most cases, colours should not distract users. Unless colour is necessary to the application's function, colour typically acts fine as a delicate enrichment. Grey has been linked with conservatism, traditionalism, intelligence, seriousness, neutrality and indifference (Ocampo, 2014). It is usually used as a background to highlight some elements in the design. Sometimes the grey is subtly used, but there are times when it is widely used for the entire application to make it look monochromatic.

2.8.4 Imagery

Images play a role in drawing attention, provide explanation and show details (Lee & Boiling, 1999). It invites interaction and also represents the content itself. Imagery can be in the forms of photography, moving images such as video and animation, icons, logos and symbol. Beautiful imagery makes the application more engaging and dynamic. Besides that, imagery related to the main content should be larger (iOS Human Interface Guidelines, 2014). This is because the larger element always catches the eyes of the audience as it tends to appear more important than smaller ones. Moreover, larger items are also easier for users to tap, which makes them especially useful in apps.

Appropriate inputs of animations preserve communicate status and offer response, improve the logic of direct interacting and assist users to picture the results of their actions. In particular, it is crucial to use motion effects with purpose and restraint, and be sure to test the results. These effects can increase users' understanding and enjoyment when used appropriately, and overusing them can make an application seem disoriented and difficult to control.

2.8.5 Controls

Controls or navigation have to be designed in a way that is uncomplicated to interact with and assist in accessing the content. Users likely to be unconscious of the interacting experience in an application except when it did not achieve users' expectations (iOS Human Interface Guidelines, 2014).

In addition, all necessary information should be readily available on the first page of the application. Labels for links have to be clear and also stand out using large fonts or colour. Home page should be designed with a large and visible menu, explain what is the application about and where does the links go to.

Menus should make available to access the functionality, and icons should be widely use as it provides graphic representation of shortcuts. Icons, text and graphic are vary in the presentation. Icons able to propose easy one touch access to the functions that often require the user to navigate through more than one menu. For that reason, icons are regularly used by designers to speed up their design progress on the navigation part which provides memorable, recognisable and clear buttons. Icons present more options to the user and bring functionality to the front of the interface.

Next, users have to constantly recognize where they are in the application and how to move on to next destination (iOS Human Interface Guidelines, 2014). The most important thing is that throughout the content, the flow of elements is expected, rational and straightforward to follow. On the whole, it is always better to provide users one clear flow or direction on each screen.

2.9 Design Principles

Design principles are the result of mix theory based knowledge, experience, and common sense. The prime objective while designing user interface is to fulfil needs of users while the second purpose is to give them an eye-pleasing aesthetics. Design principles act like triggers to designers, ensuring and suggesting they have certain features at an interface. In order to produce a visual appealing interface interactive multimedia, a number of aesthetic techniques combined with suitable design elements can be used such as clean lines, balance, colour, shape and texture (Sharp et al., 2011).

However, not all of the design principles can be applied. Problems will arise when too many design principles are applies in designing interaction product and the same could occur while using only one particular design principle. Various different types of design principles have been shared, and the researcher will discuss only two

features that were used for this research which are simplicity and the consistency (Ng et al., 2013).

2.9.1 Simplicity

Simplicity is the key here. The best interfaces are almost invisible to the user. According to Chang et al. (2012), when the users assess easy and simple application, they often comment using terms such as “simple” and “straightforward”. Negative comments received were mostly related to complexity in the usage of the application. Simple interfaces stay away from pointless components and are understandable in the language they use on navigation button and in information content. Ng et al. (2013) suggests sans-serif font type was used for its simplicity and ease in reading. The interface should be simple to avoid confusion among users.

Good design should contain the right balance among visual appeal and the grouping of text content per pages (Sharp et al., 2011). When too many elements are crammed into the interface, it would be difficult for the users to find what interest them. While designing an interactive application, some design elements can be removed or discarded in order provide appealing visual as long as it does not affect the function.

There are few ways to provide simplicity based on a research by Bhaskar et al. (2011). First of all, the application can apply progressive disclosure, and conceal more complicated and take away less commonly used functions until they are needed. Firstly, the application should presents ordinary and essential functions or the significantly important features. Secondly, provide defaults and reduce display alignment points. Finally, make frequent actions straightforward and uncommon actions harder.

2.9.2 Consistency

The interactive multimedia application needs to be designed with consistency. The designer should avoid using unnecessary unique interfaces and messages. In order to help produce efficiency, patterns of language, layout and design need to be created all the way through the application (Ng et al., 2013). For consolidating routines, the designer should identify similar processes and use similar approaches when designing the interface. User ought to shift that processes or approaches to other pages of the application once they have learned it. Consistency makes the interface much easier to learn and use. The useful design solution is to generate grouping of instructions that can be mapped into other pages for similar action (Sharp et al., 2011).

Consistency as believed by Galitz (2007) can be achieved by not changing the position of standard elements. Other than that, related elements have to design in similar appearance, have similar usage and also function similarly. In general, components that have related features have to seem related as well (iOS Human Interface Guidelines, 2014). Users frequently think that there is a motive for the contradiction they become aware of, and they will expend time trying to solve it out. To finish, the function of elements should not change. Fonts have to be used consistently too. To sum up, consistency will create an aesthetic interface.

2.10 Strengths and Limitations of Touch Screens Interface

In recent years, there is an increasing usage of touch screen applications, which has come to pass the prediction of Ben Schneiderman after 20 years (Caprani, O'Connor & Gurrin, 2012). The touch screen revolution happened principally by reason of the appearance of the Apple iPhone and iPad, and this was rapidly tag along by similar options but diverse competitors. Nowadays, devices with touch screen technologies are available with no trouble, moveable and also reasonably

priced. The nature of interaction, using finger to input directly is what formulate touch screen technology to be so interesting to users of all ages.

The advantages of touch screens usage include better interactivity and ease of use (Johari et al., 2010). Other than that, according to Bhalla & Bhalla (2010), touch screens require less thinking process and it is the easiest form of direct manipulation to learn. Other advantages include that it has the quickest pointing device and provides better hand eye coordination than traditional mouse and keyboards. In addition, it does not require additional work space when deploying touch screens and it is more durable for public access or high volume usage.

According to Bhalla & Bhalla (2010), however, user might obscure the screen with their hand during the interaction. The screens have to be positioned at a lower height and titled to reduce arm fatigue for prolonged usage. Some reduction in image brightness may occur. In some cases, the image brightness might be reduced due to hardware used. Touch screens often have higher cost than alternative input devices and they can get dirty easily when high usage occurred. Touch screen devices need more computing computer to process the input which may cost the device to run slower and introduce lower battery life. Touch screen devices does not have additional input keys in most cases, which will be troublesome when the application crashes, leaving the users stuck in an unresponsive screen, without ways of going back to the main menu.

In relation to the interface design of touch sensitive displays, Waloszek (2000) and Caprani et al. (2012) have provided some guidance. The main topics covered were screen space, screen layout, buttons and menu, data entry and complex controls. The researcher will study some of the important points here, together with other research done on visual design elements and principles, in order to come out with suitable methodology for this research.

2.11 Summary

Even though the Malaysian government had injects millions of dollars into the museums industry, museums are still faced with many challenges (Bernama, 2012). According to Elottol & Bahauddin (2011), museums or galleries are high maintenance institution yet valuable as they contain cultural knowledge and history. In addition, museums offer a good opportunity for visitors to learn through informal settings (Lin, Fernandez & Gregor, 2012). It can often fill the gap where formal learning institution could not provide, and create the potential for lifelong learning. Therefore, in order to uphold their existence, museums must also add value and contribute to the society by implementing interactive multimedia.

Engagement is an important factor in informal learning setting, as visitors have to actively engage with the content of the museum exhibits in order to make the most out of the learning process (Bitgood, 1991; Ng et al., 2013). Interactive multimedia which combine several types of multimedia, such as text, graphics, video, animation and sound, allows users to interact with the content data for both educational and entertainment purposes (Chrysostomou, Chen & Liu, 2008; Phillips & Chaparro, 2014).

The Normans' Emotional Design Model (2004) shows the importance of visual design in interactive multimedia in providing positive experience for users. According to Walter & Spool (2011), emotional experiences leave insightful imprint mark to the users' memory and forms humanize connection for users. Norman (2004) suggests that visual appealing application evokes emotion, and thus, making users to become more tolerant of minor difficulties.

In order to create a great visual presentation, during the design process the designers should adapt basic components of visual design that are grouped into two main categories: the design elements and the design principles (Yamin & Jaafar,

2013; Bakar & Long, 2013). The design elements for interactive multimedia comprise of layout, typography, images, colour, and controls (Partners, 2013). On the other hand, design principles are the result of mix theory based knowledge, experience, and common sense (Sharp et al., 2011). The main purpose of a user interface is to achieve the needs of users while the secondly purpose is to give them an eye-pleasing aesthetics.

Despite the initiative taken by the museums and galleries in Malaysia in providing visitors with a much more interactive experience, studies in the area if interactive multimedia usage are still minimal (Ng et al., 2013). Moreover, much of the studies about digital media have been undertaken in the area of website design or mobile application design (Bhaskar et al., 2011; Yamin & Jaafar, 2013). Though these studies are noteworthy, there is a need to acknowledge the interactive multimedia touch screens design in museum context.

The following chapter explains how the researcher conducts the study. Research design and data collection process will be further discussed in next chapter as well.

CHAPTER 3

METHODOLOGY

3.1 Overview

In this research, the aim is to investigate the visitors' perception and design preferences of interactive multimedia, in enhancing and engaging visitors' experience. As stated in Section 1.6, the two questions addressed in this study are:

1 What are the perceptions and preferences of visitors on current interactive multimedia in museum?

2 Does interactive multimedia application which meets the design criteria enhance visitors' museum engagement experience?

This chapter shows the research design of this study. The user-centered approach and overall procedures adapted from Simple Interaction Design Lifecycle Model (Sharp et al., 2011) are explained in the next section. The setting of the study and participants are discussed as well.

There are four stages of data collection (refer to Figure 1.2). The first stage of the study is to understand the visitors' perception and preference towards the current interactive multimedia in museum. The next three stages are conducted to identify suitable design criteria, to design and develop the interactive multimedia based on the Norman's Emotional Design Model (2004) design elements and two design principles (Ng et al., 2013), and to evaluate the developed interactive multimedia based on visitors' experience. Each of the research procedures are described in detailed and is followed by discussion on data analysis and data collection procedures. Finally, this chapter ends with a summary.

3.2 User-centered Approach

In this study, the researcher applied user-centered approach to the interactive multimedia development. This means the real users and their goals are the most important driving force for this study. The user-centered design approach was used to develop interactive multimedia to support rather than constrain the user. The three principles of user-centered design includes: early focus in users and tasks, empirical measurement and iterative design (Gould & Lewis, 1985; Mao et al, 2005).

In order to develop a useful and easy to use interactive multimedia, the first principle is to focus on users and tasks from the earliest stage. This helps the researcher to have a deeper understanding on which the users will be. This involves observing users doing their normal tasks, studying the nature of the tasks and then involving the users in the design process (Sharp et al., 2011).

The second principle for user-centered approach is empirical measurement. The researcher needs to observe and identify the user's interaction with interactive multimedia for empirical measurement early in development. This can help the researcher to choose between alternative designs and to check on the progress as the interactive multimedia is developed. The researchers observe how users interact with prototypes, recorded and analysed their performance and reactions as well.

Figure 3.1: Visitor Interacted with the Touch Screen in Gallery B of National Museum, on October 2013

All in all, iteration is one of the key characteristics of a user-centered approach (Sharp et al., 2011). It is necessary to revise ideas in light of feedback, trial and error several times, especially when trying to innovate. "Iteration is inevitable because designers never get the solution right the first time (Gould & Lewis, 1985)." However, the iterative design step is not involved in this research as it is beyond the scope of this study. The researcher will analyse the results in user testing step, and when problems are discovered, they will be written in the conclusion for future study.

3.3 Research design

Research indicates that products with high quality user experience can creates positive feelings and determine its success (Garrett, 2010). In this study, the researcher proposed the mixed methods approach to study how design of interactive multimedia affects preferences and user experience of visitors. While utilizing multiple methods, it allows a more in depth data gathering, research analysis and interpretation of gathered information (Ivankova, Creswell, & Stick, 2006).

There are four main stages for this study (Refer to Figure 1.2). For preliminary studies 1 and 2 in the first stage, direct observation was carried out to study the interactive multimedia placement and visitors' behaviour in galleries of National Museum. The researcher has observed the groups and individuals in the museum natural settings to fill in details that are not elicited from other forms of investigation. Furthermore, semi-structured interviews with visitors who have visited the National Museum help the researcher to understand their design preferences for interactive multimedia in museum. The researcher attempts to understand visitors' views and perspectives.

The researcher studied on the chosen interactive multimedia in the second stage to identify suitable design criteria. It contains information about the prime minister of Malaysia. The researcher looked at the design elements, suitable design principles to apply, and relate them to the Norman's Emotional Design Model.

In the third and last stage, a prototype is created based on the result of previous studies. The prototype is created using Adobe Flash with Action Script and the only changes are the design part. Questionnaire will be presented to visitors in order to investigate whether the adaption of design principles and design criteria have improved their museum experience and engagement. Details of the research design will be further elaborated in the next sections.

3.4 Overall Procedures

The model below incorporates the three principles of user-centered design and the four activities of interaction design (Sharp et al., 2011), which is later adapted and modified by the researcher for this study (refer to Figure 3.2).

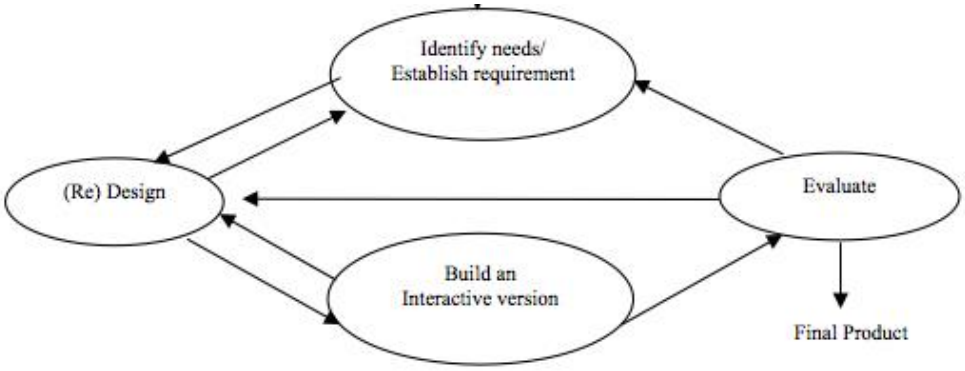

Figure 3.2: A Simple Interaction Design Lifecycle Model (Sharp, Rogers & Preece, 2011, p.332)

As shown in the figure 3.2, there are four basic activities altogether in the Simple Interaction Design Lifecycle Model. These are: establishing requirements, designing alternatives, prototyping and evaluating. The activities of interaction design are related. Again, the iterative design principle is not included in this study, which means the cycles of design-test-measure-redesign is only repeated once. This model was adapted for the research flow as it is clearly defined and guides the processes or activities involved in developing an interactive multimedia. Moreover, this model also has the characteristics of interaction design involves users, usability and iteration.

3.4.1 Stage 1: Establishing Requirements

Based on the Simple Interaction Design Lifecycle Model (refer to Figure 3.2), in order to design interactive multimedia that supports people, the researcher needs to study on the target user first. This activity is fundamental to a user-centered design approach (Sharp et al., 2011, p.330). In relation to this study, direct observation and interviews are conducted to identify the users' needs and to understand the nature of the tasks and the context in which they are performed.

3.4.2 Stage 2: Designing Alternatives

Next, the researcher analyse the data from the previous step and suggests ideas for meeting user requirements. According to Sharp et al. (2011), this is a core activity of designing interactive multimedia. The researcher studies similar interactive multimedia in the National Museum in order to generate alternative designs and prompt requirements. Findings from this stage form the basis of the material prepared for the next stage.

3.4.3 Stage 3: Prototyping

Based on the findings from previous stage, a prototype is designed and developed. A prototype is important for users to evaluate the design of the interactive multimedia effectively (Sharp et al., 2011). In this study, the researcher is modifying one of the existing interactive multimedia, which is "The prime minister of Malaysia" in National Museum.

3.4.4 Stage 4: Evaluating

In the last stage of the study, the prototype is tested in Gallery D of the National Museum. According to Sharp et al. (2011), testing a prototype is a very important part of the design and development process. Testing and evaluation simply confirms whether the application will work as it is supposed to or whether it needs refinement. Acceptability of the design is measured in terms of a variety of criteria including how appealing it is, how well it matches the requirements and so on. The purpose of this activity is to evaluate whether interactive multimedia designed with selected design criteria enhance user experience. A survey designed with 5 point likert-type scale is presented to the general public visitors in order to collect their feedbacks.

3.5 Setting of the Study

This study was conducted in National Museum or *Muzium Negara* which is located in Kuala Lumpur, Malaysia. The museum is one of the top museums in Malaysia and provides a good overview of the nation's rich historical and cultural heritage (Elottol & Bahauddin, 2011).

The National Museum was selected for the study because it has a constant stream of visitors. In fact, the museum received over 500,000 visitors in the year 2012 (Low, 2013). Other than that, National Museum is making effort to attract visitors. In doing so, the National Museum has launched a programme, Discovery Room for students to enhance their knowledge and experience during their visit. Moreover, after its recent upgrade in 2008, the museum has become a more interesting and interactive venue for visitors through the introduction and implementation of the multimedia display (UNESCO, 2014). The researcher would like to identify the perception of visitors for the latest changes in the National Museum and their expectation for further improvement.

In order to conduct study in National Museum of Malaysia, the researcher had contacted Jabatan Muzium Malaysia (JMM) at first for research permission. A formal letter from the researcher's supervisor and a letter about the research in detail were required. After a week, the application was successful and the researcher started with preliminary studies. The whole study was conducted within a period of one year.

3.6 Participants

The participants for this study were not predetermined, following a convenient sampling procedure. The participants consisted of general public from 18 years old who had visited National Museum. Youth which were the least among all

categories who visited museums in 2007 were included in this study as well (Mokhtar & Kasim, 2011). They were presumed to have basic computer literacy and were familiar with touch screens, and hence more problems could be identified. The participants were randomly selected in the National Museum, where both local and international visitors stood an equal chance to participate in the study. The researcher recorded first encountered visitors' activities. There was a time delay for preliminary studies and evaluation stage.

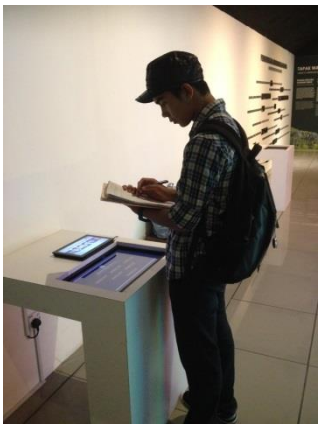

Figure 3.3: A Visitor Who Participated in Evaluation Stage at Gallery D National Museum, on 8th May 2014

3.7 Stage 1: Establishing Requirements

It will be hard for participants to explain or describe their needs accurately. Hence, both observation and interview methods were used to fill in details that other forms of investigation did not get.

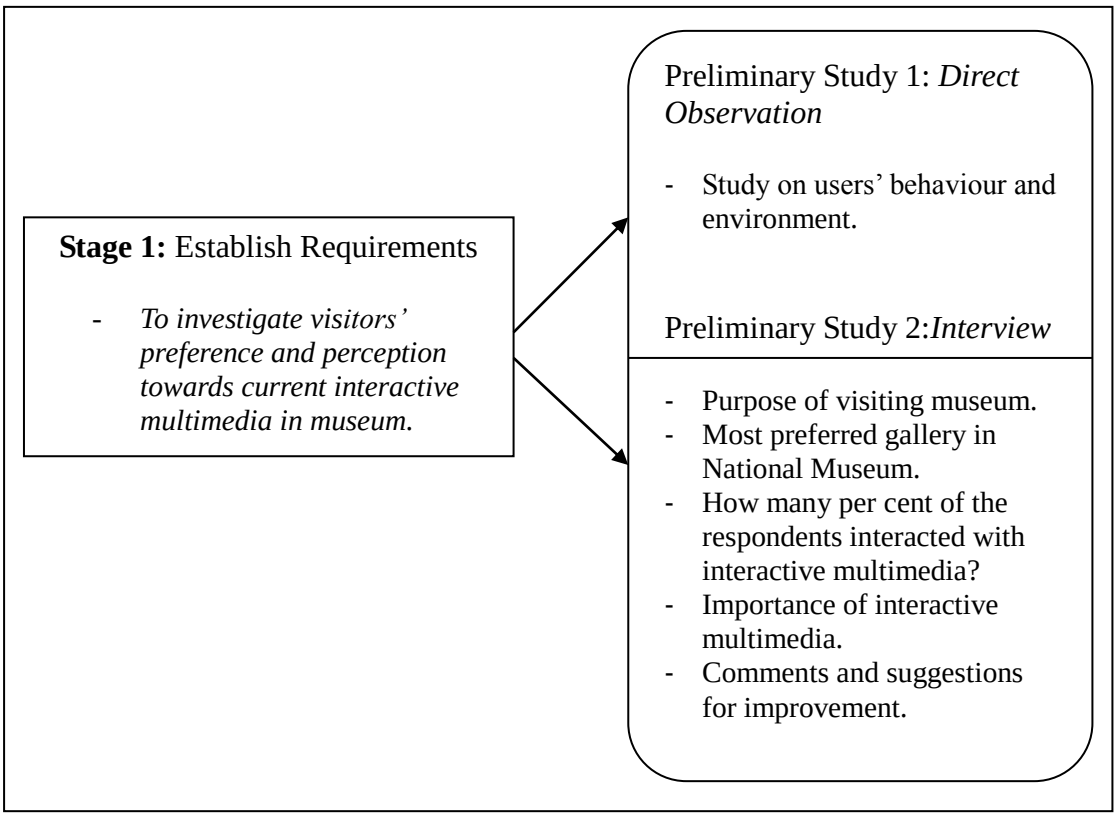

Figure 3.4: Diagram of Stage 1

3.7.1 Preliminary Study 1: Observation

The purpose of this stage is to have an overall picture and better understanding of the usage of interactive multimedia in museum among visitors through direct observation in the natural setting. Activities that take place on the site provide important information about culture. For this research, observational protocol was used as the data that collected can be organized into clear categories or groups so that the observer can record the data simply by marking off or checking a category on an observation form. The researcher studied on physical setting, participants, activities, interactions, as well as delivery of information (Savin-Baden & Major, 2013). For physical setting, the researcher observed the layout of galleries, as well as interactive multimedia that were implemented in the galleries of the National Museum. The researcher observed the visitors' behaviour as well to see how the visitors response to the interactive multimedia and the social groups. There are a number of ways to deliver information. Touch screens are the main concern in this

study.

When writing field notes the researcher included descriptive as well as reflective notes to describe the setting and the mood in details (Creswell, 2013). The descriptive observational variables required no inference on the part of the researcher. The observer observed the situation and took down notes. The traits of the participants, a reconstruction of dialogue, a description of the physical setting, account of particular events or activities were all observed. Reflective observational variables require the researcher's personal thought about what is observed and the underlying emotion. Some demographic information such as information about the time, place, and date of the field setting were written in this form also.

In order to ensure the study uses different perspectives, this study was done by two person team. The researcher acted as a passive observer, who adopted an approach right at the outside end of the spectrum. The qualitative data was compiled and analysed manually at the end of each day. Additionally, the researcher checked observations with other member of the group to ensure the results were accurate. While there were similar patterns of behaviour repeated, the researcher stopped observing. This study was supplemented with pictures.

3.7.2 Data Collection Procedure

The data collection for this study was carried out between May 2013 and October 2013. After gaining approval from Jabatan Muzium Malaysia (JMM), the researcher visited the National Museum to meet the curator in order to explain in detail the purpose and procedure of the study. Collection of information was carried out afterwards with the help of the museum staff. The information was gathered through brochure, interaction with each interactive multimedia, and observation of visitors' behaviour in the museum.

3.7.3 Data Analysis Procedure

Observation method was conducted in order to understand the visitors' behaviour while visiting museum. The researcher also studied the floor map of museum galleries and pointed out each interactive multimedia location. The data were compiled and analysed manually.

3.7.4 Selection of Gallery

There are 4 galleries in the National Museum, each with its own theme. Gallery A is about early history of Malaysia's earliest inhabitant. For Gallery B, it traces the history of the early Malay Kingdoms in the Archipelago, with special reference to the Malay Peninsula and highlights the glory of the Malay Kingdom of Melaka in the 15th century. The exhibition in Gallery C charts the history of the control and administration of the foreign powers, the colonial era. Gallery D guides the visitor through the audacious paths in the unweaving struggle of the various races for independence and the formation of the nation.

Two out of four galleries, which were Gallery B and Gallery D, were equipped with interactive multimedia using touch screen interface. The researcher studied the space and layout in both of the galleries in order to know the location of each touch screen type interactive multimedia. In addition, the researcher observed the usage of touch screen applications among visitors as well.

3.7.5 Preliminary Study 2: Semi-structured Interview

In addition to direct observation, interview is one of the data collection techniques that are commonly used for rapid assessment. An interview was carried out because the researcher would like to understand how users react to interactive multimedia in museum. Since the perception of visitors cannot be observed directly, the researcher had a conducted semi-structured interview with visitors in the museum to explore issues and get insights (Sharp, Rogers & Preece, 2011). According to Cohen and Crabtree's Qualitative Research Guidelines Project Bernard (2013), semi-structured interview is best used when there is not more than one chance to interview someone because this design types provide "a clear set of instructions for interviewers and can provide reliable, comparable qualitative data". The researcher used both closed and open ended questions for the interview (refer to Appendix 3), since the range of possible answers is known and visitors are in a rush. The questions were adapted from Katre and Sarnaik (2010) survey and the questions were divided into three sections:

1) Visitor's demographic: The first part collects participants' basic information, such as gender, age, nationality and language.
2) Visitor's behaviour and preferences: The second part studies the frequency of visit and reasons of visiting in order to come out with a design which meets visitors' expectation. Visitors' preference and interest of exhibition in National Museum helps the researcher to determine the potential theme to be developed.
3) Visitor's experience and expectation towards current interactive multimedia in museum: To identify whether interactive multimedia improves their visiting experience.

The researcher followed the pre-set questions and relied upon an interview protocol, asked questions and covered topics in a particular order, and from time to

time strayed from the guide as appropriate (Savin-Baden & Major, 2013). These interviews were conducted within the context of one-to-one interactions between the researcher and respondents. Later on, the researcher analysed the data to search for patterns, important keywords and perceptions of visitors.

3.7.6 Data Collection Procedure

The data collection for this study was carried out during a week in October 2013. The researcher invited visitors around Gallery B and Gallery D to participate in the interview. Visitors were briefed on the purpose of the study before starting, and they were given freedom to choose whether they wanted to participate in the study or not. Participants were asked demographic question first. Other questions were asked after that. The researcher only jotted down the keywords of their answers, in order to focus more on the flow of conversation and interaction. According to Marshall et al. (2013), 30 respondents is a reasonable starting point for deciding the qualitative sample size that can reveal the potentially important user perceptions. However, this research is using convenient sampling for data collection. Thus, there is the need to continue collecting the data until the researcher have interviewed an appropriate number and identified a consistent pattern.

3.7.7 Data Analysis Procedure

Thematic analysis approach was used to analyse the qualitative data because it is simple, less time consuming and flexible (Braun & Clarke, 2006). The main goal when using this approach is to provide a description and understanding of answers, by discovering patterns and developing themes. In order to analyse the comparable qualitative data, the collected data were analysed by using Statistical Package of the Social Sciences (SPSS) software. The researcher categorise the answers of the respondents into variables and put in a table. For open ended questions, answers are put into tables in Chapter 4. Findings or conclusions from this stage of the study will

be the basis of the next stage.

3.8 Stage 2: Designing Alternatives

Based on the findings from the previous stage, the researcher precedes the study by researching similar product (Sharp et al., 2011; p.366) in order to generate alternative designs. Besides that, this also prompts requirements. In this study, the researcher looked at one of the chosen interactive multimedia in Gallery D, which is the "Prime Minister of Malaysia" touch screen application. According to the result in the previous stage, Gallery D, which was recently equipped with functional touch screens, does not attract much interest among visitors (refer to Table 4.4). Other than that, the reason for choosing only one touch screen application out of six others in Gallery D is because all of them have the exact same design and layout. Since the main objective of this study is to improve visitors' experience using suitable design criteria, the touch screens are generalised with design elements. This particular subject "Prime Minister of Malaysia" was chosen as the study material because it is an important knowledge for both local and foreign tourists as it is able to provide visitors with a depend understanding about the history of Malaysia.

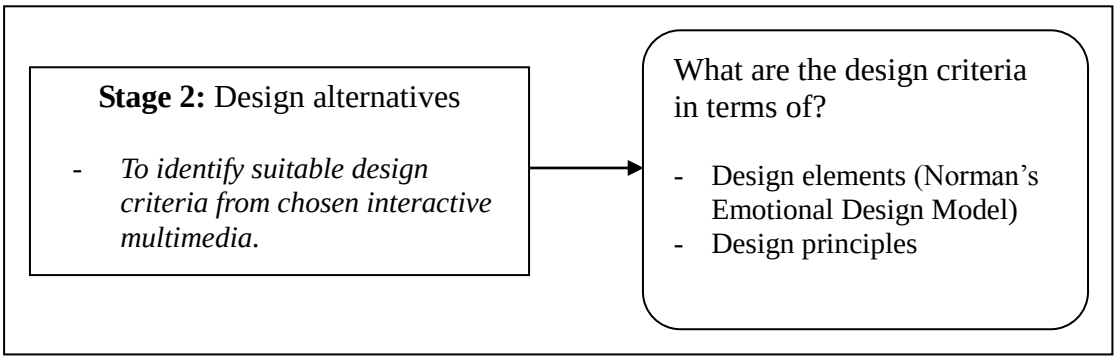

Figure 3.5: Diagram of Stage 2

Then, a test version was produced by applying design elements from Norman's Emotional Design Model (Partners, 2013) and design principles in the design. The content and the medium remained unchanged, as the focus of this study is on the design of the interactive multimedia.

3.8.1 Data Collection Procedure

The data was collected by the researcher through interaction with the particular "Prime Minister of Malaysia" interactive multimedia. The interaction was recorded in video format to be analysed later on. Photos were also taken for each different page to study the design of the interactive multimedia as well. All these data will be explained in Chapter 4 with pictures included.

3.9 Stage 3: Prototyping

The prototype is created according to the results of visitor studies, design elements from Norman's Emotional Design Model (Partners, 2013) and design principles which are the simplicity and consistency. After the development, it is implemented in the National Museum for further evaluation by the researcher. The content and pictures were given by curator of National Museum.

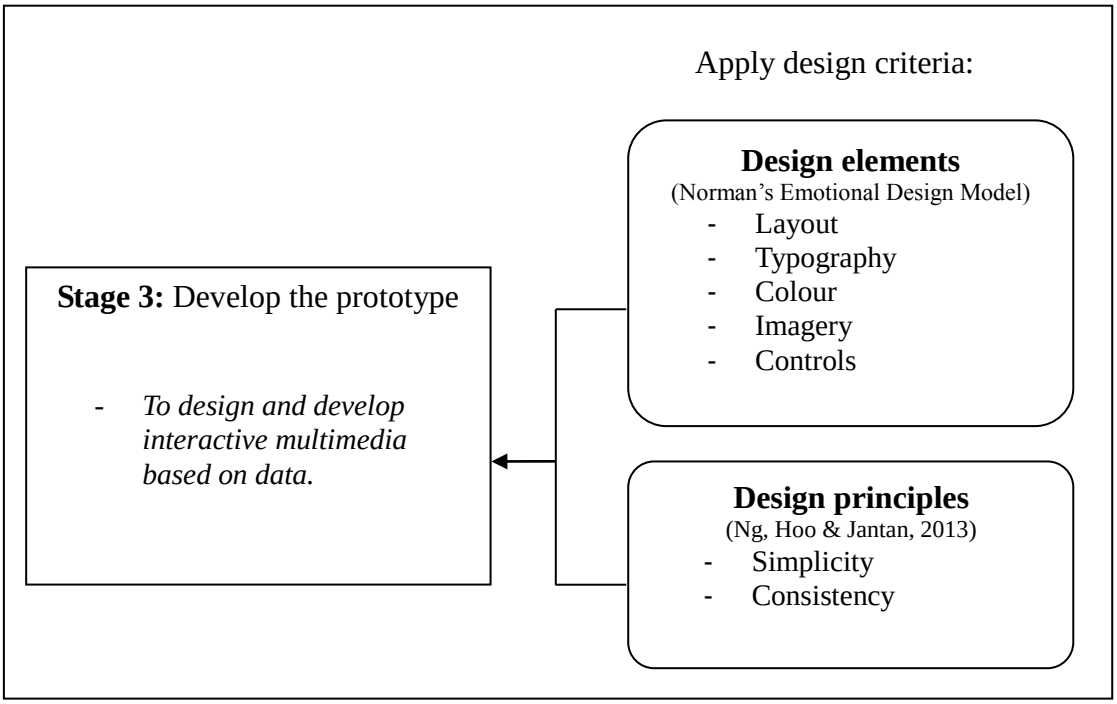

Figure 3.6: Diagram of Stage 3

3.9.1 Design and Development

Touch screen system that allows direct interaction with content information is used for this study. It is accessible and user friendly, a suitable platform for museum exhibits. Touch screen interface has become common in our daily lives since mobile phones and tablets usage have become generalize. As most visitors nowadays are digital natives who grew up with technology, they do not have to spend too much time to get familiar with the system.

The researcher has chosen one out of 6 existing interactive multimedia in Gallery D of National Museum for new design. Gallery D consists of information about independence and the formation of Malaysia. Basically the touch screen system is stored inside an enclosed box with the screen surface facing upward.

Adobe Flash is used to develop an application which provides interaction between users and content information. The researcher will capture the content and information from the original interactive multimedia, and improve the design of it based on the results in preliminary studies. The chosen content for prototype design is "The Prime Minister of Malaysia". This application will be designed in two different types of language, English and Malay in order to fulfill the needs for local and international visitors.

Based on the findings from preliminary studies and literature review, the researcher applied the design elements in Norman's Emotional Design Model (Partners, 2013), focused more on the visceral and behavioral levels, while designing touch screen application. In addition, two design principles which are simplicity and consistency have been adapted while designing the application in order to fulfill users' needs and provide eye-pleasing visual design interface (Sharp et al., 2011; Ng et al., 2013).

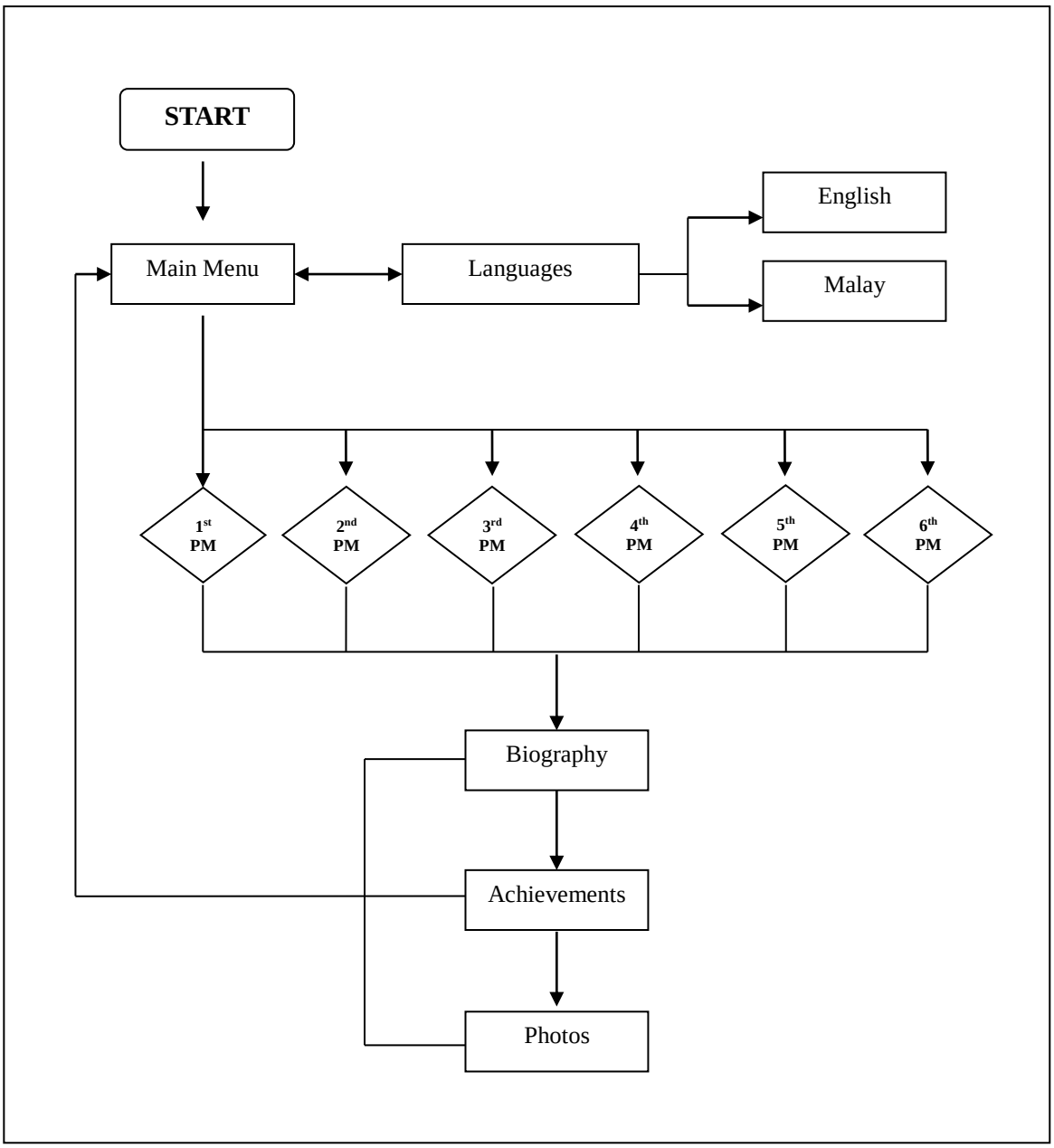

Figure 3.7: The Prototype Application Flowchart

The flowchart above was created prior to visually present the flow of data through an information processing system. Flowcharts are used in designing, documenting or managing a process or program in various fields (SEVOCAB, 2014). Different kinds of symbols were used in creating this flowchart. Rounded rectangular usually signalling the start or end of one application. Arrows were used to show the flow of control. Rectangles were used to indicate the processing steps, and diamond

indicated that a decision was necessary.

At the beginning, the researcher discussed and filtered unnecessary information with museum curator. Additional information was separated into different layers to keep the interface simple such as a lengthy text of paragraph was split into multiple pages. Navigation menu was designed to be intuitive and easy to recognize. Besides, the consistency of layout is important in order to let participants get used and familiar with the application in a short time.

3.10 Stage 4: Evaluating

Questionnaires designed with 5 Point Likert-scales are adapted from Ng, Hoo & Jantan (2013) and distributed to visitors in order to measure the overall experience of participants after using the prototype. Ng's questionnaire was adapted as she had applied relevant design principles (consistency and simplicity) while designing interactive multimedia and achieved its educational and entertainment purpose. Likert scale is often used to measure the respondents' attitudes by asking the extent to which they agree or disagree with a particular question or statement (Dawes, 2008). 5 Point Likert-scales is the most common scale and mostly seen ranging from "Strongly Disagree" on one end to "Strongly Agree" on the other with "Neither Agree nor Disagree" in the middle. This study helps the researcher to understand whether the prototype is working well and if so, to what degree.

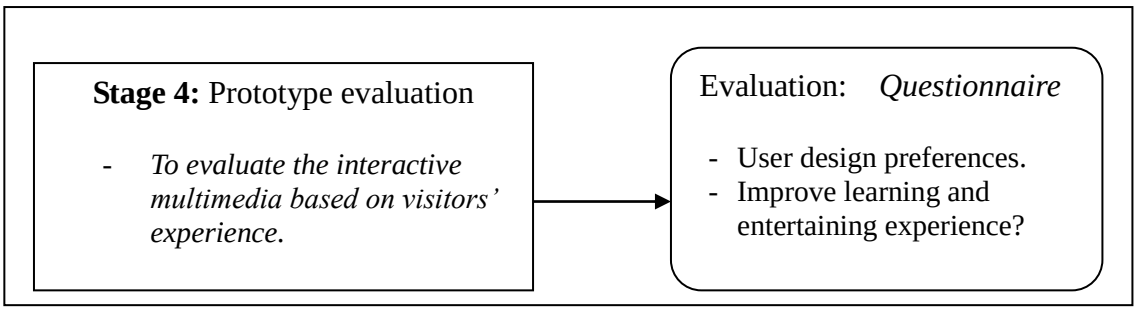

Figure 3.8: Diagram of Stage 4

3.10.1 Implementation and Evaluation

After the development, the prototype was shown to the curators of the National Museum for feedback and approval on 22nd April 2014. Later, the modified "The Prime Minister of Malaysia" application was implemented in a touch screen device and put side by side with the original application for a week (7 working days) from 5th May until 11th May 2014. Questionnaire was used to collect feedback from a large sample of visitors in order to get wider perspective (Sharp et al., 2011). The questions in the questionnaires were close ended (refer to Appendix 4). The questionnaire was created based on data from preliminary studies (refer to Table 4.10) and Ng's paper (2013). It was modified by the researcher afterwards by applying the Norman's Emotional Design Model. It consisted of three main sections, namely demographics section, user design preferences section and users' overall experience section. The demographic section requests information on age, gender, nationalities, and qualification.

User preference in touch screen design covers the design criteria: attractive, hold attention, easy to navigate, information presented was clear and consistent, well organised, comfortable to read, well balanced of colour usage, and suitable images or graphics. These criteria are related to visceral and behavioural levels of Norman's Emotional Design Model, design elements and design principles. It is important for the researcher to know whether the design of the modified application is more towards the preferences for visitors.

Table 3.1: Justification for Design Preferences Criteria in Questionnaire

Design Criteria	Justification
a) Attractive	This criteria is based on the first level of Norman's Emotional Design Model – *Visceral Level*. It is important to understand whether the visual design of modified application attract users, as visual aesthetics impact greatly on the overall impression.
b) Hold attention	This criteria is based on the second level of Norman's Emotional Design Model – *Behavioural Level*. In order to hold user's attention, a good quality of visual design leaves users with good first impression and willing to stay longer to explore more at the behavioural level.
c) Easy to navigate	This criteria is based on the suggestion from users in preliminary studies. Visitors suggested the *Design Elements – Control*, should be easy to navigate and identified.
d) Information presented was clear and consistent	This criteria is based on the *Design Principles - Simplicity and Consistency* that have been applied in the modified application design. Simplicity and Consistency have been widely applied in designing interactive product (Sharp, Rogers & Preece, 2011 ; Ng, Hoo & Jantan, 2013).
e) Well organised	This criteria is based on the suggestion

	from users in preliminary studies. Visitors suggested the *Design Elements – Layout*, has to be well organized.
f) Comfortable to read	This criteria is based on the suggestion from users in preliminary studies. Visitors suggested the *Design Elements – Typography*, should be comfortable to read.
g) Well balanced of colour usage	This criteria is based on the suggestion from users in preliminary studies. Visitors suggested the *Design Elements – Colour*, should be brighter or more colours.
h) Suitable images or graphics	This criteria is based on the suggestion from users in preliminary studies. Visitors suggested the *Design Elements – Imagery*, more graphics or pictures should be added in.

Based on the behavioural level of Norman's Emotional Design Model and comments from users (refer to Table 4.10), the researcher wants to know whether the modified application is easy to use. This question is to understand the effectiveness of modified application and users' satisfaction. In addition to that, the participants were asked if they have a positive and engaging experience interacting with the modified "The Prime Minister of Malaysia" touch screen application. The user experience section is broken down into two aspects, which are learning experience and also entertaining experience.

Table 3.2: Justification for Learning Experience Criteria in Questionnaire

Learning experience	Justification
Learned something new.	This criteria managed to encourage users to learn something new in an informal learning environment.
Curious to find out more information.	This criteria helps the researcher to know whether the modified interactive multimedia motivates users and increase their interest in finding out more information.

The learning experience is evaluated in order to fulfil the purpose of museum galleries existence, which is to add value and contribute to the society by providing education and enjoyment (Elottol, 2011). Learning something new is important as it shows users have achieved the objective of interactive multimedia implementation and gain benefits from it. Besides, if users are curious to find out more information, it indicates that the visual designs do affect learning experience too. Other than the educational purpose, interactive multimedia provides entertainment as well. Funs, entertaining and emotionally engaging are the user's experience criteria the researcher would like to discover.

Table 3.3: Justification for User Experience Criteria in Questionnaire

User experience	Justification
Fun	The researcher would like to discover whether the visual design affect fun experience of interactive multimedia.
Entertained	The researcher would like to know whether visual design helps to entertain users.
Emotionally engaged	Based on the Norman's Emotional Design Model, emotional experience leaves an imprint in the users' memory thus forming a deep relationship with users. The researcher would like to discover whether modified application had formed a connection with users.

For the last question, the researcher would like to know do visitors enjoy using modified application of the "The Prime Minister of Malaysia". This question helps the researcher to know whether modified application enhances users' positive experience. Users can further comment on the design of the modified application. The comments will be analysed and put into a table as suggestion for future studies.

3.10.2 Data Analysis Procedure

In total, 104 visitors from the National Museum who interacted with the prototype participated in this evaluation. Visitors rated their experience on a five-point Likert Scale from "Strongly Disagree" to "Strongly Agree". The data gathered were analyzed using Statistical Package of the Social Sciences (SPSS) software. Descriptive statistics were used to calculate the frequencies, mean and standard deviation of the variables.

3.11 Summary

This chapter discussed the methodology in detail of how the researcher conducted the study effectively. Four stages of studies which were adapted from Simple Interaction Design Lifecycle Model (Sharp et al., 2011) were conducted in National Museum of Malaysia. The research design and data collection procedure explained in this chapter helped the researcher to conduct data collection and data analysis methodically in the next chapter.

CHAPTER 4:

DATA ANALYSIS

4.1 Overview

In this chapter, the researcher presents the data collected from the four stages studied, as described in Chapter 3. The objectives of each of the stages are listed in Table 4.1. The qualitative data was compiled and analysed manually, and the quantitative data was measured by frequency counts using SPSS.

Table 4.1: Objectives of the Four Stages

Study	Objectives
Stage 1: Establish requirements	Investigate visitors' preference and perception towards current interactive multimedia in museum.
Stage 2: Design alternatives	Identify suitable design criteria.
Stage 3: Prototyping	Design and develop interactive multimedia based on design elements from Norman's Emotional Design Model (Partners, 2013) and design principles: simplicity and consistency (Ng et al., 2013)
Stage 4: Evaluating	Evaluate the interactive multimedia based on visitors' experience.

4.2 Stage 1: Establish Requirements

This section reports the findings from preliminary studies, direct observation and interview sessions conducted with visitors at galleries in National Museum. The researcher conducted this stage of the study for one week, which started from 24th October 2013 until 30th October 2013.

4.2.1 Preliminary Study 1: Observation

The observation was conducted to understand the usage of touch screens among visitors in the current state. According to the senior museum assistant from the National Museum, during weekdays from 11am until 4pm is the peak visiting time. On weekends, from 9am until 6pm, there are lots of visitations the whole day. Normally, all systems in the National Museum will closed down at 5.30pm. Afterwards, there is free entrance for half an hour until the closing time of the National Museum. Hence, the researcher started to observe from 11am until 4pm every day. However, the researcher noticed that the number of visitors during lunch hour, 1pm to 2pm, is relatively low.

4.2.2 Visitor Behaviour Observation

Through observation, the researcher noticed that younger visitors spent less time in the museum galleries compared to the visitors from other age groups. It shows that the objects or artefacts in the museum could not engage them for longer time. Visitors aged less than 18 years old will be eliminated from the study as the researcher noticed that children are interested with any touch screens, and was quickly bored if the touch screens are not equipped with games. Other than that, children could not form or provide their opinions clearly.

Figure 4.1: Children were Interacting with Touch Screens in Gallery D

The behavioural study of visitors in the museum gallery had shown that certain patterns in terms of the behaviour of visitor, and interaction in between their social group while visiting museum. The researcher was able to categorise the social groups among the museum visitors.

- Friends
- Students
- Families and relatives
- International visitors
- Local tourists
- Others (loners)

The visitors are further identified based on their interest levels. The interest levels are measured according to the visitors' response to the interactive multimedia (interaction, gestures and postures).

- Motivated: those who visit museum out of interest (tourists)
- Initiated: those who are guided by somebody (students)
- Neutral: those who came to pass the time

Figure 4.2: Visitors in Both Gallery B and Gallery D, October 2013

Based on the observation, the researcher noticed that tourists tend to stay in the museum for longer time and go through artefacts slowly in museum since they have the interest to understand more about the local culture and history. Most of the students do not have the intention to learn more. They only study the information which were related to their assignments or studies. As for those who visit a museum for leisure, they were only attracted to the object or artefacts that interest them. Most of the time, they were more into their own group of conversation.

4.2.3 Interactive Multimedia Observation

For Gallery B, besides the related artifacts of the early Malay Kingdom exhibited, there were six touch screens (TS) installed. However, while the researcher visited the National Museum on October 2013, one of the touch screens, TS2 Contemporaries and Successors of Melaka, was temporary off. The floor map and touch screens location are shown in the figure below:

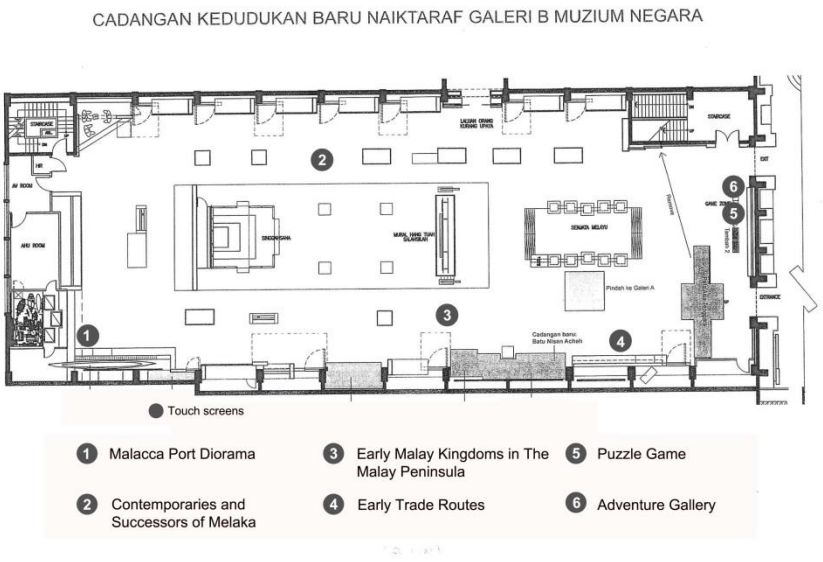

Figure 4.3: Touch Screens Location in Gallery B of National Museum

All of the touch screens in Gallery B were designed in similar layout and colours to bring out the theme of early Malay kingdom. The main menu page was attractive enough to encourage visitors to approach it. However, the information was hard to read on screen with small text sizes. Besides that, there is no feedback, such as transition while the users were interacting with the button. There is a lack of imagery usage at the interface as well, which is important to provide more engaging and enjoyable experience (Mullet and Sano, 1995; Sharp, Rogers & Preece, 2011).

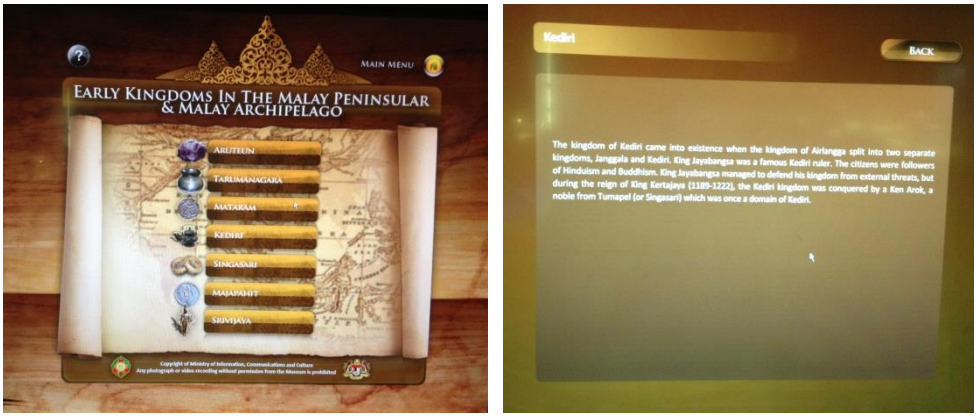

Figure 4.4: One of the Interactive Multimedia Applications in Gallery B

Two of the touch screens applications were designed in game-based content, which are TS6 the Adventure Game and TS5 the Puzzle Game. Both of them were located near to the entrance and exit doors. These two were the most popular touch screen applications among all.

Figure 4.5: Visitors Interacting with Game Based Touch Screens

Although touch screens in Gallery B were well designed with theme and correct mood, few problems occurred. Most of the touch screens were not usable because the system froze, or insensitive touch point. This had shaped bad experience as the touch screens did not fulfil the users' expectation and needs (Anonymous, 2011).

Figure 4.6: Frozen Touch Screen with "Out Of Service" Sign

On the other hand, Gallery D guides the visitor through the audacious paths in the unweaving struggle of the various races for independence and the formation of the nation. It was closed for renovation and reopened on 1st of September 2013 in conjunction with Malaysia Day.

This gallery has much more free space because there are not much of artifacts to showcase in it. This gallery is designed with much more digital technologies integrated, includes two projections, a mini theater, videos playing on two screens, and six touch screens.

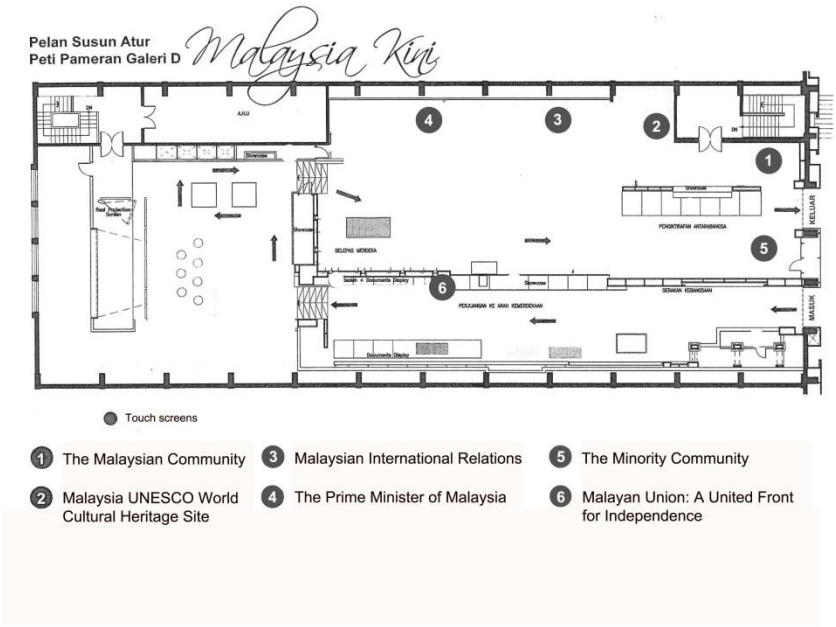

Figure 4.7: Touch Screens Location in Gallery D of National Museum

All touch screens in Gallery D have the same layout and design. The main menu page was not attractive enough as it does not use any imagery or multimedia to attract users approach. The information has been presented in both English and Malay languages on the same page and this cause difficulty for the users as they could not focus.

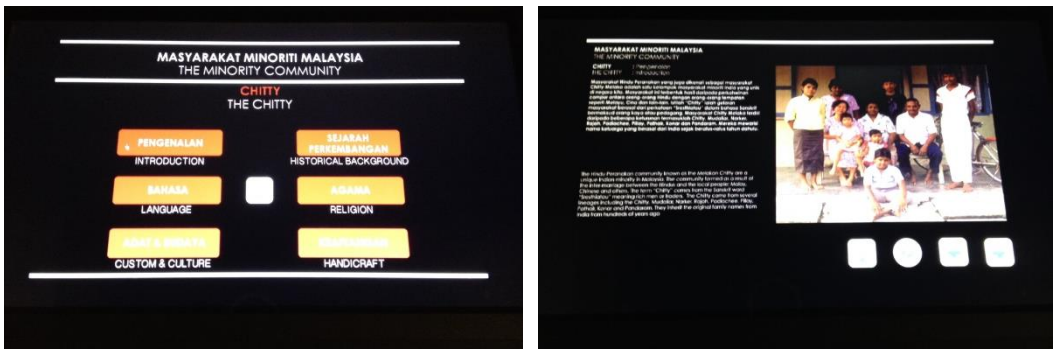

Figure 4.8: One of the Interactive Multimedia in Gallery D

Through observation, the researcher noticed that most visitors were not motivated to interact with the touch screens in Gallery D. Although this gallery has been implemented with new, fast and user friendly touch response screens, the potential and benefits of interactive multimedia did not fully maximized.

Figure 4.9: Not Much Visitors Interacted with Touch Screens in Gallery D

4.3 Preliminary Study 2: Interview

The researcher investigated visitors' design preferences and perception of interactive multimedia through interviewing them. A semi-structured interview survey, which consisted of two sections, was used for the data collection (refer to Appendix 3). The interview was conducting while the researcher conducting observation.

Figure 4.10: The Researcher was Interviewing One of the Visitors

There were 70 visitors that the researcher approached. However, only 56 visitors were willing to participate in the study. 6 of the visitors had to stop in the middle of interview session as language barrier and time constrain are the reasons. Eventually, fifty visitors who age more than 18 years old had done the interviews on the field. The respondents constituted of 26 males and 24 females (n=50). According to Marshall et al. (2013), grounded theory qualitative studies generally include between 20 and 30 interviews. That is, how large does the sample need to be to allow for the identification of consistent patterns. In order to generalize data information using convenient sampling in this research, the researcher stop collecting interviews once noticed the same patterns appeared. In next section, the researcher will discuss

the important key points that visitors had stated.

4.3.1 Purpose of Visiting a Museum

The respondents were asked about their purpose of visiting a museum in an open ended question. In general, visitors visit a museum with the purpose of gaining more knowledge, to do their assignments, and to pass the time (Table 4.2).

Table 4.2: The Purpose of Visiting a Museum

Purpose of visiting	Justification
Gain more knowledge	- "Check out is there any difference since last visit." - "Gain knowledge in casual way." - "Visiting." - "Visiting with family and friends."
For assignments	- "School project." - "For study research." - "School trip."
For leisure	- "Kill time." - "Dating."

These results relate back to the observation data were the researcher has categorized based on visitor's interest levels.

4.3.2 Favourite Museum

The respondents were requested to indicate their favourite museum that they have ever visited. Among all respondents, three of them are international visitors who came from Bangladesh, India and Indonesia. As for the local visitors, most of them think National Museum is up to their preference. Some of them suggest other local museums, and one of them mentioned the National Taiwan Museum. This indicates that visitors prefer to visit museums which have much more interactive multimedia integrated.

Table 4.3: Favourite Museum

Types of visitor	Favourite museum
International visitors	- British Museum - Hadrabat State Museum - Petrosains
Local visitors	- National Museum - Maritime Museum (Malacca) - Sultan Alam Shah Museum (Selangor) - Terengganu State Museum (Terengganu) - Islamic Arts Museum Malaysia (Kuala Lumpur) - National Taiwan Museum

4.3.3 Most Preferred Gallery in National Museum

Visitors, who have visited National Museum, were asked to choose their most preferred gallery. The National Museum has 4 galleries in total. Based on the 50 respondents, Gallery B and Gallery C were the most preferred gallery among others. On the other hand, Gallery D had the least voting.

Table 4.4: Most Preferred Gallery in National Museum

	Frequency (*f*)	Percentage (%)
Gallery A	14	25.00
Gallery B	16	28.57
Gallery C	16	28.57
Gallery D	10	17.86
Total	56	100.0

(The respondents were allowed to choose more than one gallery.)

Overall, the factors that affect visitors' preference over gallery in National Museum can be categorized into having interesting objects or informative. The reasons are given below:

Table 4.5: Factors of Preference on Gallery

Preference	Justification
Informative	- Historical information - Old history stories - Local cultures
Interesting objects	- Art related objects - Interesting artefacts - More visual appealing - Old weapons

From the results, the researcher chooses Gallery D, which is the least favourite among all galleries, to conduct evaluation afterwards and to enhance visitors' museum experience.

4.3.4 Usage of Touch Screens in National Museum

A senior museum assistant stated that nowadays too much people use digital technologies for entertainment and for education. She believes that digital interaction and multimedia might attract native youngsters who have grown up with digital technologies (Appendix 2). In this study, part of the respondents is from the younger age group as there are lots of school groups visiting the museum while this research going on. Young visitors' opinions are important because they are our potential museum professionals and audiences in future. Touch screen as the medium that provide interactivity is more attracting to younger generation since they grew up with it. As shown in the table below, 72 percent of the respondents do approach touch screens. This shows that touch screens are able to attract certain group of visitors.

Table 4.6: Did You Interact with Any Touch Screens in National Museum?

	Frequency (*f*)	Percentage (%)
Yes	36	72.0
No	14	28.0

N=50

Open ended questions are designed to understand the factors that encourage or hinder visitors to interact with touch screens. The reasons for visitors who have approached touch screens are summarized as follows. The factors can be categorized into two, which is to study for more information and entertain.

Table 4.7: Reasons for Using Touch Screens

Reasons	Justification
Education	- "Yes. To get more information." - "To learn new stuffs." - "Want to know more information." - "Search for extra information." - "Search for history related information." - "For information."
Entertainment	- "Out of curiosity." - "Interesting to be able to interact with touch screens."

On the other hand, factors that hinder visitors from interacting with touch screens can be categorized as follows:

Table 4.8: Reasons for Not Using Touch Screens

Reasons	Justification
Did not notice touch screens	- "No. Did not notice." - "Did not notice." - "Didn't notice."
Time constrain	- "Not enough time to read." - "No, there were people using it."
Languages barrier	- "Cannot understand the language."

For those who did not approach touch screens in museum, most of them did not notice the presence of touch screens. However through observation, some of them who did interact with touch screen once did not approach touch screen for the rest of their visit. As all of the touch screens have similar designs and hard to read. In addition to that, some of the samples also provided reasons of time constraint and language barriers as a factor that discouraged them to use the touch screens.

4.3.5 Importance of Touch Screens

Based on the question "Does touch screens affect your overall museum visitation experience?" high percent of visitors, which consist 88 percent of them agree on the influences of touch screens on their overall museum visit. This result suggests that touch screens are relatively important in order to enhance visitors' museum visit.

Table 4.9: Does Touch Screens Affect Your Overall Museum Visit Experience?

	Frequency (*f*)	Percentage (%)
Yes	44	88.0
No	6	12.0

N=50

4.3.6 Comments and Suggestions for Touch Screens

Some of the respondents' comments and suggestion on how to improve the overall design of touch screen are extracted and listed as follows. Similarly, many of the suggestions can be categorized into the content design elements, which match the visceral and behavioural levels proposed by Norman's Emotional Design Model. All of these aspects require further improvement to achieve greater experience and engagement.

Table 4.10: Suggestions for Touch Screens Improvement

Design Criteria	Justification
Layout	- "Layout has to be well organized." - "Creative layout needed."
Typography	- "Text size is too small." - "Too much text in one page." - "Using headlines and showing with different type of font or different size." - "Should be comfortable to read."
Colour	- "Need more colours." - "Too dark."
Imagery	- "More videos."

	- "Video." - "Listen and watch video." - "Animation." - "Graphic and visual." - "More pictures and graphics."
Control	- "Button no feedback." - "Button looks like out of the design"
Ease of use	- "Not useful and convenient."

As shown in Table 4.10, most of the comments or suggestions are based on design criteria. In relation to this, visitors are suggesting that the visual designs on the current touch screens need to be improved in order to enhance the visitors' learning experience.

4.3.7 Data Analysis

The observations as well as interviews have proposed several needs of visitors that continue unaddressed in the current informal learning settings. The prototype is proposed to focus on user interface design in order to satisfy the main concern of museum visitors.

The researcher has noticed that most visitors have limited attention span. They have no patience to read more details of historical information displayed in the museum. Hence, smaller pieces of content that can be read in short time should be presented in the interactive multimedia application. This approach implies to provide stimulation and learn new information quickly. Visual index with layered information is the method to solve this problem (Katre & Sarnaik, 2010).

4.4 Stage 2: Design Alternatives

In this stage, the researcher studied on the chosen interactive multimedia application in order to identify suitable design criteria for prototype development later. The researcher decided to improve one of the touch screens design in Gallery D as it is one of the least favourite galleries among all. The selected touch screen application is "The Prime Minister of Malaysia" which displayed in both English and Malay. This application was chosen because it contains the biography and information about prime ministers of Malaysia. The related information, content and pictures were provided by the curators from National Museum.

Findings from Stage 1 discovered that design elements which include layout, typography, colour, imagery and control from the visceral level of Norman's Emotional Design Model (Partners, 2013) are the main design elements that should be considered while designing interactive multimedia. Although the original application is designed with the basic design elements which similar to Norman's emotional design model, the overall look and feel of the application is not attractive which is different with the concept theory of Norman's Emotional Design Model. In order to solve the design problems, the researcher will apply design principles while developing the prototype.

4.4.1 Layout

The figure below (Figure 4.11) shows the most important page of "The Prime Minister of Malaysia" application. First page or main menu is important to attract users. Since the centre of the screen is the focus of vision, it should hold the main content text. However, by centring all the elements on the page, it makes it look like an amateur design. Besides, the arrangements of the navigation buttons are confusing since the figures are not placed in sequence. Position of elements needs to match the user's flow (Partners, 2013).

Figure 4.11: The Layout of the Application's Main Menu

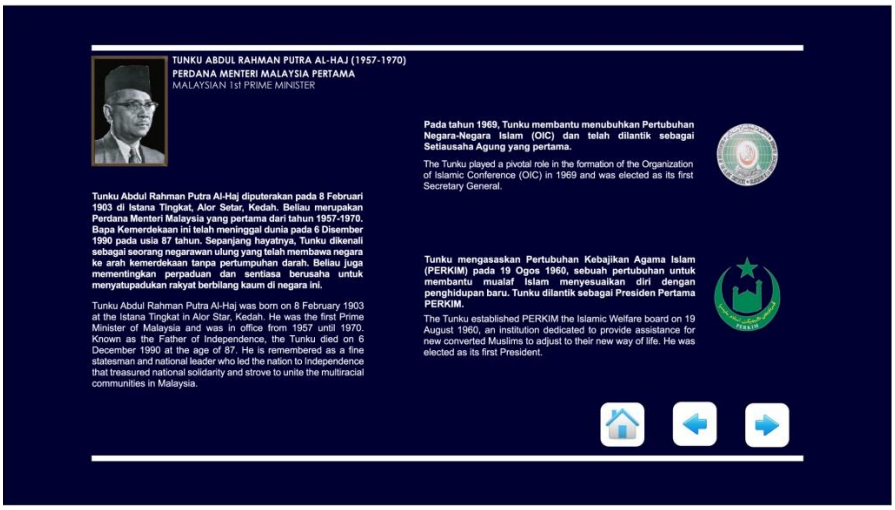

Figure 4.12: The Layout of the Application's Content Page

The layout of the content page is separated into header (title of this page information), two columns of information and footer (navigation). At first glance, it is hard for users to understand the context because the layout design did not focus on the primary context and causing confusion. It is important to put an area of focus at first for users. The spacing between elements is not consistent as well. The application is encourage using alignment to ease scanning and grouping for context (IOS Human Interface Guidelines, 2014).

4.4.2 Typography

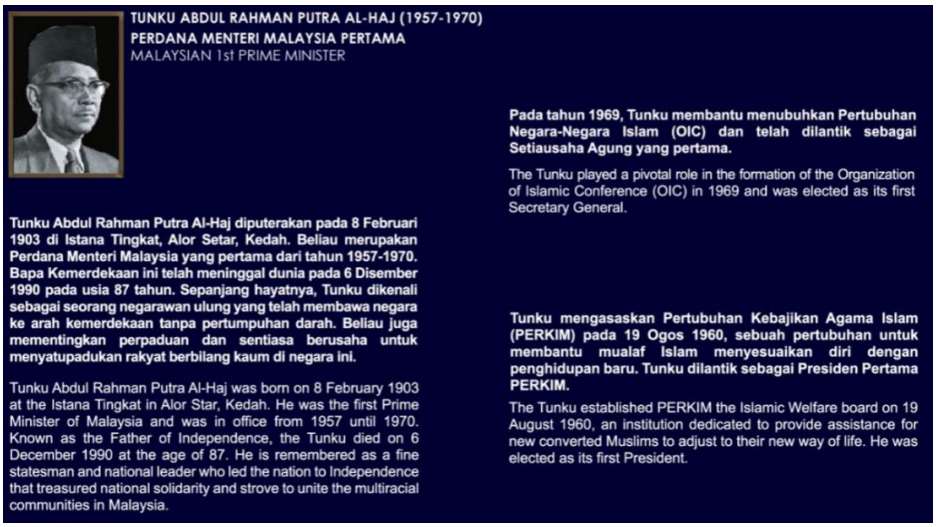

Figure 4.13: The Typography of the Application's Content Page

According to the content page of "The Prime Minister of Malaysia" shown above (Figure 4.13), it is too many words in one page. Text should be informative but not include too much reading (Bakaev, Lee & Cheng, 2007). Options should be provided to read for more information. Besides, text should always be legible (Ilene, 2010). It is important for users to be able to read the words. Some users have commented that the text size is too small to read (see Table 4.10). Text should never be smaller than 11 points, and 17 points will be the most suitable for large screen (IOS Human Interface Guidelines, 2014).

Visual weight if use properly can show users the relative importance of onscreen elements. The visual weight is use in this application to differ the languages. Moreover, the headings and body text are designed in same size. Font size should be different for heading and body text for easier scanning and the languages should be separate into different layers.

4.4.3 Colour

Colour is important to enhance communication, make a design more attractive, legible and helps indicate interactivity (Lim, 2010; IOS Human Interface Guidelines, 2014). Dark background and white text are used for the application (see Figure 4.11 and Figure 4.12). On the main menu page, buttons are designed with dark red for the background colour. The colour usage is too similar. According to the users (Table 4.10), some commented that the colour usage is too dark and more colours will be more preferable. The background should be lighten and enhance the navigation buttons with colour contrast.

4.4.4 Imagery

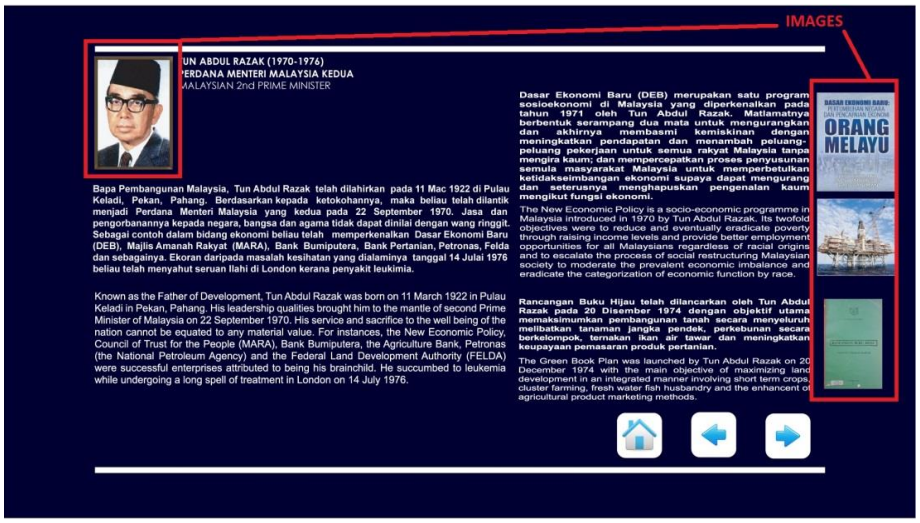

Figure 4.14: Imagery of the Application's Content Page

From the figure above (Figure 4.14), imagery relate to the content are too small. While the navigation icons are designed in similar size, the main images for content are even harder to catch the attention of users. Aside of that, lack of imagery makes visitors lose their focus in reading through the information. Especially while designing main menu, it is hard to draw attention and invite interactions without images (see Figure 4.11).

4.4.5 Controls

Figure 4.15: Navigation Buttons of the Application's Content Page

From the Figure 4.11, the controls or navigation buttons on main menu page are hard to notice. Some visitors think that the navigation buttons on the application's content pages looks out of the design (see Figure 4.15). Main menu page should be designed with a large and visible menu. Besides that, users should always know where they are in the application (IOS Human Interface Guidelines, 2014).

4.5 Stage 3: Prototyping

Suitable aesthetic techniques or design principles combines with design elements are important in creating visually appealing interface as well (Sharp et al., 2011). The research from Stage 2 suggested that there is a need to add in suitable design principles to enhance the visual design. Some design criteria are set for the proposed design for prototype. Aside of design elements adapted from Norman's Emotional Design Model (Partners, 2013) include layout, typography, colour, imagery and controls, two design principles are chosen for this study. The main design principle for this prototype is simplicity. It is important because the interface must be easy to use or navigate and comfortable to read (Ng et al., 2013). In addition,

consistency design is essential too, in which helping users to be at ease after using the application in a short time. The researcher hopes the application will provide a better user experience by combining both design elements and design principles.

The selected application was redesigned according to the original application layout, which is 1920 by 1080 pixel screen. Adobe Flash software was used for development. The content remains unchanged as the focus of this study is on the design of the application. In order to avoid distraction during the exhibition, the application is not designed with audio presentation.

4.5.1 Simplicity

Figure 4.16: Main Menu of the Modified Application

When there are too many elements in one page, it makes user hard to find information that they are interested (Sharp et al., 2011). Content in English and Malay languages are available and have been split into two different pages with the purpose of not overload users with unrelated information. Visitors are given options to read the content in their preferred language through tapping on the buttons at each pages. As hiding less frequently used functions will provide simplicity design

(Bhaskar et al., 2011).

Generally, neutral colour scheme was used for application development. Neutral colour is able to provide a sufficient amount of visual stimulation for audience to be attracted, while allow them to read the content at ease (IOS Human Interface Guidelines, 2014). In order to separate the information, colour block was used for background design. The most important colour for this application is grey. This colour gives a minimalistic look with a feel of intelligence and seriousness (Ocampo, 2014). Minor usage of orange colour is able to draw user attention to the aspects of the information.

Figure 4.17: Information is Showing in Another Layer

Further information is presented in layers to maintain the simplicity of the interface. For example, in the interface of redesign content page of "The Prime Minister of Malaysia", the information is divided into three sections (biography, achievement and photos) for simplicity and appeal (Figure 4.18). The main menu is made clear for visitors to prevent a messy screen design and let them to interact in better depth. As a result, museum visitors can learn new information in short period. The size of text has been enlarged and san-serif font type was used intended for keeping it simple and easy to read (Ng et al., 2013).

4.5.2 Consistency

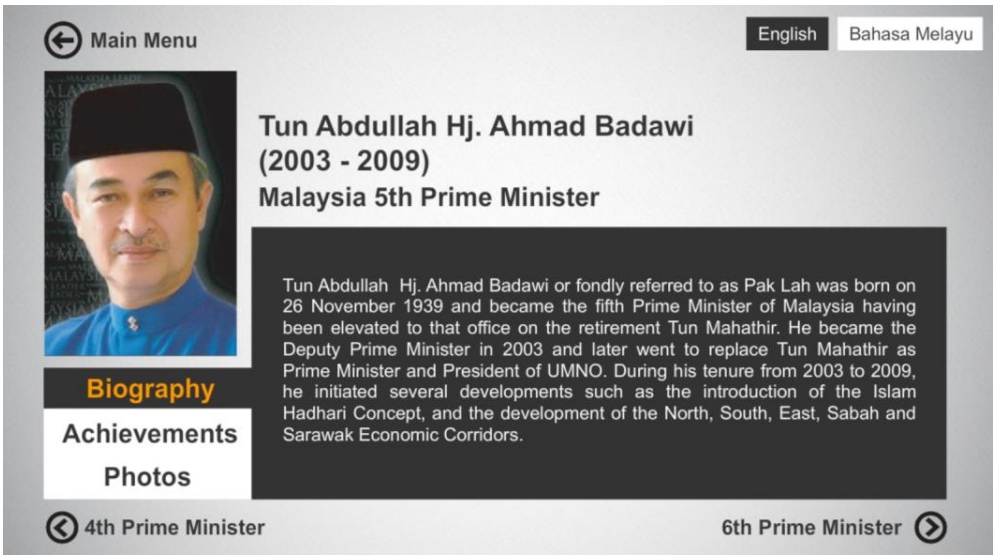

Figure 4.18: Example of "Biography" Page

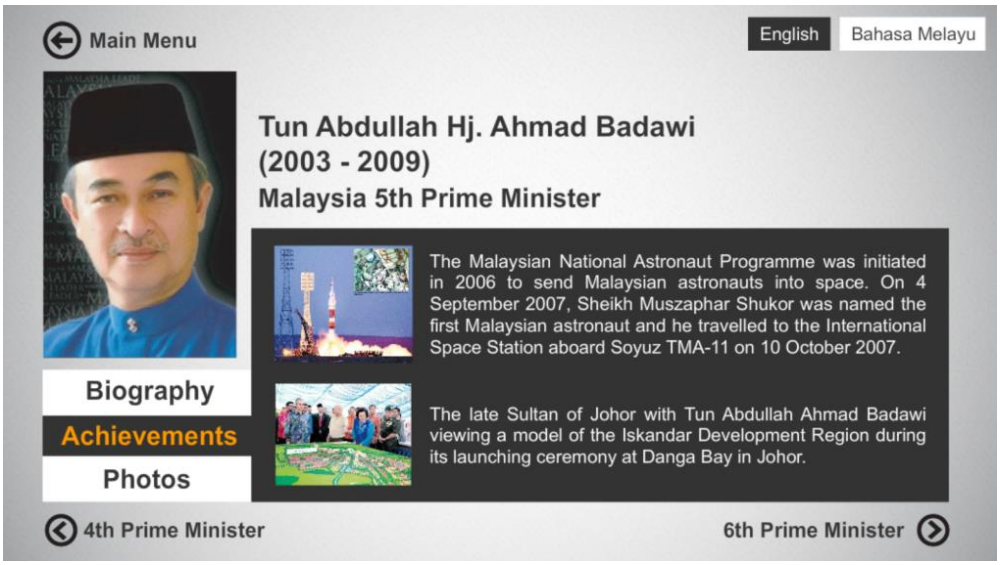

Figure 4.19: Example of "Achievements" Page

It is important to create patterns or consistency in language, layout and design throughout the application to help facilitate efficiency (Ng et al., 2013). Elements that have similar processes or functions should look similar (IOS Human Interface Guidelines, 2014). The navigation has been modified and relate back to present

design. Chevron symbol or V-shaped pattern has been used for the 'previous' and 'next' navigation icons. This symbol is easy to identify as the shape is commonly used and widely understandable, providing the best look on display (Lim & Woods, 2010). Besides that, consistency can be created by not changing the position of standard elements (Galitz, 2011). The 'previous' and 'next' icons are located at the bottom left and right.

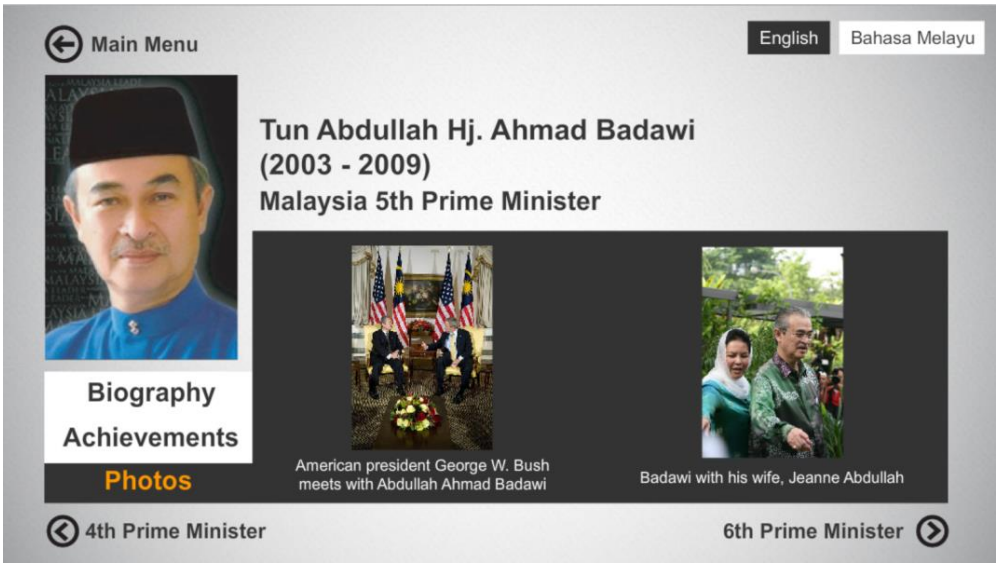

Figure 4.20: Example of "Photos" Page

The layout design for main menu page and content pages are different. Content pages have the same layout design for consistency. Besides, additional images are grouped into the "Photos" page. All the body text was left-justified as the users can read faster. The same settings were used throughout the pages to create consistency as well.

4.6 Stage 4: Evaluating

After the development, the prototype was tested out in the National Museum for seven working days in order to evaluate visitors' museum experiences. The survey was conducted to measure visitors' overall experience and engagement with

newly designed touch screen application. A paper-based questionnaire (Appendix 4) which consists of three sections was used as the instrument for the data collection. All in all, there were 104 visitors (N=104) participated in the evaluation and interacted with "The Prime Minister of Malaysia" application.

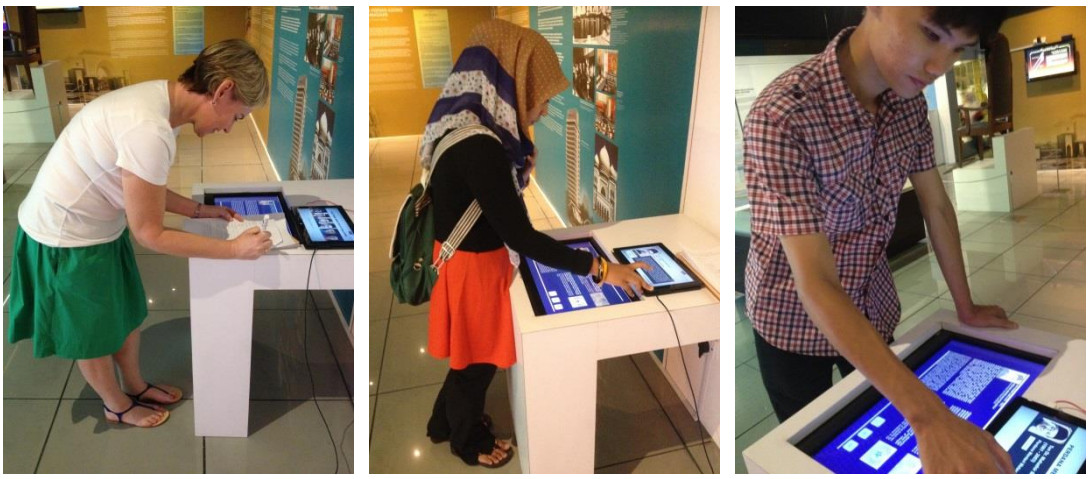

Figure 4.21: Visitors were Evaluating the Modified Interactive Multimedia in Gallery D, on May 2014

4.6.1 Demographic of Respondents

55 males (52.9%) and 49 females (47.1%) respondents had participate in the study. Most of the respondents who participated in this study are from the age group of 18-24 years old (41.3%). 34.6% of the participants aged between 25-34 years old, 14.1% between 35-44 years old, and 9.6% over 45 years old (Appendix 5). There is an even split between genders and a good spread across the different age groups according to bar charts in Figure 4.20.

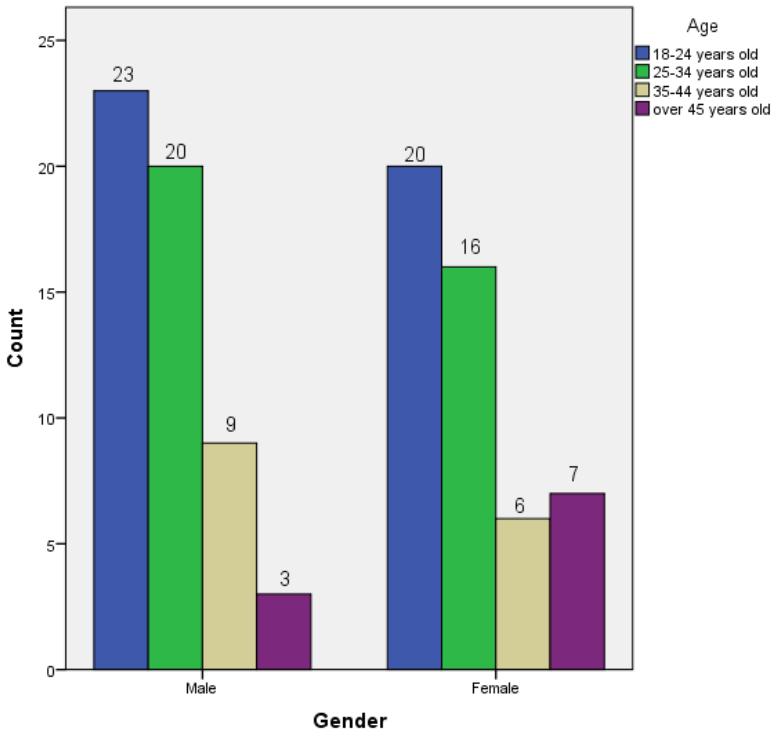

Figure 4.22: Participants By Gender and Age Group

As shown in the Appendix 5, over half of the respondents (56.7%, 59 out of 104) are local Malaysian visitors. 43.4% (45 out of 104) are international visitors, which includes visitors come from Indonesia, Thailand, India, Japan, Taiwan, China, Qatar, England, South Korea, France, Iran, Australia, USA, Sweden, Belgium and Netherlands.

The demographic data shows that most of the visitors, 73 respondents (70.2%) are visiting National Museum for the first time. On the other hand, 31 respondents (29.8%) have visited National Museum before. Figure 4.22 shows a more detailed data of first time National Museum visitors by age group.

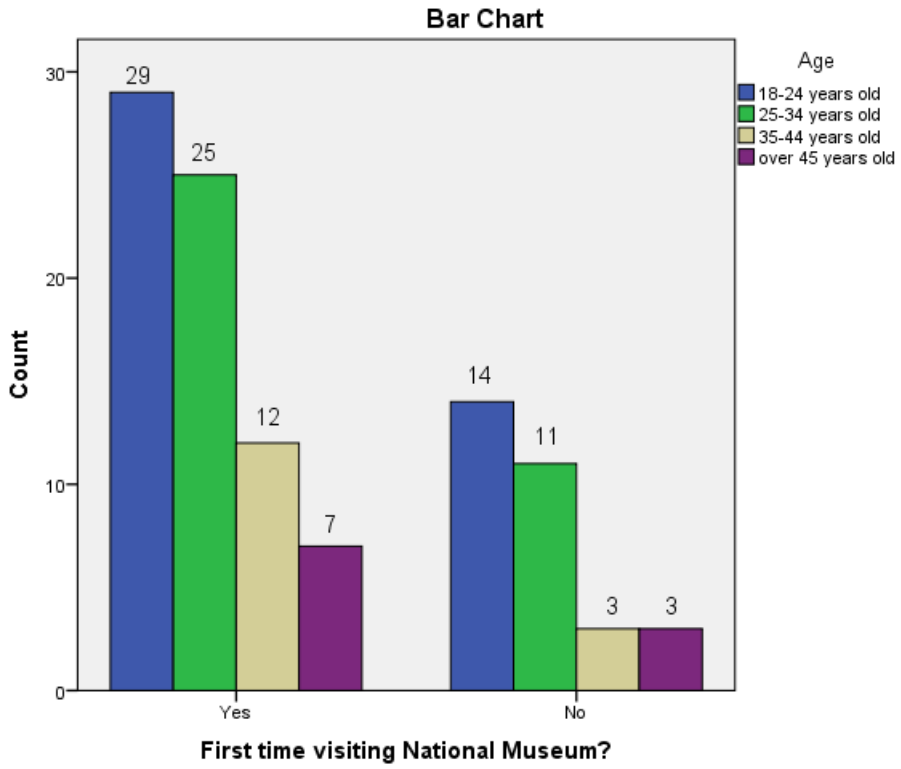

Figure 4.23: First Time National Museum Visitor by Age Group

According to Appendix 5, 44.2% respondents visited National Museum with their friends. 26% visited with their family, 14.4% visited alone, 11.5% followed school trips and 3.8% were tourists. Figure 4.23 shows the types of social group by age group. From the data, it can be seen that most of the youngsters prefer to visit museum with friends and as the age increases, they prefer to visit with their families. All in all, 45.2% of the respondents are students while 54.8% are workers according to Appendix 5.

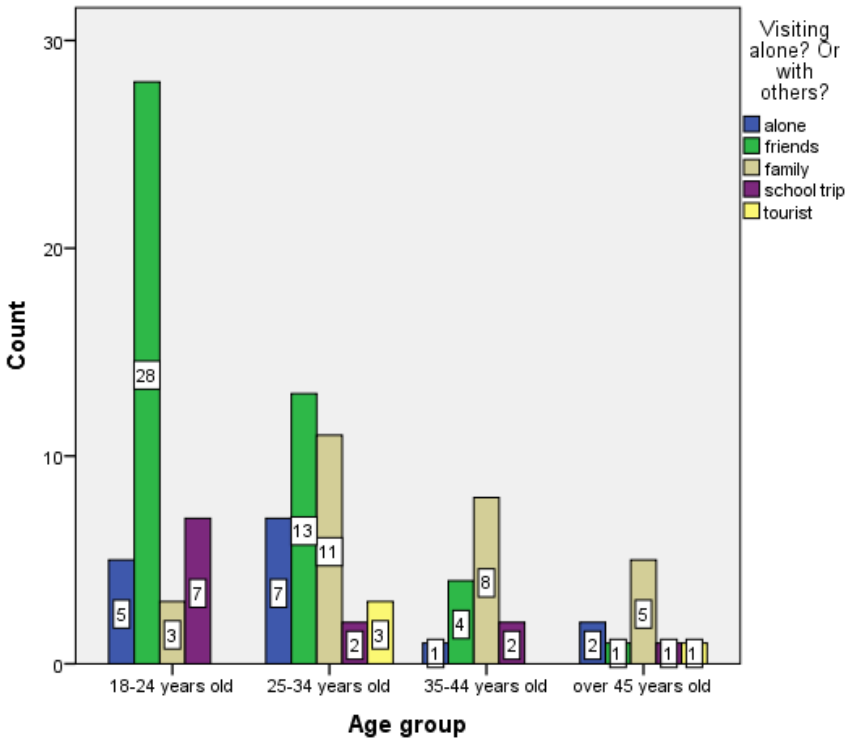

Figure 4.24: Types of Social Group by Age Group

4.6.2 Design Preference

In the second section of this survey, the visitors were instructed to interact with both original and modified applications first, and evaluate the modified version application based on these design criteria on a scale of 5 in order to know the visitors' level of agreement, where 1 is the strongly disagree and 5 is the strongly agree (Vagias, 2006). To examine the perception of visitors on the touch screen application design, nine items (question 8) were analysed through means and standard deviation using statistical analysis software package SPSS.

The mean score in this research is to analyse the visitor's average preferences of modified touch screen. If the mean score is nearly or more than 4, the result indicates that most of the visitors agree that the modified touch screens did enhance their particular experience. In contrast, when the mean score is less than 3, it means the visitors did not agree on the design changes on the modified touch screen.

Standard deviation helps to decide whether the difference among the data set is likely to be significant in order to support the hypothesis. A low standard deviation would mean that most observations cluster around the mean. A high standard deviation would mean that there was a lot of variation in the answers. A standard deviation of 0 is obtained when all responses to a question are the same. The following is the result of the analysis.

Table 4.11: Design Preferences of Interactive Multimedia

Design criteria	Mean	Standard deviation
Attractive	4.12	0.70
Hold attention	3.97	0.83
Easy to navigate	4.38	0.72
Information presented was clear and consistent	4.36	0.61
Well organised	4.34	0.65
Comfortable to read	4.50	0.67
Well balanced of colours usage	3.91	0.74
Suitable images or graphics	4.30	0.68

1=Strongly disagree, 5=Strongly agree

The modified application is more attractive (Mean = 4.12) according from the data on table 4.11. It manages to hold their attention (Mean = 3.97) and easy to navigate as well (Mean = 4.38). Moreover, participants have the same opinion that the modified application presented clear and consistent information (Mean = 4.36). They agreed the layout is well organised (Mean = 4.34), and comfortable to read (Mean = 4.50). They also approved that the application was designed with well-balanced of colours usage (Mean = 3.91) and have used suitable images or graphics (Mean = 4.30). Every design criteria have standard deviation below 1.0. This show the values in the dataset are close to each other. As a result, the design of modified

application is more towards the preferences for visitors.

Table 4.12: Ease of Use

	Mean	Standard deviation
Easy to use	4.42	0.72

The data shows significantly high mean value (Mean=4.42) when respondents were asked whether they think the modified application is easier to use. Aesthetically pleasing application does provide better ease of use due to the emotional connection with application as a result (Norman, 2004).

4.6.3 User Experience

As shown in the in Table 4.13, visitors' learning experience is increased by means of visitors have agreed that they learned something new (Mean=4.00) and are curious to find out more information (Mean=3.70).

Table 4.13: Learning Experience

	Mean	Standard deviation
Learned something new.	4.00	0.56
Curious to find out more information.	3.70	0.80

Based on the data displayed in Table 4.14 below, the mean values for fun, entertain and emotionally engaged indicate a slight increase throughout the relations. However, with all the mean values between of 3 to 4, this suggests that the modification does not significantly affect user experience. In this case, the researcher decided to focus more on visceral and behavioural levels in this study, visual design on reflective level, which enabled them to design and builds long term relationship

with users.

Table 4.14: User Experience

User experience	Mean	Standard deviation
Fun	3.60	0.76
Entertained	3.76	0.78
Emotionally engaged	3.39	0.82

93.3% of respondents found that the modified interactive multimedia was enjoyable to interact with. This shows that the redesigned application do improve their positive experience. The minority of them did not enjoy using the interactive multimedia application. On overall, an interactive multimedia that attain users' prospect requests to set off few iteration cycles.

Table 4.15: Do You Enjoy Using Modified Touch Screen Application?

	Frequency (*f*)	Percent (%)
Yes	97	93.3
No	5	4.8
Neutral	2	1.9

4.6.4 Comments

The following are some of the respondents' comments on the design of the modified touch screen application:

- *"Great job in the presentation."*
- *"Design is good. More towards interactive."*
- *"Much easier to read compare with the older version."*

Generally, the modified version of interactive multimedia is preferable compared to the original version yet, visitors are expecting more improvements for better experience. Based on the respondents' feedbacks, some aspects of the modified touch screen application require further improvement and iteration to attain greater user experience. The comments are summarized into Table 4.16.

Table 4.16: Comments on the Modified Version for Further Improvement

Comments
- Larger active area for the navigation buttons. - More colour contrast. - More imagery and animations. - Input voice or background music. - More interactivity. - Input educational games. - More different languages. - Simplify the content and highlighting key points.

Few of the participants have recommended that navigation buttons have to be outsized. Smaller touch end are tough for them to tap on it. In order to build a user friendly interactive multimedia application, finger touch size should be well thought-out.

According to the feedbacks for further improvements, more colour contrast is needed for the modified interactive multimedia as it can affect emotional feeling. Excellent colour balance is able to provide visitors a fresh feeling while reading. Normally, brighter colours appear to be more appealing. Above and beyond that, most of the respondents suggested to add more pictures, imagery, animation, sounds and videos which are able to offer engaging and enjoyable experiences.

A number of visitors recommended that features such as zooming into imagery or dragging the navigation bar for more information can be added. The flexibility of interacting with digital contents afforded by finger gestures, such as swiping, flicking, pinching, pushing and tapping, has resulted into richer ways to engage users (Sharp et al., 2011, p 196). Fun or playful experience can be created while adding in interactive features to emphasize certain information (Touw & Miller, 2012). Moreover, educational or learning based games are suggested as there are the combinations of interactivity and learning experience. Especially, some parents are concerned that learning games can attract their kids to learn and have fun at the same times. Adult users will be more involved and enjoyed in what they can learn as well.

More different languages should be provided to support international visitors from different countries. As the museum regularly receives international visitors, this can helps them to understand further nation's historical context and information. The inclusion of both entertaining and educational characteristics is significant for designing an interactive multimedia and balancing both can be a real problem. A participant propose to use timeline for the Prime Ministers of Malaysia servicing period, which would enable users to have easier and quicker reading (refer to Appendix 6). Main menu page need to be simple and straightforward for users to understand it in a short time. In addition, the respondents suggested highlighting the headline or using leading words can offer them a well reading experience.

These comments with more details help to support the result of this study, which the modified touch screen application has improved overall positive experience for visitors. More comments with suggestions on further design improvements or refinements also pointed out that there is a need for iteration process. Iteration cycle intended to ultimately improve the quality and functionality of a design. Thus, the feedbacks for more enhancements on the modified touch screen application can be further look into in future studies.

4.7 Summary

In conclusion, the findings show that visitors are more interested with the modified interactive multimedia application in general. This chapter presents the data analysis of four stages. Through first stage, the data from observation and interviewing visitors reveal their perception and preferences in interactive multimedia design. The result shows that usage of touch screens among visitors in National Museum is above average (72%). The major factors that hinder the interest of interacting with touch screens are related to the low exposure and awareness of touch screens availability, time constrain during visitation and also languages. Many of them suggest ways to improve the touch screens and the suggestions given are consistent with the content design elements proposed by Norman's Emotional Design Model.

To proceed, the researcher studied on the selected interactive multimedia and developed a prototype for testing later on. The last stage confirms that the touch screen design which adapts design criteria (design elements and design principles) has improved visitors' overall positive experience.

CHAPTER 5:

DISCUSSION AND CONCLUSION

5.1 Overview

Two research questions were addressed in Chapter 1. Research question 1 aimed to identify the visitors' perception and preference on interactive multimedia. Research question 2 was to evaluate whether the modified touch screen application enhances visitors' engaging experience.

The four stages of studies were explained in Chapter 3, which was conducted within a period of one year at the National Museum. All of the data were collected from primary source, observation, interview, and questionnaires. In Chapter 4, the researcher analysed and presented the data collectively.

In this last chapter, the researcher discusses and concludes the data that have been collected through the four different stages studies. Findings of the studies are determined to answer the research questions. Findings from Stage 1: Establish requirements and Stage 2: Design alternatives, are discussed in answering research question 1. Findings from Stage 3: Develop the prototype and feedbacks in Stage 4: Prototype evaluation, are discussed in answering research question 2.

Finally, the research contribution, recommendation for the future research and also limitation of this study will also be discussed in this chapter.

5.2 Discussion

"Understand and respect that, in the end, what individuals learn depends not only upon the content of the exhibitions and programs, but equally upon visitors' prior knowledge, experience, and interest, what they actually see, do, talk, and think about during the experience (Falk, Dierking & Adams, 2008)." Previous studies imply that interactive multimedia applied to informal learning environment helps to enhance visitors' learning and engaging experience (Katre & Sarnaik. 2010; Ng et al., 2013). Furthermore, according to Norman (2003), visually appealing application creates positive user experience. However, research that is related to this area is still limited.

This study aims to identify the perception and preference of visitors on the current touch screens and to evaluate whether touch screen application which meets the design criteria enhance visitors' museum experience. The literature review serves as a basis of the research background. In support of collecting the research data, the Simple Interaction Design Lifecycle Model was adapted to be the core research design flow. It contains four stages of interactive design cycles activities (Sharp et al., 2011). An interactive multimedia application using touch screen as medium was modified by incorporating design elements of Norman's Emotional Design Model (Partners, 2012), and design principles which are simplicity and consistency (Ng et al., 2013) to achieve research objectives. The researcher only chooses one touch screen application out of six others in Gallery D since all of the applications look exactly same in terms of design and layout and also given that the main objective of this study is to improve visitors' experience using suitable design criteria. The result of the data shows the modified application did enhance the users' engaging experience. The research data at the end provided some suggestions for future designers or curators to develop the touch screen application.

5.3 Research Question 1: What are the Perception and Preference of Visitors on the Current Touch Screens at the National Museum?

This section will address research question 1 in the view of the visitors' exposure and experience in using touch screens, their awareness and interest of the touch screens available to them in the galleries of National Museum. In order to discover the answers for this research question, the researcher had conducted preliminary studies, which are the observation and interview in the galleries of National Museum. Based on the results, the perception and preference of visitors are further discussed in the next sections.

5.3.1 Purpose of Visiting a Museum

As shown in Table 4.2, Table 4.5, and Table 4.7, it can be concluded that most visitors have two main purposes in mind while visiting the museum, either for education or entertainment. These two purposes are also the motivation for them in deciding whether or not to interact with touch screens in museum. Based on Table 4.4, Gallery C has been chosen as their preferred gallery among all four galleries. On the other hand, Gallery D which was installed with new touch screens has the least votes. This indicates that displays or artifacts in Gallery D need to be improved in order to enhance visitors' experience. In order to enhance visitors' overall experience, touch screen is influential and important as 88% visitors agree on that (see Table 4.9).

5.3.2 Usage of Current Touch Screens

As shown in Table 4.6, more than half of the visitors (72%) have used the touch screens in galleries at National Museum. It seems that the usage of touch screen application did attract certain group of visitors. However, the usage of touch screen application could be further encouraged if the strengths of the touch screens could be optimized and meet the users' needs. For those who did not approach touch

screens, most of them did not notice the presence of touch screens. Through observation, some of them who did interact with the touch screen once did not approach touch screen for the rest of the visit as most of the touch screen applications have similar design.

5.3.3 Visitors' Preferences on Touch Screens

Five elements of multimedia were suggested by respondents while conducting interviews: layout, typography, colour, imagery and control. This indicated that visitors' perception of interest on interactive multimedia depends heavily on the multimedia design elements. Besides that, ease of use of interactive multimedia application is one of respondents' concerns too. Thus, the usage of interactive multimedia could be further encouraged if the design of interactive multimedia could be enhanced. Most of these are similar with visceral and behavioral level of Norman's Emotional Design Model (Partners, 2013).

Two selected design principles were presented to the respondents: simplicity and consistency. According to Sharp et al. (2011), these design principles are few of a number of best known design principles which helps to improve design by ensuring certain features are provided at an interface.

The study revealed the importance of design criteria like multimedia design elements (typography, imagery, layout, colours and control) and design principles (consistency, simplicity) to be taken into consideration during the process of creating interactive multimedia for informal learning places or museum.

5.4 Research Question 2: Does Touch Screen Application Which Meets the Design Criteria Enhance Visitors' Museum Experience?

This section attempts to answer research question 2 based upon the results from the last stage, evaluation process. It is based on the questionnaire result incorporated with the prototype used to test. A list of recommendations for interactive multimedia design is also presented to wrap up the study.

5.4.1 Overall Design Preferences

The visitors noticed the modified application was more appealing. As a result, they give more attention to it. The modified application was generally simpler to navigate and respondents also agree that it was providing straightforward and consistent information. (see Table 4.11)

Finely arranged layout and content that was easy to read at a glance on the modified interactive multimedia were portrayed by the visitors. Furthermore, they agreed that the application has appropriate images and graphics that suits with the well-balanced colours design. These design criteria have a standard deviation lower than 1.0 which means the results are showing consistent patterns without being completely polarized. In conclusion, the visitors are displaying their preference towards the design of the modified application.

5.4.2 Overall Ease of Use

The respondents were questioned if they think the modified application is simpler in terms of usage. This can be seen from the data (see Table 4.12) that the modified application is having a marginally higher mean value. This shows that application with higher aesthetic value or visually pleasing does offer better ease of use, because of the emotional connection with the application. (Norman, 2004)

5.4.3 Overall User Experience

Previous studies imply that interactive multimedia applied to informal learning environment can improve the learning experience (Kusunoki et al., 2005; Ng et al., 2013). Some requirements are created for the prototype to accomplish the goal, since evaluating designs needs the interaction from the users.

In addition to the result data on the user experience section, as shown in Table 4.13, visitor's learning experience had grown slightly by means as they have agreed they gained new knowledge and were curious to gather more insights. It was also suggested by a few respondents that their learning experience does relate to the design of content. Some respondents do not even show any interest on the content. Consideration should be taken for the application's content when planning for any future development, in order to enhance the motivation to learn.

Moving on to the overall user experiences which include fun, entertaining and emotionally engaging (see Table 4.14), it was implied by the data that visitors' experience was not greatly affected by the modification. In addition, all levels of Norman's Emotional Design Model need to be adapted in design process to come out with a well-designed touch screen application in order to improve users' engagement and experience.

In accordance with this study, results shows that museum visitors were more likely to have positive perceptions for the modified interactive multimedia application. 93.3% of the total respondents favour the modified touch screen application as they think it has more enjoyable interaction. These positive feedback from the respondents implied that visitors are more willing to interact with touch screen application that adapts design elements and design principles into the informal learning process. This shows that modified application meeting with suitable design criteria did improve their experience in gallery, especially in terms of visual

appealing and ease of use. These two are the first immediate levels of emotion which will affect the impression of the overall experience. However, based on the questionnaire result, it suggests that the modified application had slightly improved the overall user experience in the gallery. This shows that the overall user experience can be further improved if this study looks into the reflective level of Norman's emotional design model as well. This is the level which often influenced by knowledge, learning process, and culture.

5.5 Research Contribution

The objective of this research study is to create a positive informal learning experience in the museum gallery environment. By incorporating the design elements from Norman's Emotional Design Model, and also a few design principles (simplicity and consistency), this modified interactive multimedia has become more engaging and attractive to visitors. The data collected from the interview shows that the design elements which include layout, typography, colour, imagery, and controls are the general fundamental characteristics in developing a touch screen application. Suitable design principles can provide certain features which fulfil users' needs and produce a visual appealing interface interactive multimedia. In this study, other than design elements, simplicity and consistency are the key principles in order to solve the design problems.

Additionally, the entire research design was constructed following the Simple Interaction Design Lifecycle Model which incorporated four activities of interaction design. It encourages visitors to educate and entertain themselves with interactive and multi-sensory contents. The research data can be categorised and analysed based on visitors' perception and preferences on the design of interactive multimedia, and the user experiences. The analysed results are used to answer two research questions and these summarised details are also presented in the conclusion. This result can also act as design suggestion for other designers, developers or curators who are interested to integrate interactive multimedia for a more user-centered informal

learning environment in their museum gallery.

5.6 Limitation

There are a few limitations occur throughout the study. The major constrain of this study was limited time and resources. It is because there is limited time permitted by National Museum management to conduct research.

Besides, according to the curators from National Museum, interactive multimedia, especially touch screen based, are hard to maintain. With high visitation and interaction from different types of individual and groups, the system tends to freeze down quite frequently. The maintenance was done only once in a month as there are not enough funds from government. When there is a system error, they choose to close the whole system of the particular touch screen. To avoid system errors from happening and subsequently interrupting the continuity of the study, the researcher focused on Gallery D, which has better and well functioned interactive multimedia system.

There was a restriction while designing the touch screen application. The researcher was not allowed to apply sound or music for application design. This had decrease visitors' multimedia experience in this case. For future studies, the researcher suggested placing headphones together with the interactive multimedia, which does not affect the surrounding and also able to enhances overall user experiences.

5.7 Future Recommendations

Firstly, similar research can be conducted with a larger sample. Other researchers are encouraged to apply and test these design criteria in other areas such as in corporate sector. Different design elements and design principles could also be

evaluated following the research method in this study. Different methods should also be considered, such as conduct user testing in a control field first before carrying it out in the wild, as it was time consuming.

Besides that, it is recommended for other researchers to evaluate other factors that could influence visitors' perceptions and preference on interactive multimedia. One of the recommended factors is using different types of interface. However as digital evolution is an on-going process, preference of media will be changed. Constant investigation on visitors and digital media will bring more insight on creating better experience. There is now a diversity of interface types that could be applied for different environments, people, places, and activities (Sharp et al., 2011). For example, multi touch screens interface type had been popular in recent years for offering multi-user input functionality (Ng et al., 2013).

To explore these issues in further research and to come out with good alternative designs, there is a need to research on wider similar interactive multimedia. The researcher should not only be limited to the interactive multimedia in National Museum, but should refer to more successful interactive multimedia from other galleries and museums as well.

The physical outlook of touch screen design should be considered as well. Some respondents had mentioned that they did not notice the interactive multimedia as it was flat table top design which can only be noticed if they walk close to it.

In addition, in order to speed up the research timeline and be more through in each interaction design activities, it is recommended that this be carried out by a team which includes members with different roles. The research may need to return to identify more needs or refine requirements, or it may go straight into redesigning. Design is never done. The iteration cycle might have to be gone through a number of times to ensure the final product meets the prescribed user experience and usability

criteria.

5.8 Conclusion

Norman (2004) believed that attractive application invokes mental process and emotion, allowing users to be have better tolerance of minor difficulties and enhancing their overall experience to be more positive. In this research study, the purpose of this study is to explore the current scenario of touch screens usage among visitors, to investigate visitor's perceptions and preferences on current interactive multimedia applications in National Museum, and enhance visitors' positive experience with modified touch screen application. There are a few key design criteria that should be taken into consideration when designing the interactive multimedia. In addition, usage of the Norman's Emotional Design Model as the conceptual theory, to enhance the visual design using design elements and design principles (see Chapter 1 and Chapter 2 for details).

The research methodology was designed to fulfil the research objectives and to answer the research questions. By adapting Simple Interaction Design Lifecycle Model for full development process, four stages of studies were completed to access insights of using touch screens in relation to visitor's perceptions and preferences. (See Chapter 3 for details). Only one touch screen application is chosen for this study post-testing for the reason that all of the applications in Gallery D have the exact same design and layout.

The research outcome from the analysed data was the key part in this research as it highlighted some facts that required research attention and academic discussion. The analysis process revealed that the usage of touch screens was very encouraging and widely accepted by visitors, and the current design of touch screen applications need to be enhanced for better experiences. This tallies to the positive experience feedback found in the user testing process (see Chapter 4 for details).

By combining the research design and the research outcome, the discussion, research contribution and results are further elaborated in this chapter. Based on the discussion in section 5.2, visitors agree that improvement on the design can be performed on the touch screen application in the National Museum. Most of the visitors approach the touch screens either for education purpose or entertainment purpose. A few studies show digital media motivates visitors to explore and learn in their own will where the content, location, timing and learning style can be controlled by them (Hawkey, 2001). Museum environment is very suitable for this type of informal learning. The research data provided suggestions for designers and curators who are participating in creation of touch screen application to base on Norman's Emotional Design Model.

In conclusion, both the research questions had been answered in this study. As described by the results, it was verified that touch screens design which adopts the content design elements from Norman's Emotional Design Model and design principles have enhanced the overall experience of visitors positively. As Chang, Kaasinen & Kaipainen (2012) discovered visually attractive designed touch screen application improved the visitors' experience. It is essential for the curators to make sure the touch screens are functional in the museum galleries and to update the design of touch screens in a timely manner that meets the visitors' expectation. On the other hand, the curators should be active in endorsing the visitors to interact with touch screen while having a visit. Lastly, the designers should also adopt design element and design principles while designing touch screen to make sure the design is usable and it meets the needs and expectation of the users.

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APPENDICES

Appendix 1: Observation field notes

Thursday

Observer Notes. Date 24/10/2013 1st Day

- A lot of students visitor in group. Primary + Secondary schools. Student exchange from other country as well.

- Gallery 0 has been re-open again. There are a lot of touch screen which are usable, sensitive. But plain design.

- Lack of visitors during lunch Time.

Interview note

- (11am - 4pm) for weekdays peak time.
(9am - 6pm) for weekends whole day lots of visitation.
* normally all system in NTM will closed down on 5.30pm. after that there are free entrance for half hour to total close time of NTM.

Appendix 2: Short interview with Senior Museum Assistant

Date: 24th October 2013

Name: Norrulhuda Mohd Halim

Gender: Female

Age: 36

Job Position Title: Senior Museum Assistant

- "National Museum has four galleries, and each of them conserve different era of Malaysia's history."
- "Gallery D has been closed down for 6 months to renovate, and re-opened on 1st of September this year, in conjunction with Malaysia Day. This time, we have added in more digital media, such as few touch screens, projections and a mini theater space."
- "In the late 80's, people were using paper for reading. Nowadays, there are just too much of people using digital technologies to entertain or study. Digital interactive and multimedia might able to attract native youngster who grown up with computers. Therefore, we hope that this renovation can bring better experience for visitors."
- "Touch screens are hard to maintain and have problems with functionality as times goes by. Some systems (touch screens) were out of service at times. For example, the cursor could went wrong with the touch point or the application jumped out of the system."
- "For me, I think content is the most important part, and should be the first concern. However, interaction design needs to be consider as well to create good experience."

- “I have noticed that the peak visitation time on weekdays start from 11am until 4pm. As for weekends, there’s a lot of visitors during the whole day, which start from the working time of National Museum, 9am until 6pm. All systems in National Museum will be closed down at 5.30pm normally. Afterwards, there is free entrance for half an hour until the total closed time.”

Appendix 3: Semi-structured Interview Questions

Interview: User Perception and Preference of Touch Screens in National Museum

Age:

Gender:

Country:

1. Why do you visit museums or galleries?

2. Which museum or gallery is your favourite visitation so far?

3. Which gallery in National Museum did you like the most? Why?

4. Did you interact with any touch screens in National Museum?

   If Yes/No, why?

5. Does touch screens affect your overall museum visitation experience?

6. Is there any suggestions or comments to improve the touch screens in National Museum?

Appendix 4: Interactive multimedia evaluation questionnaire

Touch Screen Evaluation

Please answer the questions below to help us understand your background and experience in using "Prime Minister of Malaysia" touch screen application. All information you provide is completely confidential and will only be reported in aggregate.

Part A: Participant Background

1) Gender

- ☐ Male
- ☐ Female

2) Age

- ☐ 13 - 17 years old
- ☐ 18 - 24 years old
- ☐ 25 - 34 years old
- ☐ 35 - 44 years old
- ☐ Over 45 years old

3) Nationality

- ☐ Malaysian
- ☐ Other, please specify: _____

4) Are you a student?

*If **Yes**, proceed to question no.**5**; If **No**, proceed to question no.**6***

- ☐ Yes
- ☐ No

5) What type of course are you currently studying?

- ☐ Secondary school
- ☐ Undergraduate
- ☐ Master's

☐ Doctorate/PhD

☐ Other, please specify: _____

6) Is this your first time visiting National Museum?

☐ Yes

☐ No

7) Are you visiting alone or with other people? Please choose one:

☐ Alone

☐ Friends

☐ Family

☐ School Trip

☐ Tourist

☐ Others: _____

Part B: Design Preferences

Please circle on which that well describe your experience with the touch screen.

(1 – Strongly Disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)

8) The design of "The Prime Minister of Malaysia" touch screen is:

a) Attractive	1	2	3	4	5
b) Hold attention	1	2	3	4	5
c) Easy to navigate	1	2	3	4	5
d) Information presented was clear and consistent	1	2	3	4	5
e) Well-organised	1	2	3	4	5
f) Comfortable to read	1	2	3	4	5
g) Well balanced of colours usage	1	2	3	4	5
h) Suitable images or graphics	1	2	3	4	5

9) This touch screen application is easy to use.

(1 – Strongly Disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)

1	2	3	4	5

Part C: User Experiences

10) I have learned something new about the Prime Minister of Malaysia.

(1 – Strongly Disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)

1	2	3	4	5

11) I am curious to find out more information about the Prime Minister of Malaysia.

(1 – Strongly Disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)

1	2	3	4	5

12) For each word below, please circle on which that well describe your experience with the touch screen.

(1 – Strongly Disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree)

a) Fun	1	2	3	4	5
b) Entertained	1	2	3	4	5
c) Emotionally engaged	1	2	3	4	5

13) Do you enjoy using "The Prime Minister of Malaysia" touch screen application?

☐ Yes

☐ No, please specify:

_____

14) Do you have any comments on the design of the touch screen?

Thank you for your participation in this survey.

Appendix 5: Interactive multimedia evaluation respondents' demographic

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-24 years old	43	41.3	41.3	41.3
	25-34 years old	36	34.6	34.6	76.0
	35-44 years old	15	14.4	14.4	90.4
	over 45 years old	10	9.6	9.6	100.0
	Total	104	100.0	100.0	

Nationality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Malaysian	59	56.7	56.7	56.7
	Others	45	43.3	43.3	100.0
	Total	104	100.0	100.0	

First time visit NM?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	73	70.2	70.2	70.2
	No	31	29.8	29.8	100.0
	Total	104	100.0	100.0	

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	55	52.9	52.9	52.9
	female	49	47.1	47.1	100.0
	Total	104	100.0	100.0	

Are you a student?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	47	45.2	45.2	45.2
	no	57	54.8	54.8	100.0
	Total	104	100.0	100.0	

Alone?Or with others?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	alone	15	14.4	14.4	14.4
	friends	46	44.2	44.2	58.7
	family	27	26.0	26.0	84.6
	school trip	12	11.5	11.5	96.2
	tourist	4	3.8	3.8	100.0
	Total	104	100.0	100.0	

Appendix 6: Interactive multimedia evaluation respondents' comments

- *"Add in animation and more colours."*
- *"Add in interaction with pictures. Example in Museum Hang Tuah Melacca."*
- *"Add information about how PM was elected. As each country has different ways."*
- *"Black colour background with white colour writing is not really good for reading. Add some colours make it more attract people. Especially make people feel fresh while reading."*
- *"Brighter colours would be more attractive. Sounds and videos would allow engaging for longer."*
- *"Can add in name of PM in first page. Tourist does not know them through photos only at first glance."*
- *"Clear. Easy to read. Well design."*
- *"Colours. Zoom effect on photos, voice over and more languages."*
- *"Complicated."*
- *"Educational game."*
- *"First page too annoying. Button should be larger."*
- *"Games will make it more fun."*
- *"Insert more info graphic."*
- *"It can have more transitions, sliding, fade, swipe, etc. to make it more lively and nice."*
- *"It is a bit too grey."*
- *"Lack interactivity, media, achievement list, information. Need more troubleshooting."*
- *"Learning based game."*
- *"Make it more attractive to make kids and teenagers interested to it."*
- *"Maybe more photos if possible."*
- *"More colours."*
- *"More language."*
- *"Most exhibits in this gallery are vertical form. Hard to notice the touch screen as it was flat. Physical angle should change."*

- *"Need videos, and music."*
- *"Cannot understand. Add more foreign languages."*
- *"Possibility of an option to learn more detail and/or to view more photos."*
- *"Should be more colourful. Highlighting on headline or leading word."*
- *"Should be more colourful, larger text. Photos of PM in content page need to be smaller."*
- *"Simplify the stories into key points section, for easier and quicker reading."*
- *"The black and white theme is common of use. Maybe using another colour would make it more attractive, But already much better than the one which is used now."*
- *"The degree/angel of the touch screen. Should make it easier to read. Add timeline feature for them to understand more about PM according their working time."*
- *"Timeline on first page, maybe use colour to assign each PM or use roulette effect. Bigger button n apply tab design for language. People should be able to choose other PM on the same page. Don't lead pop up to another page. Design should refer to good example design, not refer back current one."*
- *"Touch screen buttons are small, but overall i like the design."*
- *"Upgrade the navigation button."*
- *"Video, more information and sound."*
- *"Voice over feature."*
- *"When click on photos, enlarge it to full page. More details in it too."*
- *"Would grab my attention more if application is completed with voice over/ background music."*
- *"Zoom in effect after clicking on photos. Drag for more information. Button of Biography those not easy to notice."*
- *"Zoom feature for the photo. Add more information such as achievements and photos."*