INDUSTRIAL REVOLUTION 4.0 : IMPACT OF AUTOMATION AND ROBOTICS IN IBS TOWARDS OCCUPATIONAL SAFETY, EMPLOYEE SATISFACTION AND PRODUCTIVITY

MUHAMAD AYISY MUQIZDINIY GHAZALLI
Kolej Universiti Islam Antarabangsa Selangor (KUIS)
aisy@kuis.edu.my

NADWATUL HUSNA MUSTAPHA
Kolej Universiti Islam Antarabangsa Selangor
nadwatul@kuis.edu.my

MAZLINA BT CHE MALEK
Kolej Universiti Islam Antarabangsa Selangor
mazlinamalek@kuis.edu.my

ABSTRACT

The purpose of this research is to identify the impact of automation and robotics in IBS towards occupational safety, employee satisfaction and productivity. This study also aims to examine relationships of the determinants towards utilization of automation and robotics in IBS. Based on the research framework, there are three contributing effects identified as dependent variables namely occupational safety, employee satisfaction and productivity while the effect of automation and robotics in IBS is identified as the independent variable in this study. This is a quantitative research as the survey was done through the distributions of questionnaires filled by the respondents. A total of 50 respondents actively participated in the survey and a return rate of 100 percent were gained back from the survey. This study is to analyze the relationship between the effect of automation and robotics in IBS towards occupational safety, employee satisfaction and productivity and thus some recommendations are provided to increase the level of awareness among the developers in our country. The research suggested that the impact of automation and robotics in IBS can bring many advantages to the workers, company and our country. It is hope that the study can contribute to the improvement of using automation and robotics in IBS.

Keywords: industrialised building system; IBS; automation and robotics in IBS

INTRODUCTION

In the era of automation and robotics, there is a significant transformation regarding the way industries produce products by using automation and robotic machines in the manufacturing sector. This transformation is so convincing that it is being called the Industrial Revolution 4.0 to represent the fourth revolution that has occurred in the manufacturing sector in the country. As physical and digital worlds combined, the manufacturing processes will change dramatically in the future.

Towards the era of industrial revolution 4.0, the usage of robotics and automation in the Industrialised Building System (IBS) is increasing. Industrialised Building System (IBS) or also known as Off-Site Manufacturing is a construction technique where the component is manufactured off-site in a controlled environment or a factory then transported it and assembled it on-site (Siti Syariazulfa Kamaruddin, 2013). In Malaysia, Industrialised Building System (IBS) begins in the early 1960s when the Ministry of Housing and Local Government of Malaysia visited several European countries and evaluate their housing development program. According to (Nor Azmi Ahmad Bari, 2012), the implementation of Industrialised Building System (IBS) is strongly encouraged in the Malaysian construction industry to reduce construction time as well as the industry's dependency on foreign workers. Industrialized Building System (IBS) is more systematic compared to conventional methods in terms of time, productivity, employment, safety and reducing wastages (Siti Syariazulfa Kamaruddin M. F., 2016). The usage of automation and robotics in Industrialised Building System (IBS) is potential capability to produce higher output at lower unit cost with better quality in turn to improve global competitiveness.

The advantages of implementation innovative technologies in construction such as automation and robotics, it has the potential to improve the construction industry in terms of productivity, safety and quality. With the usage of automation and robotics in Industrialised Building System (IBS), it will promote a safe and secure building environment. The general use of automation and robotics in Industrialised Building System (IBS) will produce a high quality products produce in a controlled factory and then delivered to the construction site to be lifted and assembled in a Lego-like manner. The usage of robotic system in the factories increases productivity and reduces wastage as all materials are produced according to the particular requirement. Robots also can overcome issues on the construction site that are linked to human strength limitations. In Malaysia, Gamuda Bhd is the first construction companies that implement the usage of automation and robotics in Industrialised Building System (IBS) with the country's first Industrialised Building System (IBS) automation and robotics facility.

Hence, this technological era, construction industry demands effective construction organisations, efficient construction processes and innovative construction techniques to effectively compete with the technological advancements in the twenty-first century. But most of the construction industry is still struggling to deal with the issues related to performance, productivity, environment and health and safety, and to deal with the increasing number of foreign labour in construction sites (Siti Syariazulfa Kamaruddin M. F., 2016). These problems occur because many construction companies are still using the conventional method. According to (Mahbub, 2012) the barriers to implement the usage of automation and robotics in construction is high costs and the financial commitments in attaining and maintaining the technologies, the nature of the construction industry which prevents the implementation of new

technologies, the technologies are difficult to use and not easily understood, unavailable locally and difficulties in acquiring the technology and lastly, cost to re-training the employees and the technologies are not easily accepted by workers. These are the barriers that prevent many constructions company to buy their own automation and robotics machine.Sepang. Thus, based on the previous research, these papers try to understand and analyse whether the utilization of automation and robotics in Gamuda IBS, Sepang influencing these 3 factors which is safety, employees satisfaction and employees productivity in Gamuda IBS, Sepang. The selection of Gamuda IBS to perform this study is because as compared other construction company, Gamuda IBS is the first company in Malaysia to have their owned automation and robotics IBS facility at Sepang.

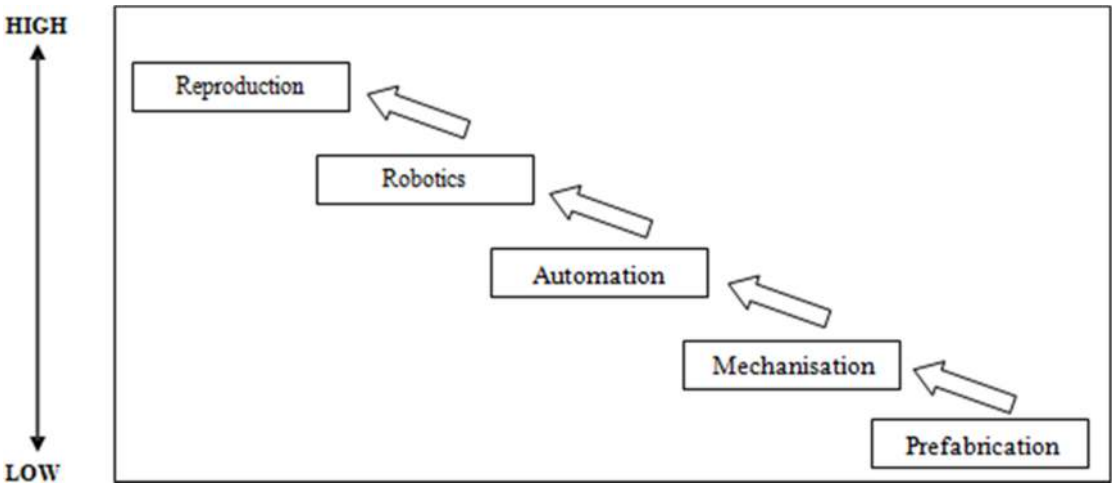
LITERATURE REVIEW

AUTOMATION AND ROBOTICS IN IBS

Automation and Robotics have been proof of improving the construction process in all aspects. The most popular advantages of the automation and robotics in IBS as mentioned in various literature are robotising and automating construction processes can speed up construction as reducing production time also reduces the overall cost (Idoro, 2011; Idrus, 2008). Other than that, automation and robotics in IBS can improve conditions, avoid dangerous work and allow work to be performed that people cannot do (Gassel, 2008). According to Hamidet al., (2008),

IBS adoption in Malaysian will gradually reduce the dependency on foreign labour thus saving the country's loss in foreign exchange According to (Richard, 2005), there are five degrees of industrialisation. Figure 2.1 shows the Degree of industrialisation. There are prefabrication, mechanisation, automation, robotic and reproduction.

FIGURE 2.1 DEGREE OF INDUSTRIALISATION



Source: (Richard, 2005)

From the figure above we can see that we are now in the degree of using automation and robotics in IBS. According to (Siti Syariazulfa Kamaruddin, 2013), prefabrication is a

manufacturing process that basically takes place at a particular facility, in which different materials are joined to form a component for the final installation at the site while mechanisation comes in whenever machinery is employed to ease the workload of the worker, automation is a situation when the tooling (machine) totally takes over the tasks performed by the worker while robotics comprises the ability of the same tooling which has the multi-axis flexibility to perform variety of tasks by itself and lastly, reproduction implies that the research and development of innovative processes is truly capable of simplifying the production process.

OCCUPATIONAL SAFETY

The use of automation and robotics in IBS has shown to be safer as applying it can help reducing building materials and is also comparatively efficient, safe and cleaner with improved and better quality of buildings (Irrma Diana Mohd. Aripin*, 2019). According to (Alexender, 2016), the usage of robotics in construction sector could potentially simplify many construction processes to make them safer for workers, take up less time, or even perform simple deadly tasks. This shows that the introduction of new robotics system can help to reduce the potential risk exposure to the labourers.

Traditional construction work is carried out on site through the combinations of manual labour and raw materials (Haupt, 2011). Typically, traditional construction methods engage workers in activities such as, excavation, concrete work, roofing, steel erection, ceiling erection, block laying, plastering work, reinforcement work, painting work, and bricklaying. However, these jobs are basically hazardous and impact negatively the health and safety of workers on construction sites. According to (Samuel, 2005), construction site activities are reportedly the major causes of health problems to workers. (Haupt, 2007) indicated that, while workers were involved on-site related work such as concreting, reinforcing, structural steelwork, masonry, roofing, plumbing and drainage/pipefitting, painting and decorating, the possibility of the workers to have ergonomic problems were highly possible.

As we can see, there is a great difference between traditional construction method and modern construction method. Offsite construction method can reduce the exposure of workers to physical demanding work related to manual material handling processes (Mckay et al., 2005). The utilization of automation and robotics would lead to improvements in overall project health and safety. Clearly, the use of the use of automation and robotics in IBS would reduce the possible hazards that could lead to unnecessary accidents and fatalities within the construction industry. The use of automation and robotics in IBS can ensure that the worker is safe from any hazard or danger. Moreover, the usage of automation and robotics in IBS will produce a good end product which is good for the safety of their customers.

EMPLOYEE SATISFACTION

Organizations have significant effects on the people who work for them and some of those effects are reflected in how people feel about their work and this makes job satisfaction an issue of significant importance for both employers and employees (Panigrahi, 2016). The use of automation and robotics in IBS can increase the satisfaction of the employees at the construction industry. This is because the automation and robotics system can increase the quality of working environment and this will ease their burden in completing their jobs. The use of robotics and automation technologies can improve the standardisation of the design and

construction process. According to (Jan et al, 2016) a person has job satisfaction if he likes his job.

The use of automation includes all formal and informal electronic systems which relate to communicate information between peoples inside and outside of the organization (Rahimi kia, 2010) and this is one of the factors that can play an important role of increasing productivity and performance. According to (Akram Ansari, 2015), the impact of advanced information is that helps employees and managers in effective decision-making and the usage of automation can enhance quality of decision-making and reform process. The advantage of using automation and robotics in IBS is that it can create a good working collaboration with all parties from the design, manufactured and construction/installation and this will ensure the success of implementation of automation and robotics in IBS (Ismail, 2012).

The usage of automation and robotics in IBS will help and assist employee in doing their job by using the system and these systems can simplify and ease their jobs. The use of automation and robotics in IBS can increase the direction of planning throughout the project lifecycle in terms of design, manufacturing, transportation and installation which generally regards as difficult by the contractors due to the nature of the construction industry, which, is split, different and involve many parties (Nawi, 2016., Tajul, 2017). Furthermore, the workers will feel satisfy with their jobs because they will learn a new things in handling the automation and robotics system. This means that the usage of automation and robotics in IBS will develop the workers skill and this will make them satisfy with their jobs and their organisation.

The organisation need to send their workers to training because automation and robotics in IBS require an experienced workforce capable of high-level planning, organising and controlling functions to production, coordination and distribution of components (Rashid, 2018). (Jabar, 2013) stated that the workers should be competent and experienced in handling and managing the automation and robotics construction activities. Successful implementation depends on the organisation ability to further the learning process from one project to another. Therefore, continuous improvement and learning can develop company understanding on the processes and the standard behind it as the knowledge will growth as experience mount up (Cooke-Davies, 2002).

PRODUCTIVITY

Industry has undergone over a time, a series of “Industrial revolutions” by increasing complexity and productivity that changed the existing paradigm, the concept of Industrial Revolution is related to a situation where there is a development of productive technological capacity through creativity with a relevant impact on the economic, environmental, and social dimensions (FONSECA, 2018). In this Industrial Revolution 4.0 era, the demanding of stakeholders is increasing and this environment has stressed Industry that produces and delivers material goods thorough mechanized and automatized process to respond to these challenges and risks while taking advantage of the newly available prospects (FONSECA, 2018).

The construction industry is widely acknowledged for important economic role and contribution to our country GDP. According to (Siti Syariazulfa Kamaruddin, 2013), the utilization of automation and robotics in IBS can increase the quality of its end-product, with faster speed of construction whilst coping with the issues of foreign workers and this will lift Malaysian construction industry to transformed into a modern and efficient industry. The use

of automation and robotics in IBS is expected to play an important role in ensuring improvement in construction activities and sustainable economic growth. This innovative system can effectively save costs and improve the construction quality by reducing labour intensity and construction standardization and besides that, it can minimises waste reduces site material, yields cleaner and neater environment, provides higher quality control, and cuts the total construction costs. (Siti Syariazulfa Kamaruddin, 2013)

METHODOLOGY

3.1 RESEARCH DESIGN

A research design is a design that is known as the framework or blueprint for this study. This study was conducted to figure out the necessary procedures that need to be taken in completing the process of obtaining all relevant data needed. This study was conducted based on the quantitative research based on the nature of the study that gathers a representative data from the targeted respondents of workers from production department, safety and health department, and human resources department in Gamuda IBS, Sepang.

3.1.1 Sampling Technique

This study use stratified sampling, questionnaires were manually distributed to the respondents. In this research, a total of 50 respondents were chosen to do the survey and in a way of selecting based on stratified sampling.

3.1.2 Sampling Size

Sampling size is important because it is referring to the actual number of the subject chosen as a sample in representing the population (N). According to Sekaran (2003), it is perhaps the best way of getting some necessary information quickly and efficiently

Before distributing the real questionnaire to the selected respondents, a pre-test is done to workers from SP Setia. This is important as to ensure that respondents understand the questionnaires and no misunderstanding to happen with regards to the items. Hence, a total of 30 questionnaires as a pre-test were distributed. A total of 50 questionnaires were manually distributed at Gamuda IBS and all of the questionnaires were collected. From that population, only 44 questionnaires were selected based on Krejcie & Morgan (1970). These are due to time constraint, and feel the sample size gained is sufficient within the period for the purpose of analyzing the data.

3.2 RESEARCH INSTRUMENT

This section describes the questionnaire survey that was used in this study. The instrument was developed and administered by the guidance in designing an effective instrument and effectiveness, and the high response rate is the reasons for this study to use questionnaires widely to collect primary data (Samouel, 2003). Closed questions are the issues with a clearly defineset of alternatives that limit respondent's choice to one of them (Sekaran and Bougie,

2012). The questionnaire is a closed question type which requires the respondents of this study to rate the scale of each question stated.

3.3 THEORETICAL FRAMEWORK

The diagram of the theoretical framework is based on what is presented in the questionnaire. In addition, the research framework is based on the preparation of the questionnaire to be conducted and given to the respondents. The study framework shows that there are three dependent variables that is occupational safety, employee satisfaction and productivity. The independent variable is related to utilization of automation and robotics in IBS from HR perspective at Gamuda IBS, Sepang.

3.4 METHOD OF DATA ANALYSIS

In this study, the data analysis method, which is descriptive and correlation statistics, was used to analyze the data obtained from the questionnaire. Next, The Statistical Package for Social Science (SPSS) version 23.0 software was used to analyze the research data.

3.4.1 Descriptive Analysis (Percentage)

Descriptive analysis is an analysis of the data obtained from the results of the study and is intended to look at several frequencies and to study the respondents' background as a whole. The data obtained is in the form of percentages.

3.4.2 Mean Score Classification Analysis

The purpose of the mean score analysis was to determine the level of the two variables by using the mean score analysis. The mean levels are as follows:

3.4.3 Pearson Correlation Analysis

The Pearson correlation was used in the study to examine the factors influencing the utilization of automation and robotics in IBS. According to (Sekaran, 2005), this can make the correlation either positive or negative between the two variables represented by 1.0 (1.0 @ -1.0) theoretically. In the field of social science research, $p = 0.05$ is generally accepted (Sekaran, 2005). According to (Cohen, 2003), the range of 0.10-0.29 has been shown as a weak positive relationship of correlation while range between 0.3-0.59 has been shown as a moderate positive relationship. Lastly, the range between 0.6-1 has been shown as strong positive relationship.

EMPIRICAL RESULTS

The results of the study were divided into several sections which is Reliability Cronbach Alpha Test Analysis, Descriptive Analysis, Comparative Analysis, Mean, Frequency and Pearson Correlation Analysis.

4.1 ANALISIS OF RELIABILITY CRONBACH ALPHA TEST

In the survey, 34 items were constructed to identify the impact of automation and robotics in IBS towards occupational safety, employee satisfaction and productivity. There are 3 dependent variables for this study. The 3 components are occupational safety, employee satisfaction and productivity while there is 1 independent variable for this study that is utilization of automation and robotics in IBS. Table 4.5 below shows the Reliability Level of the Research Instrument.

The items of the survey were analysed using reliability test. According to (Faizal Amin Nur Yunus, 2014; Fox 2007), the value of a pilot study can be divided into five categories. The first category is reliability range below than 0.5, in this case the items need to be dropped. The second category is the reliability range is below than 0.6, if below that 0.6 then the items need to be fixed. The reliability range between 0.6 – 0.7 is acceptable meanwhile, the reliability range between 0.7 – 0.8 is good and acceptable. Lastly, the reliability range that is very good and effect with high degree of consistency is range between 0.9 – 1.0.

Table 1: The Reliability Analysis (Cronbach Alpha)

Variable		No.Items	Reliability test
INDEPENDENT VARIABLE :			
Automation and Robotics in IBS		8	.872
DEPENDENT VARIABLE :			
1)	Occupational Safety	9	.834
2)	Employee Satisfaction	7	.807
3)	Productivity	10	.811

Table 1 above shows the reliability for each variable that is conducted in this study. The overall result of the reliability test (Cronbach Alpha) in this study is 0.872 which is referred to automation and robotics in IBS as the independent variable. As for dependent variable, the reliability test shows 0.834 which very high reliability that referred to occupational safety. Next, the other dependent variables which is can be referred to employee satisfaction show 0.807 result which is also very high reliability and lastly, the dependent variable that is productivity also show very high reliability that is 0.811.

4.2 ANALYSIS OF PEARSON CORRELATION

The Pearson Correlation test was conducted to determine the relationship between occupation safety, employee satisfaction and productivity towards the utilization of automation and robotics in IBS. Table 4.2.1 shows the Pearson Correlation Coefficient Value Description between automation and robotics in IBS and occupational safety. Table below shows that

occupational safety (dependent variable) has strong positive relationship correlation value that equals to .621** with significant value at .000 value. This result shows that automation and robotics in IBS give the strongest impact towards occupational safety. According to (Alexender, 2016), the usage of robotics in construction sector could potentially simplify many construction processes to make them safer for workers, take up less time, or even perform simple deadly tasks.

Table 4.2.1: Result Pearson Correlation

	1	2	3	4
Utilization of Automotinan and robotic in IBS	1			
Occupational Safey	0 .621**	1		
Employee Satisfaction	0.468**	-0.688**	1	
Productivity	-0.563**	0.725*	0.659**	1

** Correlation significance at level o.o1 *(2-tailed)*

* Correlation significance at level o.o5 *(2-tailed)*

The next dependent variable that is employee satisfaction has moderate positive relationship with correlation value at .468** with significant value at .001. This result shows that automation and robotics in IBS give a medium impact towards employee satisfaction. The use of automation and robotics in IBS can increase the direction of planning throughout the project lifecycle in terms of design, manufacturing, transportation and installation which generally regards as difficult by the contractors due to the nature of the construction industry, which, is split, different and involve many parties (Nawi, 2016., Tajul, 2017).

The last dependent variable that is productivity also has the moderate positive relationship with correlation value at .563** with significant value .000. This result shows that automation and robotics in IBS give moderate impact towards productivity. The use of automation and robotics in IBS has many impacts on productivity and economic growth. The use of automation and robotics in construction IBS is capable to generate higher output at a lower unit cost, producing better quality products and this can improve global competitiveness (Mahbub, 2015).

CONCLUSION

This research has shown that there is a significant between utilization of automation and robotics in IBS towards occupational safety, employee satisfaction and productivity. Hence, the results show the utilization of automation and robotics in IBS has strong positive relationship towards Occupational safety. It is shown that The use of automation and robotics in IBS is safer as applying it can help reducing building materials and is also comparatively efficient, safe and cleaner with improved and better quality of buildings (Irrma Diana Mohd. Aripin*, 2019)

Through this study, Gamuda IBS, Sepang understand the relationship between occupational safety, employee satisfaction and productivity towards the utilization of automation and robotics in IBS. Therefore, the organizational should maintain the usage of this automation and robotics machine and system because it can brings many advantages to their company, workers and to our own country.

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