ABSTRACT

Driving Simulation (DS) is a part of Virtual Reality (VR) technologies that have been rapidly growing and widely used in today’s vehicle application or automotive industries especially in foreign country. However, there are still some barriers of implementing DS in Malaysia especially for driving institution (DI). This paper also will determine the benefits of implementing DS. Qualitative method is applied by interviewing the expertise of DI to gain more accurate information. Therefore, this study will identify the anticipation barriers and proposed solutions for further actions that can be taken to implement DS at any DI in Malaysia in the future.

Keywords: Virtual Reality (VR), Driving Simulation (DS), Driving Institution (DI), barriers, Kedah

INTRODUCTION

Virtual reality (VR) can be defined as artificial environment which is created by software and presented to the users. The users completely belief and accepts this as a real environment and then interact with this environment (N. Chawla, N. Gupta, & K. Choudary, 2013). One of the VR characteristics that have been widely used today is Driving Simulation (DS).

DS can be defined as the practical tools for the drivers to study the vehicle behavior and how to react to those conditions without using a real car in dangerous situation (N. Fouladinejad, N. Fouladinejad, M. Jalil et al., 2011). DS already have been successfully implemented at the foreign country. For example, some driving institution in Australia have moved towards DS training such as Australian Advanced 4WD Driver Education, Driver Safety Australia and Safe Drive Training (SDT). All these three institution provide DS program and even some of them are selling DS for learning purpose. Today, the application of VR technologies has been widely expand and received overwhelming responds especially to our country. However, in Malaysia the awareness of DS training implementation still lowest and received a little response compared to foreign country.

PROBLEM STATEMENT

Driving Simulation (DS) training does provide many advantages for the user especially novice drivers to enhanced their skills and avoid car crash during practices on the road. However, there are circumstances in implementing DS in driving institution known as
DI in Malaysia. In order to obtain DS, DI needs to ensure DS training program will deliver good returns to both organization and learner which is also their customer. Furthermore, the DI or right parties such as Road Transport Department Malaysia (JPJ) and Government need to look out on the constraints available.

DS training have been successfully adopted in some organization and industries especially in foreign country. Among the first companies that develop driving simulator is Daimler – Benz, General Motors, Renault, Ford and Chrysler. In the 1990’s also many universities actively developing driving simulators such as The University of Iowa and Virginia States of University. (Fouladinejad et al., 2011). Recently, a private company from United States (US) namely UPS has slowly implementing DS to ensure safety driving while training. As a result, accident and crash decreased about 50% (Vasan, 2014).

The organizations that already implement DS in Malaysia is only Jayonik MSC Sdn Bhd. Jayonik MSC Sdn Bhd is specializing in Virtual Reality (VR) technology that develops, distributes and supplies driving and riding simulators, military simulations training, Computer Based Training (CBT) and other VR systems. The company has successfully completed their VR project by supplying their VR systems to Government sectors such as Ministry of Defense Malaysia, Malaysian Royal Academy Police and introducing first bus simulator systems for Prasana Malaysia Berhad (PRASANA) of RapidKL. Also, one of research institute that already designed and developed DS is Universiti Teknologi Malaysia Driving Simulator (UTMDS) (Fouladinejad et al., 2011). This showed that DS can be fully applied especially in training the driver in Malaysia.

As stated above, DS has been successfully implemented by some company and industries especially foreign country. Therefore, the objective of this study is to identify the barriers of implementing the Driving Simulation (DS) in Kedah, Malaysia and to examine the benefits of DS implementation.

**LITERATURE REVIEW**

**Driving Simulation (DS)**
Simulators have been widely used in construction as a part of training equipment starting by Volvo Construction Equipment (Volvo CE) as the first company to invent in simulator training. Volvo CE in their collaboration with Oryx Simulation, a company from Swedish is responsible for producing simulator in order to educate the drivers efficiently and can handled any kind of situations that may occur. Then, other construction industries such as Simlog, Tenstar and Caterpillar started using simulator training (Fjeldheim Ek, Mulisic & Syta, 2010).

In Malaysia, DS also become popular nowadays especially in gaming. However, DS not fully implemented by any driving institutions (DI) in order to train drivers on the real road situations look alike. In this part, we will look into the potential and possibly highest barriers in implementing DS training in Malaysia especially Kedah area altogether identify the opportunity and benefits of DS implementation.
Barriers of implementing DS

Traffic simulations environment
Driving Simulation (DS) required traffic flow environment where the users assess the vehicle and interact to real time environment. Traffic simulation models can be divided into three category which is macroscopic, microscopic and mesoscopic. Macroscopic models view the traffic flow as whole. Meanwhile microscopic describe the individual vehicle behavior and their interactions. On the other hand, mesoscopic combine both macroscopic and microscopic (Mathew & Bombay, 2014).

The latest traffic microscopic simulations software tools such as Sumo, Caliper Transmodeller and PTV Vissim that create realistic traffic situations and condition although it is involve complex process. According to Erath, Maheswari, Joos, Kupferschmid and Van Eggermond (2016) in their research paper, PTV Vissim which offer the widest range capabilities in urban environment that enable the users interactively interact within the simulation such as provide interface like pedestrians, bicycles, public transport, trucks, and individual cars. However, there are some limitations in rendering realistic environment such as the graphic representation of the surfaces may look too insufficient or unrealistic to consider in real life (Erath et al., 2016).

One of DS benefits is the ability is reduce fuel consumption (Wu, Zhao, & Ou, 2011). In traffic model simulations, fuel consumption models have been applied on macroscopic, microscopic and mesoscopic simulations environment. Based on these three models, microscopic simulators are the most suitable to be chosen in simulation environment as it differentiates behavior models making them ideal for scenario analysis and performance accuracy. However, microscopic simulators required a lot of computational cost, large amount of simulations replica is needed and limitation of fuel consumption model (Osorio & Nanduri, 2015).

Financial and economic factors
Cost factor need to be considered as the main issues to acquire DS. As stated in construction industries, the prices range of simulator training would be USD6,000 (RM25,000) to USD19,750 (RM82,653.75). For wheel – loader and excavator could be
from USD4,000 (RM16,740) till USD11,000 (RM49,173.75). Since there is no research paper stated the actual prices of DS, simulator training for construction are being considered to give the review of DS price estimation. In addition, it is difficult to produce the simulation systems with lower cost (A. Juarez, W. Schonenberg, & C. Bartneck, 2010). It quite expensive for the DI to acquire DS regard the budget constrain and other factors (Fjeldheim et al., 2010).

Meanwhile in European Union (EU) countries, the right parties such as local Government and policy-makers is having trouble in decisions making and determining financial evaluation because of technical problem, economic analysis and time consuming needed for collecting data (Chudzikiewicz, 2011). Same for Malaysia, the economic and financial factors should be considers when acquire these technologies as we aware that in the technologies or part of software could be obsolete and need to be upgrade in future. Chudzikiewicz et al. (2011) also stated that example of cost that will be involve such as initial cost, maintenance cost, technical services cost, and other services cost should be consider to implement DS.

Tools and software in developing DS

The tools and software that involve in developing DS will be comprise software requirement, software expertise and software frequency. First, before implement DS, we need to do checklist about the tools and its accessories first in order to ensure it can be use for the long term. One of the DS barriers is the software that are used by the developers can be revoke and need to be update from time to time according to technological changes (Punzo & Ciuffo, 2011). Furthermore, not using a proper technique while develop DS also can be misunderstood by the users. For example, poor quality of 3D models of object like building and cars making it unrealistic (Punzo & Ciuffo, et al, 2011). On the other hand, some Computer Aided Design (CAD) software required relatively high polygon counts to show complex object which need long computation time processing (Seth, Vance & Oliver, 2011). In addition, some DS also have limitations such as lower degree of realism and high risk in simulator sickness (De Rosario, Solaz & Rodriguez, 2010).

Secondly, to build realistic and high fidelity environment in DS, it required a lot of knowledge and expertise on that field. For example, some expert used traditional approaches such as exploit 3D models from 2D models to build physical prototypes so that they can identify what is lacking and need to be upgraded in the future. Therefore, expertise knowledge also plays an important role (Seth et al., 2011). Another limitations regarding software is the manufacturer and developer of the tools itself. For example, in order to produce the best and high resolution of tiles geometry, manufacturer need more time consuming depends on the speedy technology processing. It is not easy to produce base tile as it very costly. The developer also needs to generate more advance feature on DS as the driver need to communicate and interact between simulator and the environment.

Thirdly, simulation software is made up from different package and working on its own frequency. The software developers need to update the software frequency consistently to ensure correct visualization in driving environment. However, updating software frequency required to update all the information and programs that is hosted including anonymous data which could ruin DS environment. The right visualization in DS environment needs to be updated up to higher frequency usually 60 Hz (Punzo &
Ciuffo, 2011). Punzo and Ciuffo (2011) also stated the higher simulation frequency are not allowed as it will slow down the real time speed of the simulation.

Benefits of DS implementation
Driving Simulation (DS) is a useful tool to help the driver clearly defined the geometric environment and quick understanding of the environment structure to examine the damages that could be happened (Sampaio, Ferreira, & Rosário, 2010). These allow the drivers to interact with DS environment and make a decision to avoid car crash and accident.

Training through DS helps the drivers to improve their driving behavior and performance in the future. For example, they can review their driving performance through a video recording and determine which skill they are lack and what to be improved. Mostly DS are equipped with video recording to examine their driving performance. Training in DS encourage the drivers toward more safe driving skills as it increased the drivers knowledge on how to handling the environment and situations if there any collision (Beanland, Goode & Salmon, 2013).

Beanland et al. (2013) also proposed that although DS not improve the drivers experience on the road, DS helps to improve the hazardous perception which is the drivers need to highlight and handling potential hazard compared to traditional training which have high risk attitudes and driving abilities.

While identifying both barriers and benefits of DS implementation, it is not denied that there are limited studies in this field especially in chosen area, Kedah. Currently, many studies are focusing on improving driving skills in DS and on the road evaluation.

RESEARCH METHODOLOGY

Primary data sources

Interview method
An interview method is chosen compared to questionnaire method because of suitability and focus on specific industries such Driving Institution (DI). The interviewed is conducted with DI Representative as a respondent. This method is aim to achieve the objective of this study which is barriers in implementing Driving Simulation (DS) and the benefits from DS implementation. Furthermore, the purpose of this method also to obtain specific and accurate result from the DI representative regarding this field of study since there is limited study about DS implementation in Malaysia’s DI especially in Kedah. The interview question covered aspects such as demography, identifying DI, DS implementation and future studies.

The first aspect is demography. In this aspect, the respondent were asked to introduce themselves such as name, age, job position and how long they have been working on this industries.

Second, the respondent was asked based on the aspect of identifying DI. The question is how many students registered per month/per year in taking driving license test with Road Transport Department Malaysia (JPJ), how much estimate cost or fee per person
who registered in taking driving license test with JPJ, how much estimate budget cost per month/ per year and how much estimate annual profit per year.

Third is DS implementation aspect. Question that were covered is how much the exposure and understanding of DS by the DI representative, why did not implement DS in their DI, what the exact and possible barriers of implementing DS, did DS provide reliable result to the driver whether improve their driving ability or not in the real situation and is there any customer’s demand or effort from DI to implement DS.

Last but not least, the aspect of future studies was asked. The respondent was asked about which area that DS will be lead based on technological changes and capabilities in the future, what is their strategy and hopes for future DS implementation.

Secondary data resources

Internet
Secondary data have been widely used such as Internet. Materials such as case study, journal and scholarly articles are achieved through search engines and sites such as Google Scholar and UUM Online Libraries which is known UUM Pustaka Sultanah Bahiyah (UUM PSB). All online publications can be access through E – Resources. However, many results are obtained from Google Scholar since it provide various field and study regarding DS since E – Resources does not provide too many information about DS and have limited access especially for ICT papers. Moreover, additional resources are gained from official websites such as JAYONIK MSC SDN BHD, Road Transport Department Malaysia (JPJ) and Prasana Malaysia Berhad (PRASANA) which provide some sort of useful information. In addition, although some resources from internet such as websites are seems to be irrelevant, only applicable and trusted information are taken into account.

E – Books
Some e – books are be made as resources while searching for information. Furthermore, the related information was taken as references and some for better understanding of research field.

Books
Some books have been used for further readings and understanding about DS and the related field. For example, the books that have been used is “Introduction to Virtual Reality”, (2004) by John Vince. This book can be obtained in UUM PSB Library. However, since this book only can be used to gain more understanding and knowledge of research studies since some information may obsolete and the latest relevant information that more up to date are available on journal articles.

ANALYSIS & FINDINGS

Background of the study
The two driving institution (DI) that are involved in the interview were Ilmu Baru Sdn. Bhd. which located in Mergong, Alor Setar Kedah and another one is Mustika Muhibbah located in Sintok nearby UUM. The total respondent is three person where two respondent from Ilmu Baru Sdn. Bhd and one respondent from Mustika Muhibbah. The two respondents from Ilmu Baru Sdn. Bhd. is the Chairman and Managing
Director. Both of them are expertise and have about 40 years working experience in DI. Meanwhile respondent from Mustika Muhibbah is administrator officer who have 15 years working experience in DI.

**Barriers of implementing DS**
The first barriers of implementing Driving Simulation (DS) are Traffic simulations environment. Both DI did not emphasize the traffic simulations environment could be the barriers of implementing DS.

Secondly, Financial and Economic factors which is including cost factor. The respondent highlight that the cost is the main barriers of implementing DS. Both of DI stated that registration to take Road Transport Department (JPJ) road test is unstable and depends on the seasons. For example, there were many registrations during end year school holiday, after Malaysia Certificate of Education (SPM) exam and University/College semester break. Sometimes it depends on Government policy and strategy such as implement subsidy price for motorcycle in order to encourage motorcycle drivers especially students to have a motorcycle license. For example, the subsidy price for motorcycle that charged by JPJ is RM299. Meanwhile the estimate fees for registration to take driving license are depends on the DI itself plus Goods and Service Text (GST). Next, there are a few conditions need to be considered before implementing DS such as stated by the respondent below.

**Respondent 1:**  
"There is no resource allocation from Government to implement DS."

**Respondent 2:**  
"There are two conditions to implement DS. First, how many people will use DS? Secondly, we will implement DS only if JPJ instruct us to implement DS."

Based on Respondent 1, all the types of expenditures are under DI obligations and liability which means there is no budget from Government or JPJ to implement DS. Furthermore, cost to buy or lease DS is very expensive. Meanwhile based on Respondent 2, DI need consider how many units of DS they need to buy. Moreover, the cost to implement DS may not sufficient to cover the liability cost of DI. The liability cost is about nine years and will obsolete in ten years which is all vehicle needs to renew every ten years that will incurred more cost. Secondly, the DI will only implement DS if JPJ instruct them to change the syllabus. Currently, DI could not implement DS because of economic situations and current JPJ syllabus.

The third barriers are the tools and software in developing DS. The respondent did not stress about the tools and software as they are less expertise in this field. However, they did stress that technological skills and advanced are depends on the suitable area.

**Respondent 3:**  
"Factors such as places and technology skills should be consider when to implement DS. For example, an area like Kuala Lumpur (KL) could implement DS to avoid traffic jammed."

Currently, it may not suitable for DI which is located in town especially rural area to implement DS as technology skills still lower. For example, Mustika Muhibbah in
Sintok which is nearby UUM is a surrounded by village area and have a gap in terms of technological changes and knowledge compared to developing area like Kuala Lumpur (KL).

The findings have shown among the barriers stated before, the main barriers of implementing DS is cost. This is support by the previous research in literature review which stated that financial and economic factors are one of the barriers that exist. With the current economic environment, DS could not be implemented as it involved high expenses and have no allocation from Government.

**Benefits and proposed solutions**
The benefit of Driving Simulation (DS) implementation is the ability to reduce fuel consumption and avoid car crash. However, since DS are not implements in Malaysia yet, Return on Investment (ROI) are analyze in order to identify the benefits of DS implementation. J. Donald L. Fisher, Matthew Rizzo, Jeffrey Caird, et al., (2011) on their e-books on Handbook of Driving Simulation for engineering, medicine, and psychology stated that based on foreign country implementation of DS in the evaluation of ROI will reduce instructor function while DS equipped by virtual driving instructor and enable the drivers to learn three time faster compared to practical training. The most important ROI value is the DS provide effectiveness training to the drivers. In comparison between the cost of DS implementation and cost of the car involve for training in Driving Institution (DI), DS implementation benefits the drivers to learn at a lower cost, long term usage and lower risk of damages. Compared to cost of car in DI such as fuel, maintenance and recovery cost if accident occurs. However in practical, mostly DS training are focused on the road environment and did not provide too many on-circuit practical training such as car parking. In contrast, the DS environment may not compatible and different from a real world. While training, the drivers may found the similarities of DS with playing a driving game since it is part of VR simulations.

For the proposed solution, the right parties such as Government, policy-makers and Road Transport Department (JPJ) need to consider the DS implementation in DI. Resource allocation such as capital sources and fund from Government could help DI to implement DS at the same time increased the skills and knowledge, and keeping up the nearby locations with technological changes. In addition, the respondent also cherish that Government should reconsider the GST and take some action to implement DS. Moreover, both of DI agreed that in the future, they would implement DS if JPJ instruct them to change their current syllabus to DS implementation.

**CONCLUSION**

There are some limitations while conducting this study in terms of limited resources regarding DS topics such as journal articles, budget, locations and time constraint. Therefore some comparison from foreign country and Malaysia are made to derive the barriers that exist in the focused area. Also, some area such as Kuala Lumpur (KL) and Kedah is compared in extend to achieve the objective of this study. In addition, ROI is evaluates to further knowing an exact benefits of DS. However it contains both pros and cons. In terms of VR technologies, it provides many pros as well may give the cons to DI in terms of the number of people that will use DS. It is not denied that DS has been popular topic to make a research. This is showing that DS is beneficial for specific
training and skills but more space leave for other related field to be discovered in the future. Therefore, further researchers are encouraged to explore more about DS technologies and knowledge that can be added to current research.

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