

# Heuristic Evaluation for Virtual Museum on Smartphone

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**Abstract**—Virtual Museum can present user experience in visualizing the real museum. This technology can give better communication and interaction with visitors. According to the preliminary study, most tourists have difficulty getting information about Muzium Negara and the website of Muzium Negara which does not provide enough information about galleries and collections before, during and after visiting the museum. In this study, heuristic evaluation was conducted with six experts in evaluating Virtual Muzium Negara prototyping. Several comments from experts for improving the prototyping obtained. The findings show the experts' comments are helpful in improving the prototype and the result of the Content Validity Index is acceptable. Hence, it is hoped that the Virtual Muzium Negara prototyping can give several information to tourist and this can encourage them to visit Muzium Negara.

**Keywords**—component; mobile usability; prototyping; virtual museum; evaluation; user-interface

## I. INTRODUCTION

Nowadays smartphone are the popular gadget in the world. Recently smartphones and tablets are the most popular product sales [1]. By using smartphone, we can run any web application either in different operating systems (OS), such as Android, iOS, Blackberry and Symbian. According to this functionality, users can access to the web applications by accessing to the web pages in World Wide Web (WWW) and they could navigate to a special Uniform Resource Locator (URL) and install in their smartphone [2].

The mobile web application can be run by any browser on smartphones and tablets and usually written by Hyper Text Mark-up Language 5 (HTML5). Mostly the mobile device use HTML5 system and mobile jQuery were used to design the user interface. jQuery is a simple high level language code, which is built with progressive improvement, and has selectable theme for design. The slogan of mobile jQuery is "Write less, do-more". Developers design a single, highly branded website or web application by using the jQuery mobile framework which it works on all smartphones, tablets, and desktop PCs [3].

Virtual Museum (VM) is an application that can be presented virtually through the smartphone. The virtual

museum was the idea of André Malraux, who imagined the museum without walls, presented in 1947 [4].

The definition of VM has been defined as a set of digital objects with a range of media that provides connections and a variety of points of access. It also disseminates objects and related information all over the world and helps visitors to communicate and interact with museum in a better way [5].

Another definition mentions that, VM helps user to get experiences to interact with the virtual environment. They were constructed with the most advanced technology of the day in an effort to reconstruct the past. It is also can propagate or display new ideas in a way the observer would feel they are actually taking part in the real thing, or push the observer closer to the actual experience [6].

According to the previous studies, Table I provided the most important characteristics for developing VM. It is discovered that Human Computer Interaction (HCI), 3D modelling, and text are the main characteristics for designing the VM. Whereas other characteristics such as pictures in panorama 360° form and combination of audio and video are needed too. Moreover, for giving better information to users, additional information collections such as; object, text can be added also in the application.

Heuristic approach is an assessment method for smartphones, mobile application and computer software (HTML5, jQuery) that helps to evaluate the usability problems of an interface design. It involves asking from some evaluators with a variety of experience in designing or using software applications. The Heuristic Evaluation (HE) still is used because this method is cheaper, more popular and performs quickly without involving end users [16], [17]. In this HE, the evaluators try to evaluate the interface design against a set of checklist. This checklist tries to help the evaluators to understand the interface design of prototype [18].

The significance of this research is to explore and find information about Muzium Negara. This prototype can attract tourists to be encouraged to go and visit there because of getting promotable information from the mobile web application on their phone system by using virtual interaction features. This research can help to define which factors are

TABLE I. CHARACTERISTICS OF DEVELOPING VIRTUAL MUSEUM BASED ON PREVIOUS STUDIES

Attribute Author	HCI	GUI	Text	Picture	Audio	Video	2D	3D modeling	Information Collection	Floor Map	Navigation System	List of Pieces	Graphical Info/Object	Laser Scanned
[7]	✓		✓					✓	✓		✓			
[8]	✓		✓	✓	✓			✓	✓	✓	✓			
[9]	✓	✓	✓		✓		✓	✓			✓		✓	
[10]	✓		✓	✓	✓	✓		✓						✓
[11]	✓		✓	✓		✓		✓	✓	✓		✓	✓	✓
[12]	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		
[13]	✓				✓	✓								
[14]	✓					✓		✓				✓		
[15]	✓		✓			✓		✓	✓					
Total	9	3	7	3	5	6	2	8	5	3	4	3	2	2

important and should be considered for providing a web-based museum application for mobile phone systems. The outcome of this project is that, it also can be useful for tourism service providers such as hotels, tour programs and travel agencies.

The objectives of this article are: (i) to identifying the design problems in developing Virtual Museum Negara prototype by HE and (ii) to calculating the results of heuristic in the Virtual Museum Negara prototype.

## II. METHODOLOGY

Before developing the VMN software, a preliminary study via structured interviews was conducted in identifying problem faced by tourists and officers. The analysis of VMN started with the researcher conducting with a structured interview with 17 tourists and two officers from Muzium Negara. This interview was held in order to identify and define problems faced by the tourists and the officers. From the structured interviews, the Software Requirement Specification (SRS) was developed. Besides that, literature review has been conducted in identifying the characteristics of developing the VMN software. During the development of VMN, the software was evaluated by experts.

### A. Respondents

In this study, six experts (4 males and 2 females) acted as evaluators and tested the Virtual Museum Negara (VMN) against 10-usability principles for User Interface (UI) design. The experts are divided into three groups. The first group involves two officers came from the museum, the second group involves three software engineers who are expert in

mobile application and the last expert is human computer interaction practitioner.

In conducting the evaluation, the evaluators got a list of user interface guideline of Jakob Nielsen to read, and then they worked with prototyped VMN. Evaluators responded to the usability test and give their comments about problem that they faced during testing the VMN. Fig.1 shows the officers of museum working with the VMN prototype.

### B. Research Instruments

Two research instruments were used in this study. The first instrument is a prototype VMN application install in the mobile device. The second instrument is a questionnaire, which called the "Heuristic Evaluation Questionnaire (HEQ)". A five point Likert Scale was used in this HEQ to evaluate the prototype.

### C. Research Procedures

HE was used to evaluate the interface design of the VMN. The evaluation process was come about in the evaluators' environment. Every expert spent about 30 minutes to 45 minutes examining the prototype. The procedure's steps were as follows:

- Identify the number of experts.
- Identify appropriate evaluators.
- Arranging an appointment with the evaluators.
- Spread the questionnaire to experts to review the questions for better understanding.
- The prototype was used by experts.
- Fill up the questionnaire by the evaluators.
- Getting comments for improving the design.
- Redesign the application based on expert's comments for better interactive interface.

### D. Software Development Methodology

In this study authors developed the VMN software. The characteristics of software development is based on the Table I before it tested by experts. The hardware required a PC with windows operating system which includes variety softwares for developing the VMN:

- Adobe Photoshop for pictures of galleries and panorama pictures.



Fig. 1. Officers of museum with the VMN prototype

- Dreamweaver was used to build HTML5 and mobile jQuery scripting for prototyping application.
- Share point designer

In addition, several smartphones devices with different operation system were used to test the prototype such as: Apple’s iOS, Google’s Android OS, BlackBerry’s OS and Widows phone.

III. RESULT

Finding from HE checklist was divided into 10 attributes which conducted in HEQ, such as; (i) Visibility of System Status (ii) Match Between System and the Real World (iii) User Control and Freedom (iv) Consistency and Standards (v) Help Users Recognize, Diagnose, and Recover From Errors (vi) Error Prevention (vii) Recognition Rather Than Recall (viii) Flexibility and Minimalist Design (ix) Aesthetic and Minimalist Design (x) Help and Documentation. This checklist was design according to the previous researcher [18].

Besides the results of HEQ, experts not only provide valuable comments about VMN but also gave important guidelines for improving the VMN application. In answering the first objective, the result of this evaluation was used in redesigning the application. Based on expert’ comments, the most important issue was related to the user control and freedom. The experts mentioned that adding moving options (next and back button) between fields or dialog box must be easy. The other important issue was about error message. There was not any error handling or help button to guide user about problems. Table II shows the important comments of experts.

Table III shows the improvement in the VMN application based on HE. Based on results, some parts of VMN were changed to improve the system and other parts remained the same because of lack of resources. For example, more images were put in the masterpieces to attract tourists. In addition, the back button was placed in video page and help button in the home page. All starting letter of titles were capitalized. However, it was not possible to take high quality pictures and videos due to the lack of professional video camera. Based on HLTM5 limitation, some additional tools were added to tackle video issues such as pause, play, volume and full screen button.

TABLE II. EXPERTS’ COMMENTS FOR USABILITY

Experts	Suggestions
HCI Practitioner	<ul style="list-style-type: none"> <li>• Title of menu parts should be started by capital letter</li> <li>• Putting more pictures and information about galleries</li> <li>• Putting on voice on picture for better understanding</li> <li>• Help system to guide novice users</li> </ul>
Mobile Developers	<ul style="list-style-type: none"> <li>• Providing back button</li> <li>• Providing home page button in every part of application</li> <li>• Higher quality pictures</li> <li>• Improving video part</li> </ul>
Museum’s Officers	<ul style="list-style-type: none"> <li>• Providing game or puzzle about museum</li> <li>• 3D model of artefacts</li> </ul>

In answering the second objective, Content Validity Index (CVI) was used to evaluate the expert’s results. Only items rated by the experts as “agree” or “strongly agree” are considered in calculating the CVI and the total validity index is 1.00 [19]. Table IV shows the relevance rating of six experts for ten main items and their sub items. The final result of CVI is 0.8. The CVI should be 1.00 when there are five or fewer experts. But when there are six or more experts the CVI should be more than 0.78 [19]. Therefore, in this study, the result of CVI is acceptable.

TABLE III. IMPROVED VMN BASED ON HEURISTICS EVALUTION

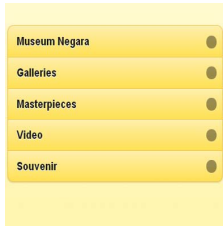
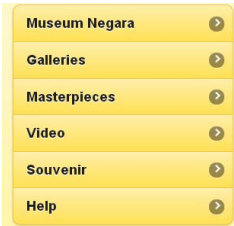
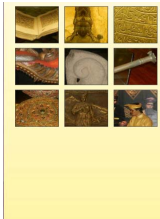
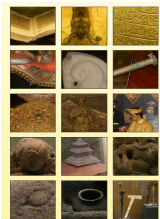

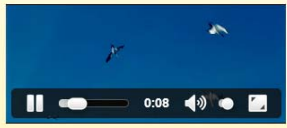

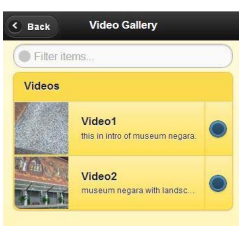
First Prototype	Second Prototype
<p>The first version did not have Help in main menu and any other pages.</p> 	<p>In the second design, the help button was added in the main menu.</p> 
<p>Masterpieces preview was 9 pictures per page.</p> 	<p>In second design, it changed to more pictures.</p> 
<p>In the first design, video player had only start for play video.</p> 	<p>In the second design video player tools were added to video player.</p> 
<p>Title of video at first prototype was started with small letter. In addition, the first design did not have guide buttons for video page to help user back to previous page.</p> 	<p>In the second prototype, the title of video is in capital and back button was added in header top-left for video page to guide user.</p> 

TABLE IV. CONTENT VALIDITY INDEX

Items	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	No. in Agreement	CVI
<b>1. Visibility of System Status</b>								
a. The status of an icon is clearly indicated.	✓	✗	✓	✓	✗	✓	4	0.66
b. Every display begins with a title or header that describes screen contents.	✓	✓	✗	✓	✓	✗	4	0.66
c. A selected icon is clearly visible when surrounded by unselected icons.	✓	✓	✓	✗	✗	✓	4	0.66
d. There is a consistent icon design scheme across the application.	✓	✓	✓	✓	✓	✓	6	1.00
<b>2. Match Between System and the Real World</b>								
a. All icons are concrete and familiar.	✓	✗	✓	✓	✓	✓	5	0.83
b. Menu choices are ordered in the most logical way, given me, the item names, and the task variables.	✓	✓	✗	✓	✓	✓	5	0.83
c. The selected theme colours are appropriate.	✓	✗	✗	✓	✓	✗	3	0.50
d. Menu choices fit logically into categories that have readily understood meanings.	✓	✗	✗	✓	✓	✗	4	0.66
e. I can understand the language used in the system.	✓	✓	✓	✓	✓	✓	6	1.00
f. The words used in the system easy to understand.	✓	✓	✓	✓	✓	✓	6	1.00
<b>3. User Control and Freedom</b>								
a. I can go back to a previous menu easily.	✓	✓	✗	✗	✓	✗	3	0.50
b. I can move forward and backward between fields or dialog box options.	✓	✓	✗	✓	✓	✗	4	0.66
c. I can easily reverse their actions.	✓	✓	✗	✓	✓	✗	4	0.66
<b>4. Consistency and Standards</b>								
a. Each page has a title.	✓	✓	✓	✓	✓	✓	6	1.00
b. Vertical and horizontal screen are possible in my device.	✓	✓	✓	✓	✗	✓	5	0.83
c. Menu titles either centered or left-justified.	✓	✓	✓	✓	✓	✓	6	1.00
d. High-value, high-quality is used to attract attention.	✓	✓	✓	✓	✓	✓	6	1.00
<b>5. Help Users Recognize, Diagnose, and Recover From Errors</b>								
a. The system supports both novice and expert users.	✓	✓	✓	✓	✓	✓	6	1.00
b. The application has error messages.	✓	✗	✗	✗	✗	✓	2	0.33
c. Error messages suggest the cause of the problem.	✓	✗	✗	✗	✗	✗	1	0.16
<b>6. Error Prevention</b>								
a. Menu choices are logical, distinctive, and mutually exclusive.	✓	✓	✗	✓	✓	✗	4	0.66
b. The system displays multiple pages.	✓	✓	✗	✗	✓	✓	4	0.66
c. Navigation between pages is simple and visible.	✓	✓	✓	✓	✓	✓	6	1.00
<b>7. Recognition Rather Than Recall</b>								
a. Items have been grouped into logical zones.	✓	✓	✓	✓	✓	✓	6	1.00
b. Videos or image gallery used to get the user's attention.	✓	✓	✓	✓	✓	✓	6	1.00
c. Size, boldface and colour are used to show different pages and importance of different screen items.	✓	✓	✗	✓	✓	✓	5	0.83
d. The same colour has been used to group related elements.	✓	✓	✗	✓	✓	✓	5	0.83
e. There is good colour and brightness contrast between image and background colours.	✗	✓	✓	✓	✓	✓	5	0.83
<b>8. Flexibility and Minimalist Design</b>								
a. Menu lists are short (seven items or fewer).	✓	✓	✓	✓	✓	✓	6	1.00
b. I have the option of touching on fields easily.	✓	✓	✓	✓	✓	✓	6	1.00
c. The system offers forward and backward options.	✓	✓	✗	✗	✓	✓	4	0.66
<b>9. Aesthetic and Minimalist Design</b>								
a. All icons are in a set visually and conceptually distinct.	✓	✓	✓	✓	✓	✓	6	1.00
b. Each icon stands out from its background.	✓	✗	✓	✓	✓	✓	5	0.83
c. Each data has a short, simple, clear, distinctive title.	✓	✓	✓	✓	✓	✓	6	1.00
d. Menu titles are brief, yet long enough to communicate.	✓	✓	✓	✓	✓	✓	6	1.00
e. There pop-up or pull-down menus are well-defined.	✓	✓	✗	✓	✓	✗	4	0.66
<b>10. Help and Documentation</b>								
a. Information is easy to find.	✓	✓	✗	✓	✓	✗	4	0.66
b. The visual layout is well designed.	✓	✓	✗	✓	✓	✗	4	0.66
c. The information is accurate, complete, and understandable.	✓	✓	✓	✓	✓	✓	6	1.00
d. The information is relevant.	✓	✓	✓	✓	✓	✓	6	1.00
<b>Average CVI</b>	<b>0.80</b>							

For future work, there are several observations that might be useful. First, the video produced on Muzium Negara can be improved so that it could be compatible with all models of mobile devices. To do this, a new interface design for video players might just be the answer. Second, the 360 degree panorama view in VMN can be improved by exploring more possibilities in new technologies of HTML5 and JQuery used for mobile devices. Third, video panorama is a new technology that can be added to VMN to make the application more attractive and interesting. Fourth, VMN can be dynamically done by using MySQL and one scripting language such as PHP. MySQL database can store all data and makes it possible to add, delete and edit data whenever is needed. PHP is a programming language that helps users to execute tasks in application. In conclusion, exploring and adding new features to the VMN could be another future research in improving the application.

#### IV. CONCLUSION

This study is to identify the usability problems for Virtual Museum Negara prototype and calculate the experts' results via Content Validity Index in improving the interface design. Moreover, our Virtual Museum Negara prototype was validated by six experts is gathered from Heuristic Evaluation Questionnaire (HEQ). Our findings show that VMN prototype has been redesigned in improving the user interface. From the HEQ, Content Validity Index was calculated and the result is 0.8. According to previous study the result is acceptable because is more than 0.78. Some limitation might be related to developing the VMN prototype. A first limitation might be the programming part. The technology of HTML and JQuery still has some loopholes and need improvement. Another limitation is about the quality of the picture. This is because researchers did not use a professional camera, the quality of panoramic picture was a bit lacking. Even though some limitation occurs, for the future work, the VMN prototype will be tested to the end users to get their feedback. Hopefully, this VMN application will help tourists in getting information about Muzium Negara in the future.

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