

CONSTRUCTION PLAYER'S PERCEPTION OF TRAINING APPROACH USING SERIOUS GAME—A PILOT STUDY

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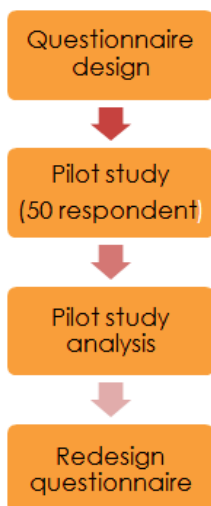
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Graphical abstract



Abstract

Construction workers are always exposed to numerous occupational hazards of different kinds and levels of complexity in every project they engage in. Therefore, there is a need for training modules which can provide the knowledge to construction workers to acquire the skills necessary for occupational and environmental safety on site. However, current safety training still lacks hands-on approaches and it is theory-oriented. This is due to the nature of the construction environment itself in which hands-on approaches are impossible to be applied for certain types of hazards. Training which is assisted by technology is an effective tool in improving learning for not just for children but also for adults. Currently, serious game has become a new approach in training and learning not limited to the field of education but this approach has been applied across disciplines and areas including military, mining, transportation, oil and gas and also the construction industry. Therefore, this paper sought to review construction workers' perceptions toward serious game as a training tool. Fifty players at various levels from the construction industry participated in a pilot study. A set of questionnaire was distributed to the participants during an occupational safety and hazard (OSH) training course with the cooperation of OSH state agency in the southern region of Peninsular Malaysia and also online. Descriptive statistics were used to analyze data from the questionnaire. Preliminary findings of the pilot study indicated that construction workers had high expectation toward serious game in delivering hands-on training in safer environment. They also believed training module using serious game had the potential in creating affordable, interactive and entertaining training module for the industry. The study contributes to an understanding of occupational safety training needs in the construction industry for a safer, more affordable and interactive as well as entertaining approach.

Keywords: Safety training, hazard identification, serious game, construction industry

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1.0 INTRODUCTION

The rapid growth of technologies and transferring culture of information technology has created the generation of IT [1-3]. This environment has made gaming industry become more powerful in creating product and become root of entertainment and transferring technology to a number of serious industries. Games become powerful products and

have been adopted for many industries such as defense, medicine, architecture, education, city planning, and government applications. Computer games or video games become an effective tool in improving learning and training for adults and children [4,5].

Since 1970s computer game has been a part of education known as edutainment. Edutainment is a term that covers the combination between

educational and entertainment, it is inspired by behaviorism, cognitive and socio-cultural theory [5]. Simple and straight-forward games become the main focus of edutainment in delivering information toward players. However most edutainment has failed to achieve expectations, these occur because the games have been designed poorly and too simplistic compared to video games [6]. After that, more researcher were argued that serious games, including simulations and virtual worlds, have the potential to be an important teaching tool because they are interactive, engaging and immersive activities [7, 8].

Thus, this study was designed with the aim to review construction workers' perceptions toward serious game as a training tool. This study is in line with current approach [9], which promotes game as an effective tool in training architecture, engineering and construction (AEC) students to identify hazard on sites. It has been shown that game has the potential to induce what is defined as 'flow' [10], which indicates that players will be immersed and engaged in the action. Time and place become unimportant. There has been increasing interest in using games within educational contexts since the current generation has been growing up playing computer games [11, 12].

As a result, in this pilot study, an attempt was made to explore the perceptions of construction players of the practicality of using serious game as a tool in hands-on OSH training. Eventually, it is anticipated that this study will be further extended to develop a training tool that will be able to identify occupational hazards on construction sites as well as train construction workers in making wise decisions in handling such hazards. In sum, the results of this study will not only contribute to a better understanding of construction workers' needs in the area of continuous learning but the findings are also expected to have significant implications on the Malaysian construction industry at large.

2.0 SERIOUS GAME AS TRAINING TOOL

Indeed, games have become powerful tools and adopted for use not only in education but in a wide range of industries and sectors across many fields such as defense, medicine, architecture, engineering, city planning, and government applications in the public sector. Computer games or video games have also become effective tools in improving learning and training for adults and children [13]. For example, in New Zealand, its transportation department uses a module of video game as a simulation of driving to measure the awareness and decision making among new drivers in identifying hazards [14].

By using this module, when the novice drivers are exposed to a certain risk, they can react immediately because they have been trained to respond toward hazard [15]. Besides that, simulation of war game has also been applied in the United States military defense to train their army personnel tactical strategy within virtual war environment. Not only that, even now

football players can also practice playing soccer game to improve their skills that will help them play the game better. These are some of the evidence of the practicality of game not only as an entertainment tool but also a training tool. Table 1 shows the numerous industries impacted by game technology (see Table 1).

Technology application for safety training has been explored by many researchers [9]. Research interests in the benefit and usefulness of technology to be adopted in training have been on the rise. 'Serious games' have increasingly been used to enrich learning and development for both commercial and academic purposes. A Google search on the term 'serious games' may yield almost over 1,090,000 results which shows that it is one of the trending terms on the Internet [16]. Although the use of the term itself has already been established, there is yet a formal definition of the concept of 'serious game' as training tool.

Serious game is often used in training or education and advertising as well as for simulation. This is due to the multi-faceted features and characteristics of serious game compared to other types of computer or video game for it is not only about the story, the art and the software—it goes beyond that. Serious game has the additional pedagogical input with activities aimed at educating and imparting knowledge and skills to the players [19]. Although pedagogical components are part of what make up a serious game, they are usually subordinate to the story and entertainment components. Once all the components work, the pedagogy will follow. Thus, as defined by Girard, Ecalle and Magnan, serious games can be described as a "digital games, simulations, virtual environments and mixed reality/ media that provide opportunities to engage in activities through responsive narrative/story, game play or encounters to inform, influence, for well-being, and/or experience to convey meaning" [17].

Table 1 List of industries impacted by game technology

Industry	Impact
Transportation [14]	Training novice driver to respond toward road hazard wisely
Military [18]	Training soldiers and leaders in the tactics and strategies of war. Three dimensional modeling of equipment to illustrate or explore its capabilities
Education [19]	Augmenting classroom instructions in nearly every subject –English language, mathematics, physics, history, etc
Business [20]	For team building, office management
Emergency Management [21-23]	Training emergency responders, fire-fighters, police and others to deal with terrorism and natural disasters
Construction and Architecture [24-26]	Planning and designing a building
Health Care [27,28]	Educating patients on treatments, rehabilitation, and managing anxieties. The next generation of workout videos
Sports [29,30]	Recreating live sporting events for review and for prediction of potential outcomes. Rehearsing for critical "one time" events like Olympic Games ceremonies Fantasy sports leagues in 3D
Law [31]	Illustrating crime scene activities for judge and jury Analyzing crime scene data

3.0 RESEARCH METHODOLOGY

This pilot study sought to review the perceptions of construction players in the construction industry at various levels. Survey was employed as method of data collection and a questionnaire was developed for this purpose. Descriptive statistics were used to analyze the data.

3.1 Participants

The sample size of pilot study has been followed the rule of thumb which stated to test the survey on at least 12 to 50 people must be carried out [31]. This range will efficient number of people in term of cost, energy and time, 50 people a large enough to note same problems with the survey questions [33]. Thus, for these pilot study 50 construction players has been selected. Respondents were grouped into according to their trade, and type of workers such as general workers and semi-skilled workers (7 participants), skilled workers (5 participants), supervisors and managers (14 participants) and others which represented consultants like quantity surveyors, clients, and trainers (24 participants)

3.2 Method, Instrument and Procedures

For this pilot study, the questionnaire was divided into three sections: 1) user characteristics; 2) user needs analysis; and, 3) user perspective towards training using serious game. However, in this paper only the third section will be discussed. There were two parts in the third section: 1) familiarity of user towards game; and, 2) respondents' perspective toward using game as training tool. There were thirteen items that were used to measure respondents' perception in the third section. These items were adapted from previous

studies on students' perceptions of the advantages of using game in learning [34].

Data were collected by distributing the same set of questionnaire among participants in an occupational safety and hazard (OSH) training course and online. This pilot study took two weeks to be completed, from 15th November 2014 until 23rd November 2014. Descriptive statistics were used to analyze data from the pilot study. Table 2 shows the scoring used to interpret respondents' perceptions towards serious game as training tool.

Table 1 Level of scoring perception based on mean

Scoring	Mean Score
Low	1.00-2.33
Moderate	2.34-3.66
High	3.67-5.00

4.0 PRELIMINARY RESULTS

From the total number of 50 respondents, half of them were participants from the OSH training course. The other half of the respondents came from online survey

4.1 Respondent's Familiarity With Game Approach

Most participants were in the age group of 21-30 years old (32 respondents, 64%), followed by 41 years old and above (11 respondents, 22%), 30-40 years old (6 respondents, 12%) and 20 years old and below (1 respondent, 2%).

As far as experience was concerned, nearly half of the respondents had between 1 year and 3 years of working experience (24 participants, 48%). This was followed by respondents who had more than 10 years of experience in the industry (10 respondents, 20%), those with 5-10 years of experience (7 respondents, 14%), and respondents who had 3-5 years of experience (6 respondents, 12%). There were only 3 respondents (6%) who had less than a year of working experience. All respondents were active workers in construction industry at the time the pilot study was conducted. More than half of the respondents (37, 74%) were already familiar with game approach. Figure 1 shows the results of the first part of the third section of the questionnaire in terms of familiarity of user towards game according to age groups. The age group of 21-30 years old had the highest number of respondents who played video games (23 respondents, 46%), followed surprisingly by the group of 41 years and above (8 respondents, 16%).

This finding shows that age was not a significant factor as playing game was already a routine activity in respondents' lives.

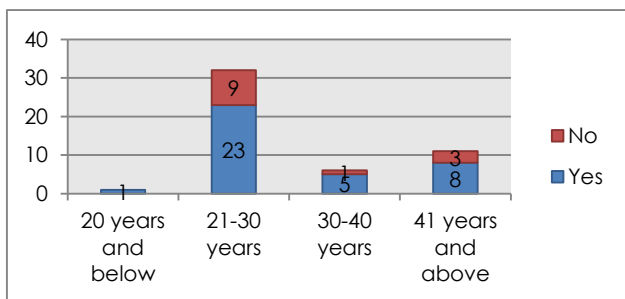


Figure 1 Numbers of respondents who played games according to age groups

Table 3 shows more detailed descriptive statistics of respondents' familiarity with the game approach. Based on the results presented in this table, it can be summarized that the highest frequency of workers' weekly playtime was once a week (18 respondents, 36%), followed by everyday (12 respondents, 24%) and twice a week (9 respondents, 18%). The purpose of checking workers' weekly playtime was to determine the frequency of time that they were able to allocate to play games. From this finding, it was discovered that respondents among the construction workers were able to allocate their time for training at least once a week. The survey assessed more than mere hours of playtime, as workers were asked to point out their preferred genre of video gaming as well (see Table 3). Only workers who played games answered this item. Respondents selected the puzzle games (18%) and action games (16%) as the preferred genres, while arcade game, sport game and role play-game (10%), simulation game (6%) and strategy game (2%). The distinction made between puzzle games and action games was necessary in order to get some insights into the familiarity of video games respondents played during their spare time.

Table 2 Descriptive statistics of workers familiarity with game approach

Group	Group of workers								Total	
	General workers & Semi-Skilled Workers		Skilled Workers		Supervisors & Managers		Other		N	%
<i>Weekly Playtime</i>	N	%	N	%	N	%	N	%	N	%
Once a week	3	6%	3	6%	5	10%	7	14%	18	36%
Twice a week	2	4%			1	2%	6	12%	9	18%
Everyday	2	4%			6	12%	4	8%	12	24%
	Total :								39	78%
<i>Preferred Genre</i>										
Arcade Games	1	2%	1	2%	2	4%	1	2%	5	10%
Puzzle Games	1	2%			2	4%	6	12%	9	18%
Simulation Games	1	2%			1	2%	1	2%	3	6%
Role-Play Games	1	2%			3	6%	1	2%	5	10%
Strategy Games	1	2%							1	2%
Action Games					3	6%	5	10%	8	16%
Sports Games			1	0.02	1	2%	3	6%	5	10%
	Total :								36	72%

4.2 Respondent Perception Towards Using Serious Game as a Training Tool

Table 4 shows respondents' perceptions of using the serious game approach in training, as defined by Girard, Ecalle and Magnan [16]. This view is one of the advantages offered by the game approach to construction workers. Results showed that three out of five groups (other, supervisors & managers, skilled workers) had high expectation toward game approach in helping them enhance their knowledge and skills in accordance with the requirements of the current market. Their mean scores of 3.74, 3.67 and

3.60, were the highest respectively. These findings indicated that respondents who were construction workers would be willing to use game approach in OSH training continuous learning among them. All respondents agreed that practice using the game approach could save time and cost, apart from providing a safer approach to training especially when handling hazards on site. Besides, training using gaming approach also allowed a flexible schedule in which construction workers could participate in training sessions according to this flexible schedule without neglecting their daily routines.

Table 3 Mean scores of respondents' perceptions by different types of workers

Group of Workers :	General workers & Semi-Skilled Workers		Skilled Workers		Supervisor & Manager		Others	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
I always try the latest computer applications	3.00	1.73	2.60	0.89	3.79	0.97	3.50	0.78
I am quick learner	3.43	1.51	3.00	1.22	3.71	1.14	3.63	0.92
I am confident with the simulation application that can support training in decision-making processes	3.43	1.40	3.60	1.14	3.64	0.93	3.79	0.98
I am comfortable with digital-based training environment	3.29	1.50	3.20	1.30	3.57	1.02	3.71	1.00
In my opinion, a digital learning environment can help me to make training in anywhere and at anytime	3.29	1.25	4.00	1.22	3.86	0.66	3.88	0.90
In my opinion training based skills will be more effective with the help of game	2.86	1.68	3.40	1.14	3.64	0.84	3.63	1.06
I think the use of the game will be of interest and contribute to an enjoyable training environment	3.29	1.70	4.20	0.84	3.93	0.92	3.83	1.01
I believe that the use of gaming into training can provide a different approach in training delivery	3.43	1.40	4.00	0.71	3.71	0.83	3.88	1.03
Training based on experience to identify hazards can be done easier by using game applications	3.14	1.57	3.80	0.84	3.64	0.74	3.83	1.05
I feel very excited to take part in the training methods using game	3.00	1.41	4.20	1.10	3.86	0.77	3.75	0.99
I am sure with the help of game, I will have a better understanding to the theories and knowledge	3.14	1.46	4.00	1.00	3.36	0.93	3.75	1.03
I can train myself to make the decision by playing a game	2.50	1.38	3.40	0.55	3.43	0.94	3.63	1.06
With the help of simulation, I am expected to be better prepared for the work environment at construction sites	3.50	1.38	3.40	1.14	3.57	1.16	3.79	0.98
Total Means:	3.18		3.60		3.67		3.74	

5.0 DISCUSSION

This study identifies attributes of serious game offer in delivering training for construction workers: visual training, immersive and safer learning environment, hands-on training with scenario-based, flexibility and affordable. The nature of construction industry which needs a simulated training with the real people and hazard simply is very unlikely. This is where serious games can become the missing link between knowledge and hands-on training. The preliminary findings indicated similar perceptions of the use of serious game as training tools among respondents who were construction workers at various levels. This is because game training module offer a lot of opportunities such as in terms of flexibility, cost and time, respondents totally agreed that serious game could provide a solution and choice according to their time. Besides that, training for construction industry especially on hazard identification needed to be done using hands-on module. Thus, with the features offered by serious game which are being visual, immersive, and scenario-based training construction workers can experience the scenario of handling occupational hazards. Therefore, they could react accordingly and can see the consequences of their action and decision without getting harm or injured [23].

Serious game also enable construction worker to practice their skills using "trial and error" approach with their own existing knowledge and experience [32]. Workers also agreed that serious game offer a safer environment for training; they believe that the risks of being exposed to occupational hazards during on-site training will be reduced. As mention by Lin *et al.* [26] the environment in serious games is safe for training workers who will be able to practice their skills in a realistic environment and minimize human errors that construction workers will make in real world. Based on this discussion, construction workers belief that the application of technology which had significant impact on safety training in other industries may as well has similar impact on safety training in the construction industry. More importantly, this approach not only provided a cost-cutting and safer hazard identification training environment, it was also very interactive and entertaining.

However, this game training module also has weaknesses need to be addresses such as the interface challenge like wires and displays, to use the serious game on the PC/laptop or television, it is necessary for the user to connect a few wires and modify the setup. It may be too difficult for non-expert users, especially for senior worker who are not familiar with the technology. Besides that, this software is difficult to use—construction trainer are not programmers. Therefore, to utilized maximum usability and usefulness of the training program based on serious games, special attention should be given to build an intuitive training module. Similarly, with the application used to demonstrate the improvement of the performance, it should be intuitive and easy to

use. The biggest weakness of game training module is addicted. Like many digital games, serious game could cause addiction [33]. Even have mainly training purposes (e.g., decision making, identify hazard, etc.), but when workers start to spend too much time playing, they will reduce the amount of time for daily activities (e.g., physical activity, hygiene, etc.) and become addicted with this game training module. Thus, all this weakness needs to be address and take a precautious action before it become huge problems in future. Figure 2 shows the summary of SWOT analysis for game training module.

<p>STRENGTHS</p> <ul style="list-style-type: none"> • Visual training • Safer training environment • Hands-on training • Real-time feedback delivery • Low-cost duplicate environments • Independent practice and self-assessment 	<p>WEAKNESSES</p> <ul style="list-style-type: none"> • Workers has knowledge and experience with technology • Trainer must expert using technology • the interface challenge like wires and displays • Software difficult to use • Addiction.
<p>OPPORTUNITIES</p> <ul style="list-style-type: none"> • Flexibility training module • Development of new approach of training • Technology progress in Construction Industry • Fulfill construction players needs • Emerging advances in technology 	<p>THREATS</p> <ul style="list-style-type: none"> • Ethical challenges • Lack of assessment methodology • Lack of regulation

Figure 2 SWOT Analysis for Game Training Module

6.0 CONCLUSION

The main goal of this study was to review construction workers' perceptions toward serious game as a training tool. The overall results showed an encouraging degree of readiness for all groups of construction workers. It is anticipated that the development of such blended training module will be of great significance to safety training among construction workers in handling occupational hazards. By adopting serious games as tool for training, these workers can be trained to make wise decisions in handling hazards in virtual environment that is close to reality at the workplace. More importantly, this approach is not only safe and affordable but also very interactive and entertaining, which can make it available anytime and anywhere.

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