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Investigating the Awareness of Onsite Mechanization in Malaysian Construction Industry

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Abstract

The Malaysian construction industry is vital for the country economy and always played a key role towards the development of national infrastructure. The ever-increasing market competitiveness and the widespread adoption of Industrialized Building System (IBS) by the local contractors derive the industry to improve the existing processes for achieving higher levels of quality and products. This transition from traditional methods of construction give a momentum to the deployment of onsite mechanized equipments. The utilization of mechanized equipments increases construction productivity and as well as reduces the dependency on foreign labour. However, a large amount of construction company's capital is also invested in procuring these equipments. In addition to this, varieties of construction equipments are also required for carrying out these operations. Therefore, the aim of this paper is to investigate the current awareness and application of onsite mechanization in Malaysian construction industry. A questionnaire survey was conducted among a classified group of Construction Industry Development Board of Malaysia (CIDB) G7 Class 'A' contractors. The results of the survey show that there is a good understanding of Malaysian contractors towards mechanization. It is also revealed that the adoption of IBS have a direct correlation with the usage of onsite machineries and equipments. Results further indicate that excavation, earthworks, pilling works and structural works have high utilization of mechanized construction equipments. The study will help to find out the existing level of mechanization practices in Malaysian construction industry.

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1. Introduction

The Malaysian economy is a fast growing and industrialized based economy since 1980s [1]. In 2007, the Malaysian economy was recorded as the 3rd largest economy in South East Asia. It was also ranked as 28th largest economy in the world in 2008 with GDP 639.6 billion RM [2]. The Malaysian economy is based on agriculture, forestry, fishing, mining, manufacturing, construction and services sectors. In the last decade, the Malaysian construction industry has played an important role towards the growth of national economy. This sector keeps on adding value in the national GDP's and has a positive impact towards the development of social-economic infrastructures. It accounts for almost 4.6% of the country's GDP in 2011 [3].

This industry is also great source of providing job opportunities to the local and foreign people. According to Economic Planning Unit (EPU) 6.3% of the country workforce were involved in construction related jobs [3]. This sector accounts for 18.5% of total sectoral distribution of privatized projects (1983 – 2011) and remained highly attractive for private investment [4]. The industry is comprised of thousands of contractors which are classified by the CIDB Malaysia into G1, G2, G3, G4, G5, G6 and G7 categories. Among these categories, G1 is the smallest and low volume contractors (worth- wise) where as G7 is the high volume contractors with no limit of works (worth-wise). According to the CIDB, the total numbers of registered contractors as of 1st quarter of 2011 were 63, 875. This sector is fragmented in nature and involves a number of stakeholder such as consultants, developers, clients (government and private), manufacturers, material and equipment suppliers etc. The government, its associated Ministry of Works and departments like Public Works Department (PWD), CIDB, the Contractor Service Centre (PKK), the Board of Engineers, the Board of Architect and Board of Surveyors are important players and exert influence. All these organizations are actively involved in the expansion and advancement of Malaysian construction industry. During the early years of post independence, the Malaysian construction industry was a low-tech, labour intensive and craft-based industry. However, the implementation of National Economic Policy in 1970 acted as catalyst to speed-up the public sector development mainly in public infrastructure. During this era, a rapid growth been observed and the industry increased from 3.38 percent in 1970 to 10.71 in 1971 and 10.84 in 1973 resulting in the increase of residential, commercial and industrial buildings. The enhancement of Foreign Direct Investment (FDI) in late 70s further expand the annual growth from 2.13 percent in 1978 to 17.18 percent in 1979 [5]. Due to the international recession in mid 80s, there was a noteworthy deceleration in overall construction activities which led to negative annual growth rates. After the recessionary years of mid-eighties, the industrialization programme of country has changed the construction demands. Now, the clients were demanding more complex architectural and civil engineering works with shortest completion timelines. As a result, there was a continuing shift from traditional construction techniques towards modern construction activities. The embarking of Vision 2020 in 1994 further propelled the construction boom in the country at an annual average rate of 14 percent till 1996. During this period, highly mechanized production techniques were seen in projects such as PETRONAS Twin Towers, Kuala Lumpur International Airport (KLIA) and Sepang Formula-1 racing circuit [6]. The East Asian economic crisis drastically effects the growth of construction industry to a lowest level of -24% in 1998 and slows down the country economic growth. Although, the country economy resumed due to the governments supporting initiatives during 7th and 8th Malaysian Plan [7]. Nevertheless, the industry remained under continuous pressure to deliver and to tackle issues on performance, productivity, affordable public infrastructure and lack of Foreign Direct Investment (FDI) in construction projects. Besides this, cheap and skilled workforce is also remained a critical issue for the industry. In order to overcome these issues and foster the modernization of Malaysian construction industry, the 6th Prime Minister of Malaysia Seri Najib Razak has emphasized the adoption of mechanization, automation and robotics in construction practices [8]. Therefore, the aim of this paper is to investigate the current awareness of Malaysian contractors towards onsite mechanization. This paper further explores onsite construction works where mechanized equipments and machineries are mostly used by the contractors.

2. Mechanization in Construction

The term 'mechanization' in construction is defined as the application of plant, equipment and machineries for carrying out construction activities [9]. After the World War II, the growing need of infrastructure and industrialization has changed the manual methods with the mechanized and equipment based in order to meet the

shorter timelines and complexities of designs. During this era, construction equipment capacities were also increased with the innovation of torque convertor and power shift transmission system. The old concrete batch and mixing facilities were replaced from manually controlled to hydraulically and electronically controlled systems [10]. As a result of this incremental development in construction technology, today's construction projects are highly mechanized and becoming more so every day [11]. The role of construction machineries are being increasing to improve the performance, productivity, working standards and efficiency of contractors [12]. These require innovative and modern machineries to cater the needs of the clients and contractors and achieved project objectives [13]. Furthermore, the growing industrialization in construction leads to offsite prefabrication of concrete, structural and finish elements that are then installed or assembled rather than produced on site. Consequently, production equipment is being replaced on the construction site by earth moving, transportation and other material handling equipments [14]. The typical construction site will employ several or all of the following equipment types: such as earthmoving equipments, transporting equipments, material handlers, concrete pumps, hoists and lifts cranes etc. [15]. Researchers have suggested that the adoption of mechanized practices speed up the execution of site works, thus shorten the project completion time and cost. Many manual methods are getting obsolete and redundant in industrialized countries due to expansive and shortage of skilled labour [13,16,17]. The construction projects are usually classified into residential, commercial, industrial and heavy works [18]. Therefore, each of these categories has its own level of equipment usage. For example residential projects have a light level of equipment use. It requires simple and traditional machines like fork-lifters, backhoe, hauling and hoisting equipments, material handling along with pneumatic tools. Commercial projects have moderate use of equipments and machineries. Industrial and heavy construction projects required intense and high utilization of machinery for carrying out mass excavation, stabilizing, compacting, asphalt paving and finishing, pipelines, railroads and many other special activities [19]. The common application of onsite mechanization includes but not limited to [20];

- Earthwork
- Structural steel works
- Concreting
- Building/assembly
- Lifting and positioning of components
- Painting and finishing

In the last 60 years, architects and civil engineers have delivered gigantic and huge infrastructure around the globe. It can be stated without any doubt that such enormous achievements in modern civilization cannot be possible without the aid of mechanized construction practices.

3. Need of Mechanization for the Malaysian Construction Industry

The lesson learned from the 9th Malaysian Plan indicates that the construction sector did not grow at 6% per year during the 05 years plan period. There are many underlying causes for this slow growth rate; however, the most notable is slower construction activities in the civil and non-residential sub-sectors. The implementation of 10th Malaysian Plan envisaged a high-income economy with a higher productivity. During this plan period (2011 – 2015), the government has allocated RM 138 billion for the development of physical infrastructure. During this period, 52 mega projects are being take-up from various sectors, such as highways, power stations, double track train project, LRT expansion, Iskandar development, Greater KL etc [18]. The timely and successful completion of these projects requires enhance productivity, quality, efficiency and high class workmanship. In order to achieve these goals and optimize cost, the local construction industry needs to adopt mechanization, automation and robotics beside IBS practices. Shaziman Abu Mansor (Minister of Works, Malaysia) in his key note address at the 7th Malaysia Construction Sector Review and Outlook Seminar highlights the successful execution of construction projects and improvement of the construction industry through the enhancement of process and technologies [21]. Seri Najib Razak (6th Prime Minister of Malaysia) has also embarked on embracing new technologies and mechanization during his opening speech at the International Construction Week (ICW) 2012. He further

emphasized that the government would take all the necessary measures and provides support through its encouraging policies and regulations for the adoption of mechanization in the industry. He further said that “Labour intensive industries such as the construction industry must shed their traditional dependency on labour and focus on alternative production inputs that can boost productivity” [8]. Malaysian construction industry is labour intensive. It involves thousands of skilled and semi-skilled workers and comprised of large proportion of foreign labours as well [9]. However, the implementation of free flow of workers within the ASEAN countries by 2015 will bring a pressure in the construction job market of the country [22]. Furthermore, the Government is determined for the realization of free market strategies through liberalizes regional economic accords. With these policies and reforms, it is not possible for the construction industry to flourish by relying on cheap labors. The dependency of foreign skilled labors is also acts as an inhibitor for the growth of construction sector during the 10th Malaysian Plan period. In this scenario, mechanization and other technological methods must be encouraged in order to achieve the maximum yield of construction workers.

4. Research Objective

The main objective of this research paper is to determine the awareness, current understanding and level of implementation of mechanized construction practices in Malaysia.

5. Methodology

This research was conducted by using both the qualitative and quantitative research methods. The qualitative research approach required to develop a basis to establish background knowledge about the mechanization and its needs for the Malaysian construction industry. In this phase of research, relevant published data from periodicals, journals, conference proceedings, web-based knowledge and other research reports were analyzed to establish descriptive survey. The primary data required for this study was collected through descriptive questionnaire survey. This methodology is considered as a cost effective and time saving in order to achieve better results in shorter duration [23]. The traditionally techniques for collecting responses from the targeted respondents are postal mails, fax and electronic mails. However, for this research work a web survey tool was used effectively for getting feedbacks from the respondents. This has helped us a lot in achieving momentum and a good data base of the survey participants. For the purpose of achieving the desired research objectives, a structured or close-ended questionnaire was designed to gain the views from the industry practitioners. A total number of 400 Class ‘A’ Grade G7 civil contractors were randomly selected from CIDB Malaysia database. This sample size is selected from the list of around 2500 Kuala Lumpur and Selangor based contractors. In Malaysia, Grade G7 Kuala Lumpur and Selangor based contractors are large contractors and usually engaged in heavy and complex construction activities with no limit. Hence, they are more familiar with the phenomenon of mechanization. Before sending the questionnaire, it was dully confirmed and assured that all the targeted respondents are doing construction business and engage in civil and infrastructure works. According to the Master Builder Association of Malaysia (MBAM) survey that despite a high percentage of contractors in Malaysia, only 12% are actually running construction business [24]. The main constructs of the study were assessed for reliability by using Cronbach’s alpha coefficient. Ideally, the Cronbach alpha coefficient of a scale should be greater than 0.70. The reliability analyses revealed that most of the scale items have higher reliability values (i.e. Cronbach’s Alpha = 0.831). This is consistent with their use in the precedent studies. The first section of survey questionnaire comprised of respondents demographic information and their organizational background. The second section is based on a Likert scale questions which asked the respondents to rate the choices on a five point scale (with 1 = never/not at all, 2 = seldom/slightly aware, 3 = sometimes/somewhat aware, 4 = regularly/moderately aware and 5 = highly/highly aware). After a rigorous follow-up 126 responses were accordingly. After removing invalid and incomplete responses, a total of 124 completed questionnaires were acknowledged and taken into consideration. This gives an overall response rate of 31%. This response rate is well acceptable in view of past researchers. According to them, the outcome of a postal survey for the construction industry is usually in the range of 20 – 30 percent [25, 26]. Hence, the current percentages of feedbacks are good enough for a meaningful analysis.

6. Results and Analysis

6.1. Respondents Background and Experience

The importance of demographic information cannot be undermined for a meaningful quantitative analysis. During the empirical survey, background and general information from the respondents were also sought. As the aim of research are focused on the construction phase of the project, so it was envisaged to get on board all the key players of construction project team having satisfactory professional experience. Fig. 1 shows their pie-chart distributions of respondents. The data analysis indicates that the feedbacks from project managers are relatively higher (35%) as compared to the other categories of respondents.

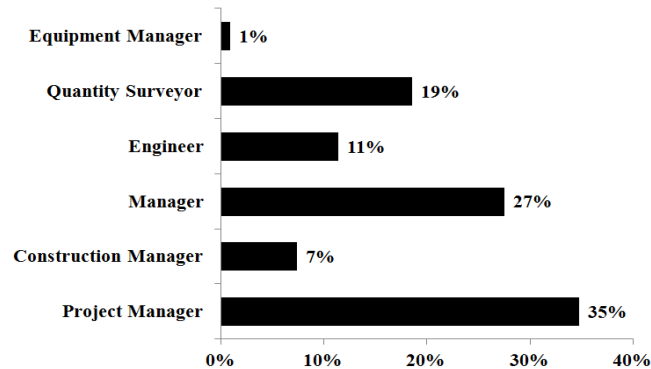


Fig. 1. Bar chart of respondents primary job function.

Table. 1 shows the involvement of construction firms in different infrastructure projects. It has been observed that majority of the respondents i.e. 61.3% are participating in roads and highways projects (It is to be noted that respondents are provided more than one options to select in this question of the survey).

Table 1. Respondents participation in infrastructure projects.

S.No.	Construction Experience	Percentage
1	Roads & highway	61.3%
2	Railway	6.7%
3	Dams & irrigation	16%
4	Bridges	26.9%
5	Ports	9.2%
6	Tunneling	7.6%
7	Airports	21.8%
8	Pipelines	33.6%

Analysis of the feedbacks shows that respondents are mainly from the private sector and having satisfactory working experience. Among them, 36.2% of the respondents have working experience within the range of 11 to 20 years, while 43.54% have more than 20 years of field experience. The result of the survey shows that 88% of the respondents have completed their bachelor's education. Some of the respondents have also acquired additional postgraduate qualifications i.e. MSc and Master degree with a percentage of 3.25% and 4.8% respectively. The respondents demographic information reveals that they have good academic background and satisfactory knowledge for providing sufficient details and inputs for the outcome of this research work. The statistics represent that questionnaires are mostly filled by the experienced and senior professionals having vast experience in construction projects. Their opinions and views are quite important and reliable in order to establish the findings.

6.2. Understanding of Mechanization in Construction Projects

The response of the questionnaire survey indicates a good understanding of Malaysian contractors towards mechanized construction practices. The current level of understanding and awareness with the mechanization is shown in Fig. 2 as pie-chart distribution. It shows that 23% of the respondents have high level of acquaintance with the mechanization where as 45% have moderate understanding with this phenomenon. 20% of the respondents are 'somewhat aware' with the mechanization. Apart from that, 7% are 'slightly aware' whereas only 5% are not familiar with the mechanization.

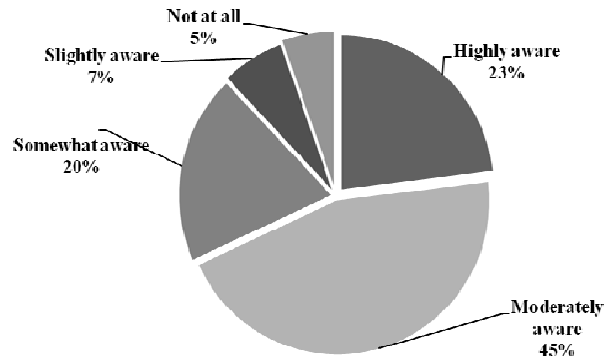


Fig. 2. Current state of understanding of mechanized construction in Malaysia.

The above statistics provides very useful information in respect of mechanization among Malaysian contractors. Two important conclusions can be drawn from the analysis.

- Good knowledge of mechanized equipments, technologies, procedures are vital for its adoption. It shows the readiness of the industry professionals for its effective implementation. It is imperative to note that majority of the respondents are well aware and have satisfactory level of knowledge in the mechanized construction.
- The results of the survey also depicts that those firms who are using Industrialized Building System (IBS) in Malaysia are more inclined towards mechanization as compared to those who are still using conventional construction techniques. A total of 46% respondents are using IBS components and have also adopted mechanized practices. From the survey, 63% of the respondents (including IBS adopted firms) are using heavy mechanized equipments at sites. Hence, there is correlation between the usage of IBS and mechanization. The more the usage of IBS, the higher will be the rate of mechanization.

6.3. Mechanization of Onsite Activities

The above survey result shows that 63% of the contractors in Malaysia are adopting mechanization for onsite activities. However, a more useful approach for finding its usage is by looking at areas within which the machines and equipment are mostly used. The measurement of usage is analyzed via Likert scale of 1 to 5 (with 1 = never, 2 = seldom, 3 = sometimes, 4 = regularly and 5 = highly). The reliability of 5-point Likert scale was determined by using Cronbach's alpha coefficients. Ideally, the Cronbach alpha coefficient of a reliable scale should be greater than 0.70 [24]. A reliability test for the eight onsite construction activities as shown in Table 2 was conducted by using the SPSS software. The Cronbach alpha for the used Likert scale is 0.831. This indicates that the data collected for the analysis is interrelated and consistent.

Eight main onsite construction activities were identified from the precedent literature as the potential areas for the application of mechanized equipments and machineries. Their overall mean score and the corresponding rankings were determined based on the level of usage and application for each of the construction activity. Secondly, the mean index was compared with the average index assessment scale which indicates the importance assessment of

each of the heavy construction activity [27]. According to this average index assessment scale, the derived importance levels are as follows;

- Very high > 4.50
- High 3.50 – 4.50
- Average 2.51 – 3.50
- Low 1.51 – 2.50
- Very low 0.00 – 1.50

Table 2 shows the details of mechanization assessment of each construction activity in respect of its mean index, ranking and average index indicator. It is important to note that none of the activity has a “Very high” average index indicator which shows lack of knowledge, skills and technology. It also indicates the barriers that inhibit the player of Malaysian construction industry to embrace mechanized practices. The results further shows that out of eight onsite construction activities, Activity No. 1 to 6 have a high mean index values, hence it is found out that these activities have high utilization of mechanized construction equipments. Apart from that, Activity No. 7 and 8 have average utilization of equipments and machineries.

Table 2. Comparison between mean index and average index scale

Activity No.	Heavy Construction Activities	Mean Index	Rank	Average Index Indicator
1	Excavation, earthworks and pilling work	4.05	1	High
2	Structural works	4.03	2	High
3	Demolition, site clearance and alterations	3.72	3	High
4	Concreting and formwork	3.59	4	High
5	Assembly and installation works	3.55	5	High
6	Road making, flooring and pavement	3.50	6	High
7	Plumbing and drainage	3.17	7	Average
8	Brickwork and masonry	2.88	8	Average

7. Conclusion and Future Work

The scope of the current study has investigated the understanding of onsite mechanization and its level of implementation among the Malaysian contractors. It is determined from the respondent’s feedbacks that they are well aware and have a good knowledge of mechanized construction practices. However, its level of implementation is high among those contractors who are already using IBS components in their projects. Analysis of the data shows that excavation, earthworks, pilling and structural works are the high ranking activities where machineries and equipments are mostly used by the contractors. As these activities are intensive in magnitude and complexity, so the technology driven approach is more viable solution for handling them. But still there is room to increase the level of mechanization for these construction activities. In Malaysia, the availability and abundance of cheap foreign labour is a priority option for the contractors and it surpasses the use of mechanized equipments. It is due to this phenomenon that Activities from serial No. 7 to 8 (Ref. Table 2) have relatively low average index indicator values in terms of mechanization. Among these activities, plumbing, drainage, brick work and masonry have low demand of mechanization and investment to procure equipments and machineries is considered to be uneconomical.

This research work is a part of ongoing PhD research at the Civil Engineering Department of Universiti Teknologi PETRONAS. The results of this study have provided an insight about the mechanization in Malaysian

construction industry. In addition to this, more pragmatic research is underway to find out the enablers and barriers of mechanized practices in Malaysian construction industry which will provide new perspectives to improve its adoption.

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