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User experience evaluation for a bus tracking apps in smart campus initiative

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ABSTRACT

Satisfying user experience (UX) is one of the major goals for any application. A good UX will contribute to the higher rate adoption of the application itself. With the emergence of IoT, the concept of smart campus is widely being researched and developed. Smart campus initiative is relatively important as the campus can be considered as a small town by utilizing the same IT infrastructure as smart city. Bus tracking system is one of the initiatives in smart campus environment. One of the main issues is to assess the usability of this apps before it can be deployed widely in campus. This paper will discuss the user experiences evaluation using MeCUE technique on UMS HopIn! a bus tracking apps an initiative towards implementation of smart campus in Universiti Malaysia Sabah. The app gives user the real time location of campus buses and the estimated time of arrival (ETA) for each of the buses. Based on user evaluation it has been found that the application has meet within the expectation with most of the requirements has been fulfilled and the good of UX rating. Thus, the same approach can be applied to support the development of any future smart campus initiative.

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1. INTRODUCTION

One of the important goals and the key success of any applications is by satisfying user experience (UX). Good UX refers to the higher rate of user satisfaction when they used the applications. Thus, the major aim of current application is not only meeting user's requirements but also user's experience. Creating a useful and intuitive user experience for any internetof things (IoT) application itself can be challenging given the complex nature and novelty of this technology. Creating user interface or user experience design for IoT mobile applications is particularly important as many end-users will communicate with their connected systems via apps. Thus, the mobile user experience will impact the rate of adoption of the apps itself. A poor user experience can kill even the most useful product.

The advances of software and information technology in recent years has changed most of our lifestyle. More IoT based application has emerged. For example, people are finding their way using Google Map on their smartphone; using smartphone for ride hailing services; and applications of smart home for a better lifestyle. This project uses the advances of IoT to help students of Universiti Malaysia Sabah (UMS) Kota Kinabalu campus to track campus buses to move around the campus. The growth of populations has also led to the growth usage of smartphones [1]. Nowadays to locate the location of one person is an easier task. With the advances in technology, there are many resources available in our smartphone that can be utilized to track data that can be used later. Smart campus or smart universities is one of the examples where

the utilization the benefit of IoT and cloud computing to enhance productivity. In campuses, many places normally will be crowded with students and staff at certain hours which usually will indicate a large volume of possible passengers using the bus services. Typically, students during peak hours do not know how crowded the places are on the campus, i.e., how many persons are in the cafeteria, in the library or any other public space. Most of the time students go tothe desired place only to realize that there is no place available for them, resulting in a waste of their time. In this paper, we report on a real-world use case where we used the MeCUE questionnaire [2] to assess students and related staffs' experience with the first prototype of the bus tracking application in their university. Based on this evaluation, the usefulness and relevance of the applications can be improved for the next steps toward a fully implementation of the bus tracking system in UMS.

2. SMART CAMPUS

IoT is one of the fast-growing technologies in nowadays. IoT ismade up of many connected devices communicating with each other to form a network which helps human tobecome proactive and less reactive [3]. IoT is also defined as "group of infrastructures interconnecting connected objects and allowing their management, data mining and the access to the data they generate" [4]. IoT has dramatically improve people lifestyles. With all the sensory connected to the internet, it can help human to turn data into wisdom. For example, patients are ingesting Internet devices into their own bodies to help doctors diagnose and determine the causes of certain diseases [3]. In education, IoT can play significant role and the whole campus can be converted to smart campus. In a nutshell, IoT is becoming the next evolution of Internet. With huge amount of data collected and helping human to communicate, IoT has the potential to make the better world. What does it mean by a smart campus? Smart campus will connect people with device or application and providing a new services and experience without forgetting/eliminating the efficiency of the operation. For example, wayfinding, bust tracker, smart parking, food ordering in the cafeteria, lost and found services and many more are the example of services or experience that can be provided to the students. In the early introduction of a smart campus, it begins with theobjective of providing the foundation of ubiquitous, reliable wired and wireless connectivity. Most of the Higher Learning Institutions (HLE's) has achieved this goal. Campus are interconnected in and out. With smart campus, all peoples, devices and applications will share the same technology infrastructure, enabled them to experience a better and more efficient compared to before. Now added with the benefits of IoT, the campus has become an innovation platform. Among the benefits of smart campus are increasing the operational efficiencies and improving student engagement in helping them during the transition of the campus life.

2.1. Smart campus architecture

Smart campus has become one of the major attractions when students deciding which universities or colleges they will enroll. Today's generation which has been raised in a tech-driven, connected world will more attract the campuses that can provide or accommodate their digital needs. According to [5] "smart campus uses networked technologies to facilitate collaboration, use resources more efficiently, enhance security, save money, and make the campus a more connected and enjoyable place". According to [6], smart campus architecture has gone several evolutions that can be referred in Figure 1.

2.2. Mobile bus tracking

One of the applications in smart campus is the smart mobile bus tracking system. Since bus schedules are unreliable, an effective bus tracking system is developed to replace bus schedule [7], [8]. A tracking is defined as the act or process of following something or someone. A system is set of devices powered by electricity, forexample a computer or an alarm. So, a bus tracking system is a device powered by electricity or service that can follow a bus. Bus tracking has become very common especially in developed country [9]. There are also many universities implement bus tracking system to track bus in their campus [10]. People who depends on public transport on daily basis concerns a lot to know about the real time location of the bus and the time that will take for the bus to reach their bus stop [7]. Such information will help them to make better travelling decision,improve their life quality. Common bus tracking system will track buses and give out information like estimated time of arrival of bus, route information of bus, and bus schedule. The main effect in using the systemincludes reduce wait time and reduce uncertainty time.

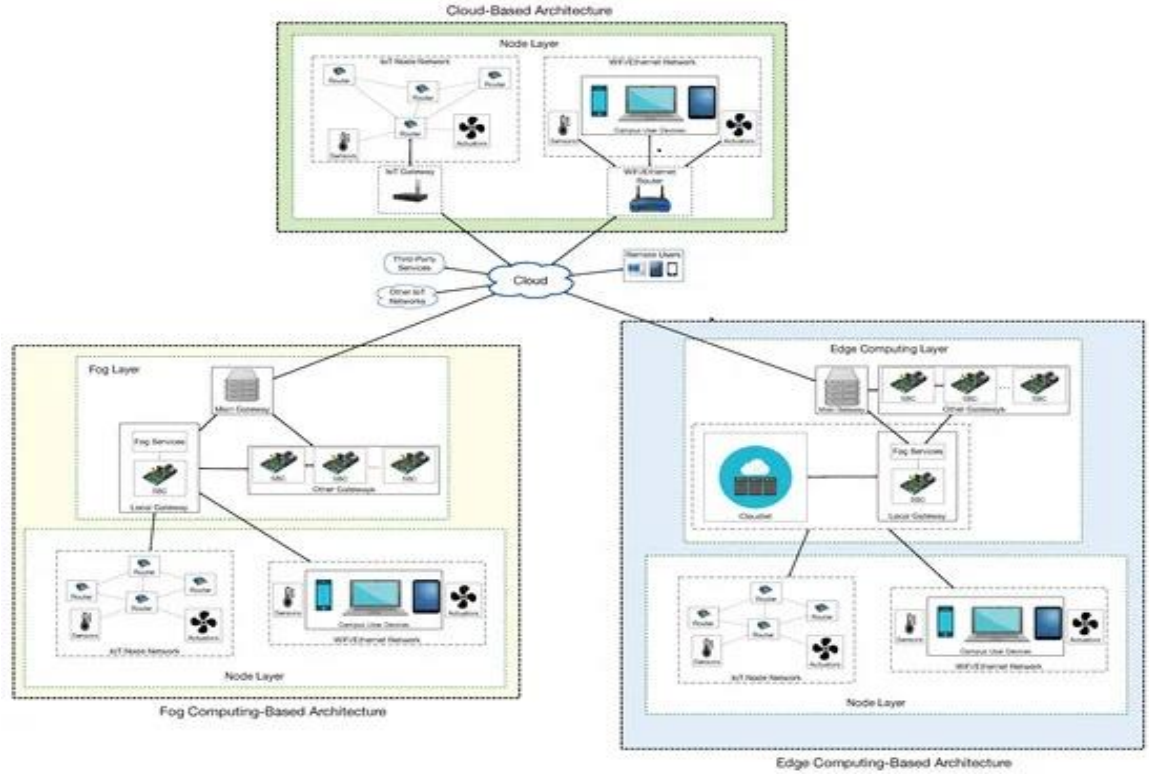

Figure 1. Smart campus architecture evolution [6]

2.3. Universiti Malaysia Sabah bus services

UMS of Kota Kinabalu campus is 999 acres big [11]. Since most students do not have their own transportation, bus services are provided especially for students to get around the university. UMS Bus Services is managed by UMS Development and Maintenance Department (JPP) and are available every day except during public holidays and semester breaks, starting from early morning 6 a.m. to late night around 10 p.m. UMS. UMS bus services play a very important role in UMS. Without the bus service, students will have trouble goingto classes, especially student who lives in hostels outside the campus. Despite of having the bus service, student's still face difficulty in using the bus service. One of the factors is inconsistency of buses. For example, students who uses the 'Campus bus' must wait blindly for bus to come because the bus has hard time to follow the provided bus schedule. Other than that, sometimes bus does not transit for some reason and student are not notified. An example regarding this problem is buses for hostels outside campus. The 'Usia bus' and 'Kingfisher bus' only transit one time every one hour. Without knowing the situation, the student will have to for another one hour to get the next bus at the bus stop. This is a waste of time because student could have utilized the one hour for academic purpose. A matter of security could also arise due to the inconsistency of bus [10]. Students may become target of robbery while waiting long time at the bus stop, especially when they have wait at the bus stop alone [10]. For example, a student plan to take the bus back to hostel after finishing a class at nine o'clock in the night. If the bus is not coming on time based on the schedule, the student will be exposing to various kind of danger since the student is waiting alone at the dark bus stop. Thus, an effective system that can provide bus tracking information is necessary to ensure the quality of the bus services. The following section discussed the development of UMSHopIn! as part of the initiative towards smart campuses. This application is the first mobile bus tracking system developed to be use in the Borneo's HLEs.

3. METHODOLOGY

One of the crucial tasks in developing any application is selecting the proper methodology. A good methodology will ensure the comprehensiveness of requirements of the system will be captured and the success of development within the budget and time allocated. We apply the rapid application development (RAD) method as it able to monitor the progress of development through several prototyping during the

process [12], [13]. RAD is a method that focuses on designed development cycle much faster with higher quality results compared to other development methodologies. The emphasis is less on the task of planning and an more emphasis on further development [14], [15]. The implementation of this project begins with identifying the requirements of the proposed system. To get the functional and non-functional requirement for the proposed system, a fewrequirement elicitation techniques are used such as interview and questionnaire. These techniques will helpto develop a basic understanding of the requirements and get the "big picture" [16]. After conducting interviewand questionnaire, functional and non-functional requirements were analysed. Functional requirements refer to what the software needs to do, while non-functional requirements are the characteristics of what a system needs to have. Instead of only focusing on the functional and non-functional requirements of the system, the UX guidelines [17], [18] has been embedded in the development methodology as shown in Figure 2. This is to ensure the requirements elicit will be able to fulfil two main objectives, user requirements and user experience [19], [20].

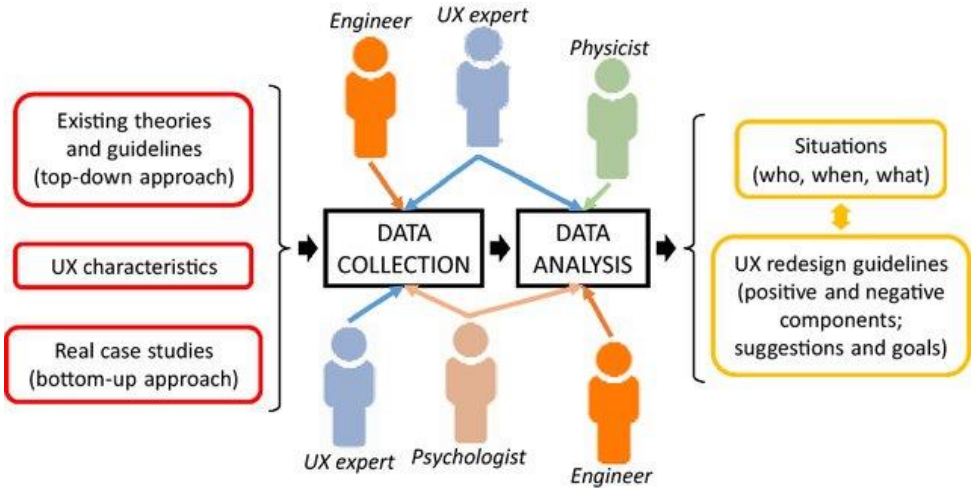

Figure 2. UX guidelines methodology [18]

3.1. UMS HopIn! software design

Requirements for UMS HopIn! Some of the HopIn! requirements are presented in Table 1. UMS HopIn! is a system that consists of two mobile application and a web application. The mobile applications are called "UMS HopIn!" and "UMS HopIn! Driver". Both of these applications are built as Hybrid app. Hybrid app are very similar from Native app, but they are built similarly as websites, using combination of HTML, CSS and Javascript [21]. On the other hand, the web application is known as "UMS HopIn! Admin". The system is a client-server architecture [22]. Hence, all of these applications need to be connected to the internet in order to get access to the database server as shown in Figure 3.

Table 1. Functional requirement for UMS HopIn! mobile application

ID	Functional Requirement	Descriptin
F01	Track buses	Mobile application can track real-time bus location.
F02	Real-time bus	Present real-time bus schedule by giving out live ETA of bus.
F03	Show bus route	Show different bus routes on map.
F04	Bus reservation	Allow user to make bus reservation for events or activities usingform through the mobile application.
F05	Bus route filter	User can filter out bus route, either to view only one bus route or toview more than one bus route.
F06	Announcement	The mobile application will notify user when there is announcement from the Management of UMS bus service.
F07	Report	User can use the mobile application to make report by using form regarding on the UMS bus service. For example, student can makecomplain about the service with this feature.

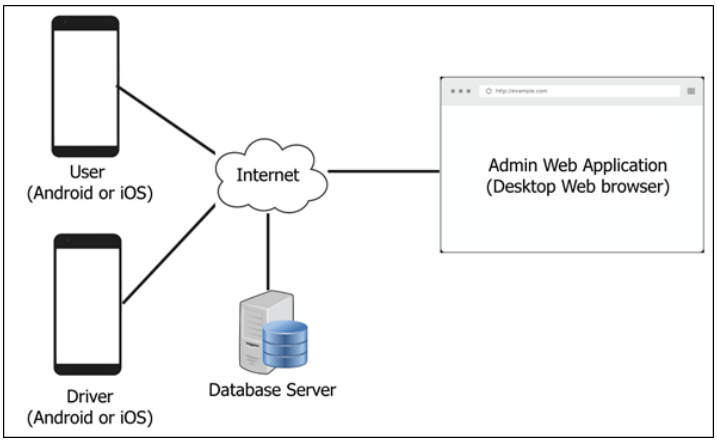

Figure 3. Architecture design for the UMS HopIn!

UMS HopIn!" mobile application is a client-side application. User are students of UMS who will use the UMSbus service. The mobile application mainly functions as tracking bus location in real time as shown in Figure 4. Otherthan that, the mobile application has function such as view the real-time bus schedule, make bus reservation, filter bus route, view announcement given from the UMS bus operator, and make report.

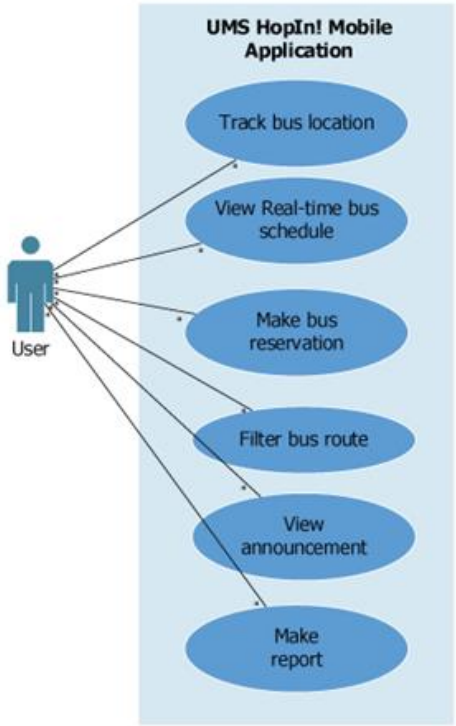

Figure 4. UMS HopIn! mobile application use case diagram for users

"UMS HopIn! Driver" is another client-side application used by the bus drivers. The mobile application function mainly to update the bus location to the database server in real time, only when the 'Driving Bus' switch is on. Besides, the mobile application has function such as displaying assigned route, update the bus condition switch and make report. "UMS HopIn! Admin" is a server-side web application for the UMS bus service provider to manage the wholeUMS HopIn! system. The web application has activities such as route manager, bus manager, driver manager,report manager, bus reservation manager, announcement manager, and bus stop manager.

3.2. UMS HopIn! implementation

The mobile application starts with a map from Google Map API [23] that shows default selected bus route and the location of the bus in real time. In order to get the bus location in real time, the bus location is being upload to the server by the "UMS HopIn! Driver" mobile application for every 5 seconds. Then the "UMS HopIn!" mobile application will download the bus location from the server in every 5 seconds interval. Each bus route is represented with different colours, which is implemented using Google Map Polyline API [24]. Other than that, user can change to view different bus route by clicking the icon at the bottom right of the application as shown in Figure 5. Figure 5 also shows the 'Bus Schedule' page, which shows the bus schedule in real time mode. Besides, the mobile application broadcasts the announcement made by UMS bus provider in the "Announcement" view of the mobile application. All announcements are downloaded from the database server, where the admin has created the announcement from the "UMS HopIn! Admin" web application and upload to database server. User can click on any announcement to view more in details.

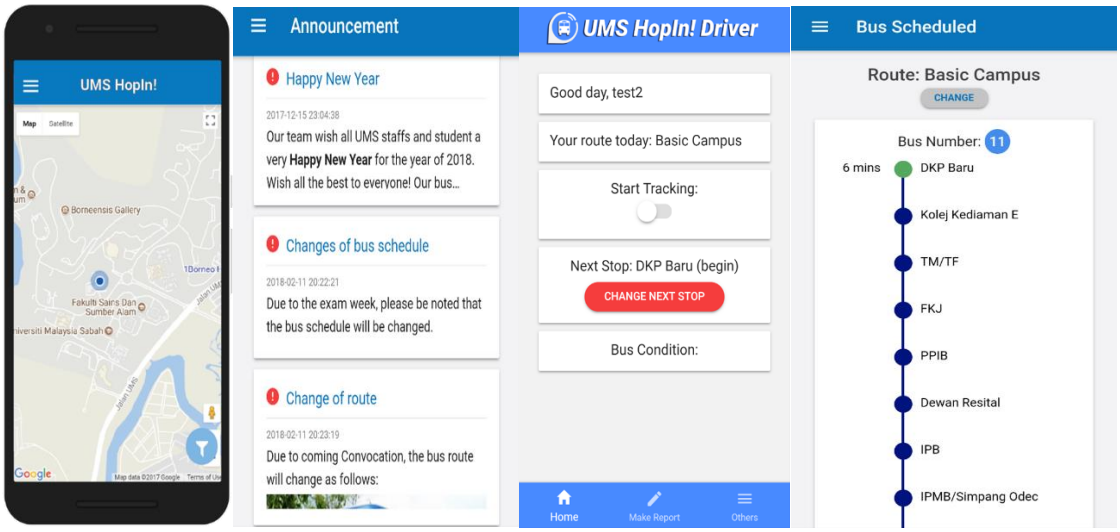

Figure 5. Pages for "UMS HopIn!" mobile application

4. RESULTS AND DISCUSSION

A success application is not based on the completeness of the requirements of the system only. There are many applications that able to serve users need but failed to have a good adoption rate. Thus, instead of evaluating the correctness of the system, user experience evaluation is also important. In order to evaluate the user experience of UMS HopIn!, an acceptance test is carried out by using meCUE (modular evaluation of key Components of User Experience). meCue is a scientifically founded questionnaire, which focuses on the modular acquisition of user-centered reviews and their experience to an interactive technical product [2], derived from CUE (an analytic framework, the Components model of User Experience) by Thüring and Mahlke [25]. As describe by the author, The meCUE questionnaire [2] is "a freely available, scientifically-founded questionnaire, which focuses on the modular acquisition of user-centered reviews and their experience of interactive technical products" (source: *http://mecue.de/english/home*). It is a modular UX assessment scale based on Thüring and Mahlke's CUE-model [17] and composed of 34 items divided into 4 dimensions: *instrumental and non- instrumental product perceptions, emotions, consequences* and *overall judgment.*

The meCUE questionnaire is given to 20 people (n=20) including one officer from the JPP and the rest are students from UMS. Based on the questionnaire, meCUE conclude the user experience into five modules. Module I and Module II both refers to 'product perceptions'. However, Module I is instrumental and it refers to usefulness and usability. On the other hand, Module II is non-instrumental and refers to visual aesthetic, status, and commitment. Module III refers to 'user emotion' where positive and negative emotion isanalysed. Module IV refers to the 'consequences of usage', analysed with the product loyalty and intention ofuse from the user. Last module, Module V shows the overall evaluation of the product. Figure 6 shows the result of Module I, where the score for usefulness is as high as 6.65 and the score for usability is 6.32. Both scores are quite high and this indicate that most user thinks this application is useful and usable. Figure 7 shows the result for Module II. Score for visual aesthetics is 4.98, whereas score for status is 5.60 and this application gets commitment score of 5.15.

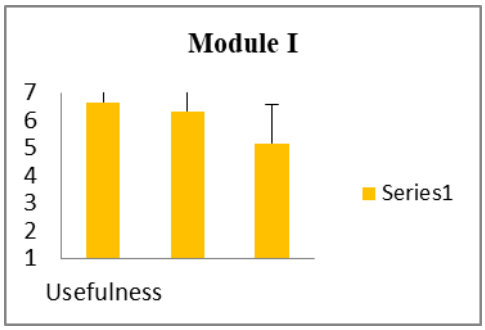

Figure 6. Module I-product perception (instrumental)

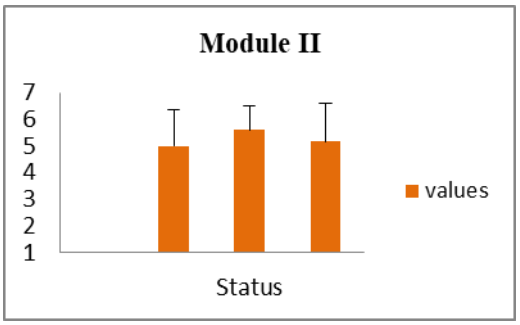

Figure 7. Module II-product perception (non-instrumental)

Figure 8 shows the result for Module III. The result shows that most users are having positive emotions inusing the mobile application, with score for position emotions of 5.56. Figure 9 shows the results for Module IV. The score for 'intention to use' is 5.62 whereas the score for 'product loyalty' is 5.98.

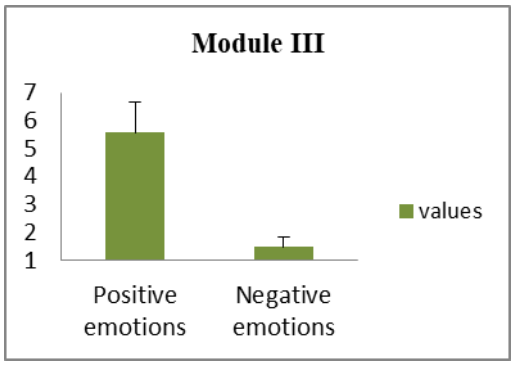

Figure 8. Module III-user emotions

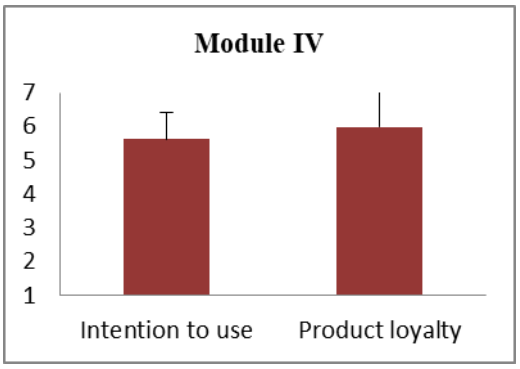

Figure 9. Module IV-consequences of usage

Figure 10 shows the overall evaluation score. In the end of the questionnaire UMS HopIn! got an overall evaluation score of 4.0, which is a good result. Hence, all the testing and evaluation is done to UMS HopIn!. The overall result from the evaluation is within the expectation with most requirement has been fulfilled. A rework to fix all the failure in the system will be carried out in the next iteration of this project.

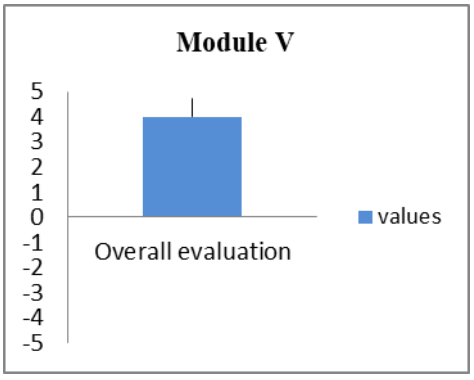

Figure 10. Module V-overall evaluation

5. CONCLUSION

UMS HopIn! is one of the initiatives towards smart campus in Borneo's Higher Learning Educations generally, UMS specifically. The application consists of two mobile applications–namely UMS HopIn! and UMS HopIn! Driver, and a web application namely UMS HopIn! Admin. The application promoted a real time bus tracking system that can be monitored by the students as well as a system for the UMS administration to monitor their bus servicesand route. One of the important goals and the key success of IoT apps is by satisfying user experience (UX) showed by the higher rate of user satisfaction when they used the applications. Thus, the major aim of UMSHop In! is not only meeting user's requirements but also user's experience. Creating a useful and intuitive user experience for any IoT application itself can be challenging given the complex nature and novelty of this technology. Thus, the mobile user experience will impact the rate of adoption of the apps itself. A poor user experience can kill even the most useful product. Based on the results from the user evaluation, it shows that the application able to score a high user experience score. The feedback received will be an input to further improve the apps to ensure its will be bringing the benefits to the campus wide.

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