



Contractors' Perspective on the Main Factors Influencing On-Site Labour Productivity: A Focus on Malaysian Infrastructure Projects

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Abstract: The overall performance of construction projects has been seemingly low and has negatively affected its efficacy in fulfilling national development agenda. Infrastructure projects are complex and riddled with numerous construction risks, and often involve large financial investments as well as several resources, particularly labour. The objective of this research paper is to identify the main factors that influence labour on construction sites of infrastructure projects. In achieving this research objective, 26 factors were extracted from literature and subsequently distributed for assessment by 355 identified respondents via a questionnaire-based survey. 63 respondents, representing a response rate of 17.75%, participated in returning completed questionnaires for further analysis. The main factors that influence on-site labour productivity were identified through the use of Relative Importance Index analysis. The three most significant factors identified were co-ordination between sub-contractors, labour skill and expertise within specific job scopes, and, availability of updated construction drawings at the project sites. Several other factors were also extracted through the analysis conducted on the garnered data. These factors will collectively be able to accord contractors a better comprehension of the influencing elements that either impinge or promote labour productivity. These findings are pertinent for construction firms in the efforts to progressively increase the level of labour productivity in the Malaysian construction sector, particularly within the parameters of infrastructure projects.

Keywords: On-site labour productivity, main influencing factors, infrastructure projects

1. Introduction

The construction industry is significant towards the physical development of any nation, in particular developing countries. This important role can be keenly observed through the ability of the construction industry in tandemly providing fixed capital and assets as well as basic infrastructure facilities. This in turn effectuates a positive return to a nation's supply chain and overall economic standing. Products from the construction industry mainly comprising of different types of buildings and structural engineering works as well as infrastructure-based services are by nature large, expensive and immobile. This industry also heavily relies on the use of numerous building materials and components which are produced by other industries, mainly both the domestic and international manufacturing sectors.

Although the construction industry plays an important role within a country's economy, its level of efficiency is arguable and disputed (Business Roundtable, 1982; Egan, 1998; Hanafi *et al.*, 2010, Juan *et al.*, 2019; Pham *et al.*, 2020). Construction projects are typically associated with late delivery and liquidated ascertained damages; constant reworkings and failure in achieving intended functionalities; work accidents and stop work incidents; cost overruns;

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and incomplete work leading to the dismissal of work contractors. These seemingly inherent issues have marred and diluted the importance of the construction industry. In addition, the level of effective implementation within the industry is also increasingly difficult due to the involvement of labour force in large numbers at construction sites (Nariman *et al.*, 2018) and this is all the more evident in complex projects such as infrastructure facilities.

Infrastructure revolves around services and basic facilities aimed at activating the economic cycle as well as in fulfilling the social necessities of a country (Zhang, 2006). The term 'infra' carries the meaning 'under' in Latin while the term 'infrastructure' originates from France and its original definition relates to the installation of basic elements within any form of operation or works. In early history, infrastructure represented 'sub grade' underneath laid railway lines and road pavements. According to Zhang (2006), infrastructure can be defined as the layers that are installed underground or support systems, basic facilities, equipment, services, and, installations required for communications and accessibility within an organization or country. Touran and Lopez (2006) define infrastructure as a basic system of a country that requires high levels of financial investment. Priemus and Flyvbjerg (2007) meanwhile classify infrastructure into categories of personal and institutional, primary and non-primary, material, economic and social, core and supporting, and, network infrastructure. In a different sense, infrastructure comprises of physical network facilities pertaining to goods and services provided for general consumption. This forms an economic network that is complex and diverse as it directly influences production and consumption of goods as well as services. This, in fact, creates both positive and negative spillover effects, and involves huge outflows of investment within a country. The focus of this study, however, will only be limited to large scale, physical forms of infrastructure which form an important aspect of products in the construction industry.

Given the significant magnitude of infrastructure projects as well as the perceived low level of efficiency within the industry, it is apt that an evidence based empirical research needs to be conducted encompassing these two aspects. Therefore, this research intends to identify the main factors influencing labour productivity at infrastructure project sites from the perspective of the contractors. The findings of this research will largely benefit and contribute towards increasing labour productivity within the construction industry, especially in Malaysia through enhanced performance, quality and project output in the near future.

2. Factors Influencing On-Site Labour Productivity

Labour productivity is a major concern in almost every economic sector and is even more evidently significant within the construction industry as it relies heavily on mass labour in its activities. According to Muhammad *et al.* (2015), labour productivity in the construction industry is influenced by numerous factors. Among these factors are the availability of materials and machinery, availability of drawings, worker attendance at sites, and, safety and health training. The combination of these numerous factors will undoubtedly have different effects on the level of labour productivity at construction sites. In addition, top management commitment towards the project team will also influence on-site labour productivity. Delays in payment of wages and salaries, inadequate and inefficient workforce, and, incompetent supervision at construction sites may also directly influence labour productivity levels. Issues pertaining to the complexities of design as well as equipment and machineries have also brought significant impact on labour productivity at construction sites. The workforce was found to be more motivated and productive in their jobs when they were adequately remunerated with financial incentives. Construction material shortages also do have a big impact towards on-site labour productivity.

Issues relating to construction productivity needs to also be seen from both the managerial and operational levels in better understanding the breadth of this issue. A study conducted by Kazaz and Acikara (2015) compared the different perspectives shared by both the managers and the labour force towards productivity at construction sites. Findings of this study indicate that the most important factor for both parties was a common factor that dealt with the organization of the management component at the construction site. According to Dai and Goodrum (2012), the construction industry of the United States of America experienced skilled labour shortages almost a decade ago. Numerous studies were undertaken to address this shortage and at the same time, efforts were also made to attract the influx of a new workforce while maintaining the existing skilled workers. Jarkas and Bitar (2011) conducted studies in Kuwait to ascertain the main factors influencing labour productivity at construction sites. This study addressed 40 productivity influencing factors that were categorized into 4 main groups, namely, management, labour, external and technology. This study then listed 10 main factors; where 6 of these factors relate to designers and engineers. Dai *et al.* (2009) emphasized that there is rarely a situation where certain factors only influence individually as it is normal to discover that certain factors aggravated the effects of other factors in a complex manner that influences labour productivity levels at construction sites. As an example, the availability of building materials, and, equipment and machinery may be more readily controlled and managed but coupled with the availability of skilled workers at the construction sites may prove to be a more intricate issue that would need more scrutiny and control.

The construction sector in a different setting or country will undoubtedly face different issues due to a variety of locality-based factors. A study by Kazaz *et al.* (2016) revealed that every country has its own issues regarding factors that influence labour productivity in their respective construction industries. For instance, vague job specifications have a huge impact on labour productivity in Kuwait. At the same time, shortages of building materials at construction sites, delays in payment of wages, unskilled labour, lack of financial incentive schemes, and, repetitive reworkings are all significantly major issues in Palestine, Egypt, India, Lithuania and Qatar respectively. Gopal and Murali (2015) through

their study discovered that the major issues that affect labour productivity are supervision, unskilled labour, lack of plants and machineries, worker absence at sites, and, financial constraints. According to the significant priorities of these issues, the category of management and labour was seen to have the biggest impact towards labour productivity in the construction industry.

Another study by Abdul Kadir *et al.* (2005) stress that main labour productivity issues in Malaysian housing construction projects are lack of building materials at the construction sites, disruption of material delivery to site due to payment defaults to material suppliers, lack of construction workers in the job market, and, co-ordination issues between the main and sub-contractors. Out of these factors, it was found that lack of building materials to be the most critical issue. Muhammad *et al.* (2015) discovered through their study that factors related to management, such as machinery shortage, lack of motivation and incentives, delays in inspections, and, disruptions in power and water supplies formed the major factors that influence labour productivity. 6 other main factors that were discovered revolved around the environment of the construction site including communication issues between local and foreign labour, delays in building material supply, weather conditions, size of the workforce, unskilled labour in specific job scopes, and, site accessibility.

Therefore, the issues and factors relating to labour productivity can be diverse and varied, largely due to the environment of a certain country. A majority of previous researchers emphasize the factors that influence labour productivity albeit in a vast and generic scope of study, with no clear focus on the specifics of a certain type of construction project. In-depth studies on the main factors that influence labour productivity within the settings of an infrastructure project are therefore necessary and warranted. As a means to verify the study findings and achieve a high level of reliability, the contractor's perspective on labour productivity issues is sought as the contractors are the main party in the operations of an infrastructure project at construction sites. These outstanding issues are what validates and gives credence to the intent of this research as stated earlier. By focusing one on key typology of construction projects and underpinning that with the main entity directly involved in productivity, namely the contractors, a greater understanding of productivity influencing factors may be captured. This will greatly benefit the industry as a whole through the identification of these factors and the subsequent implementation of strategies for increased productivity based on the findings of this research.

In setting the overarching parameters of this study, a summation of the literature review pertaining to the factors that influence labour productivity at construction sites are as listed in Table 1. This is then subsequently used as the basis in achieving the objective of this study. There are 26 significant and main factors in total that influence labour productivity at construction sites. These main factors are categorized as internal factors such as the management of basic necessities, personnel and resources, and, technology. External factors on the other hand, refer to adherence to local authority requirements and unexpected contingency factors at construction sites.

3. Research Methodology

Research methodology is a series of research processes that are undertaken to achieve an intended aim or objective. It is pertinent that the methodology is conducted effectively in ensuring and promoting the quality of the undertaken research, particularly in terms of accuracy and reliability (Kumar, 2005). In achieving the objective of this study, the use of a research survey employing a questionnaire as the research tool was employed as it would allow primary data to be garnered and canvassed in a wider scale. This approach also allows data to be collected and analyzed in a more systematic manner, thus ensuring a higher level of quality in the findings in representing the study population.

This study was conducted throughout the Klang Valley, encompassing both the state of Selangor and the Federal Territory as a vast majority of large-scale infrastructure projects are constructed within this region surrounding the capital city of Malaysia. Grade G7 contractors (refer to Table 2) formed the unit of analysis of this study as large-scale infrastructure projects involve significantly high financial costs. A total of 7,013 Grade G7 contractors are registered with the Construction Industry Development Board of Malaysia (CIDB) with 3,656 of these contractors having their headquarters within the study area (CIDB Malaysia, 2019). The Federal Territory recorded the highest number of registered contractors amounting to 1,882 (26.8%), followed by the state of Selangor which saw 1,774 (25.3%) Grade G7 contractors based here, out of the entire total of number contractors within this grade in Malaysia. After considering their active status, a total of 3,142 contractors were selected for this study. Using this as the base population, the study sample was determined to be 355 construction firms, as calculated in Equation 1; as previously utilized by researchers such as Abas *et al.* (2013); and Thanoon *et al.* (2003) in their corresponding studies.

Table 1 - Main factors influencing on-site labour productivity

Number	Main Factors Influencing On-Site Labour Productivity	Kazaz and Acukera (2015)	Ghoddousi and Hosseini (2012)	Kazaz et al. (2016)	Dai and Goodrum (2012)	Durdyevand Mbachhu (2011)	Fugar and Agyakwah-Baah (2010)	Muhammad et al. (2015)	Jarkas and Bitar (2011)	Gopal and Murali (2015)	Abdul Kadir et al. (2005)
1	Accuracy of planning and scheduling activities at construction sites	√	√	√	√	√	√	√	√	√	√
2	Competent and professional construction/site managers as project team leaders and drivers	√	√	√	√	√	√	√	√	√	√
3	Experienced and capable construction/site managers in handling the challenges of the construction site	√	√	√	√	√	√	√	√	√	√
4	Ability to control and monitor performance and works undertaken at construction sites by the site supervisors	√	√	√	√	√	√	√	√	√	√
5	Construction site workers clearly and precisely understand technical specifications				√	√		√	√		
6	Mitigating miscommunication issues between workers at the construction site				√	√		√	√		
7	Co-ordination between sub-contractors				√	√		√	√		
8	Workers are able to handle their tasks and are capable of handling arising challenges at the construction site	√			√	√		√		√	
9	Adequate labour force at the construction site	√			√	√		√		√	
10	Skilled and competent labour within specific job scopes	√			√	√		√		√	
11	Electrical, power and water supply at the construction sites					√		√	√		√
12	Construction site weather conditions					√		√	√		√
13	Frequency of job variation/amendments/changes during construction period at the construction sites					√		√	√		√
14	Difficulty in anticipating unexpected events and adherence to statutory requirements					√		√	√		√
15	Efficiency of machinery at the construction sites	√	√	√			√	√		√	√
16	Building materials are provided adequately according to required quantities at the construction sites	√	√	√			√	√		√	√
17	Availability of the latest updated construction drawings	√	√	√			√	√		√	√
18	Availability of suitable plants, equipment and machineries at the construction sites	√	√	√			√	√		√	√
19	Implementation of modern construction methods, such as industrialized building systems (IBS) as opposed to conventional/traditional construction methods		√			√				√	
20	Use of technology at the construction sites, leveraging on modern technology such as building information modelling (BIM) and Industry 4.0 in construction		√			√				√	
21	Contractors' financial stability to avoid late payments to the workforce and suppliers		√			√				√	
22	Worker attitude at construction sites (absenteeism and tardiness)	√		√	√	√		√		√	√
23	Workers receive timely wages and salaries	√		√	√	√		√		√	√
24	Work environment and culture that is easily acceptable among the labour force at the construction sites	√		√	√	√		√		√	√
25	Competitive remuneration packages that include overtime payment at the construction sites	√		√	√	√		√		√	√
26	Motivated and committed workforce at the construction sites	√		√	√	√		√		√	√

Table 2 - CIDB Contractors Grade and Tendering Capacity

Grade	Paid-up Capital (RM)	Tendering Capacity (RM)
G7	750,000.00	10,000,000.00 < Tender Sum < No limit

Source: Construction Industry Transformation Programme (CITP) 2016-2020

Equation 1 - Study Sample Calculation

$$n = N / (1 + N (e)^2)$$

Whereas,

n = Sample size,

N = population size,

e = error of ±0.05 percentage point (in decimal value)

Equation (1)

This study utilizes the Likert scale as a means to quantify the answers to questions related to the level of importance of the identified factors; where 1 refers to 'very important' and 5 denotes 'not important at all'. To ensure the objective of this study is achieved as well as to test the suitability of the survey questions, a pilot study was initially conducted as prescribed by Thabane *et al* (2010). The questionnaire was tested through this pilot survey to ensure its functionality and utility within the Malaysian environment. The pilot study involved 10 respondents from randomly selected Grade G7 construction firms. After the conclusion of the pilot study, the questionnaire was improved and amended using the feedback obtained from the respondents.

The questionnaires were distributed to the study respondents via both face to face and non-face to face interaction during a period beginning February 2019 and ending on June 2019. A computer-generated random sampling process ensured fairness and probity in the participation of the selected population representatives who formed the study sample size. This is in line with Kirk (2011) who stressed that simple random sampling gives a fair chance to all members of the population to be selected as respondents. A total of 63 selected respondents returned completed questionnaires, amounting to a response rate of 17.75%. However, the final number of questionnaires that was eventually utilized in the study analysis was filtered down to 60 as 3 respondents were found to be within the outliers' category. After all primary data was attained and recorded; the data was then analyzed using the IBM Statistical Package for Social Science software (SPSS Version 24).

According to Field (2009), the reason behind the reliability test is to determine the consistency of study findings; in order to minimize abnormal, skewed and impartial findings. It is essentially an extended process in determining whether the same results and findings would be obtained if the study was undertaken and conducted all over again. A predetermined coefficient value of Cronbach's alpha is used as the basis for this purpose; where if the coefficient value is more than 0.6 and 0.7, it is accepted to be reliable; where as if the coefficient value is less than 0.6, it is deemed to be unreliable (Kerlinger and Lee, 2000). Subsequently, the Relative Importance Index (RII) was employed to obtain results in fulfilling the study objective through Equation 2 (Kadir and et.al, 2005; Hanafi *et al.*, 2010; Lim and Alum, 1995; Mat Seman *et al.*, 2013) as follows:

$$Relative\ Importance\ Index\ (RII) = \frac{\sum W}{A \times N}$$

Whereas,

W = weight given to each attribute by respondent

A = highest weight

N = total number of respondents

Equation (2)

This research paper will only explain and delve into the findings of Section B of the questionnaire as they pertain to the identification of the main factors from the overall list of factors that influence labour productivity in Malaysian infrastructure construction project sites.

4. Findings and Discussion

The reliability test conducted on Section B of the study questionnaire returned a coefficient Cronbach's alpha value of 0.835. This value clearly indicates a high significant value, giving the qualified impression that the data collected can be analyzed towards identifying the main influencing factors. The factors listed in the questionnaire were then arranged according to their relative importance as indicated by the RII analysis. The overall analysis undertaken on the complete

list of 26 factors employing the Relative Importance Index, as well as their respective mean scores and response rates are as demonstrated in Table 3.

Table 3 - The importance rank of main factors affecting on-site labour productivity

Factors affecting On-site Labour Productivity	Importance degree which stated by 60 Respondents*					Response Rate	Importance Index (II)	Position
	1	2	3	4	5			
Co-ordination between sub-contractors	36	24	0	0	0	100	0.9200	1
Skilled and competent labor within specific job scopes	36	20	4	0	0	100	0.9067	2
Availability of the latest updated construction drawings	33	22	4	1	0	100	0.8900	3
Construction site workers clearly and precisely understand technical specifications	24	35	1	0	0	100	0.8767	4
Efficiency of machinery at the construction sites	24	31	4	1	0	100	0.8600	5
Workers receive timely wages and salaries	24	30	6	0	0	100	0.8600	6
Accuracy of planning and scheduling activities at construction sites	20	38	2	0	0	100	0.8600	7
Competent and professional construction/site managers as project team leaders and drivers	19	39	2	0	0	100	0.8567	8
Mitigating miscommunication issues between workers at the construction site	17	43	0	0	0	100	0.8567	9
Electrical, power and water supply at the construction sites	24	27	9	0	0	100	0.8500	10
Workers are able to handle their tasks and are capable of handling arising challenges at the construction site	22	31	7	0	0	100	0.8500	11
Adequate labour force at the construction site	21	33	6	0	0	100	0.8500	12
Implementation of modern construction methods, such as industrialized building systems (IBS) as opposed to conventional/traditional construction methods	20	35	4	1	0	100	0.8467	13
Building materials are provided adequately according to required quantities at the construction sites	19	36	5	0	0	100	0.8467	14
Ability to control and monitor performance and works undertaken at construction sites by the site supervisors	17	40	3	0	0	100	0.8467	15
Experienced and capable construction/site managers in handling the challenges of the construction site	17	39	4	0	0	100	0.8433	16
Motivated and committed workforce at the construction sites	17	37	6	0	0	100	0.8367	17
Competitive remuneration packages that include overtime payment at the construction sites	20	30	10	0	0	100	0.8333	18
Use of technology at the construction sites, leveraging on modern technology such as building information modelling (BIM) and Industry 4.0 in construction	23	27	5	5	0	100	0.8267	19
Contractors' financial stability to avoid late payments to the workforce and suppliers	21	26	13	0	0	100	0.8267	20
Frequency of job variation/amendments/changes during construction period at the construction sites	13	41	6	0	0	100	0.8233	21
Difficulty in anticipating unexpected events and adherence to statutory requirements	13	36	11	0	0	100	0.8067	22
Availability of suitable plants, equipment and machineries at the construction sites	11	40	9	0	0	100	0.8067	23
Worker attitude at construction sites (absenteeism and tardiness)	17	28	14	1	0	100	0.8033	24
Work environment and culture that is easily acceptable among the labour force at the construction sites	10	40	8	1	1	100	0.7900	25
Construction site weather conditions	10	25	23	2	0	100	0.7433	26

Note: 1 – Very Important; 2 – Important; 3 – Neutral; 4 – Not Important; 5 – Not Important at all

The top 10 most significant factors that influence on-site labour productivity in infrastructure projects arranged in order of importance as ranked by the study respondents are as follows:

- | | | |
|-----|---|---------------|
| 1. | Co-ordination between sub-contractors | (II= 0.9200) |
| 2. | Skilled and competent labour within specific job scopes | (II = 0.9067) |
| 3. | Availability of the latest updated construction drawings | (II = 0.8900) |
| 4. | Construction site workers clearly and precisely understand technical specifications | (II = 0.8767) |
| 5. | Efficiency of machinery at the construction sites | (II = 0.8600) |
| 6. | Workers receive timely wages and salaries | (II = 0.8600) |
| 7. | Accuracy of planning and scheduling activities at construction sites | (II = 0.8600) |
| 8. | Competent and professional construction/site managers as project team leaders and drivers | (II = 0.8567) |
| 9. | Mitigating miscommunication issues between workers at the construction site | (II = 0.8567) |
| 10. | Electrical, power and water supply at the construction sites | (II = 0.8500) |

4.1 Co-ordination between Sub-Contractors (II = 0.9200)

Co-ordination between sub-contractors returned the highest score being the most relatively important factor that influences labour productivity at construction sites of infrastructure projects. 60 percent of the study respondents agree that this factor needs to be given the most significant emphasis in the efforts to increase labour productivity levels at construction sites. Co-ordination between sub-contractors is a dire necessity and these parties need to communicate in an effective manner if they are to avoid any work overlap throughout the entire duration of the construction phase. This finding is aligned with previous research. According to Durdyev and Mbachu (2011), work co-ordination issues can effectively influence labour productivity at construction sites. Their study discovered that 54.29 percent of their study respondents attribute this co-ordination factor as the most influential and positioned as the most important compared to all the other factors in New Zealand.

4.2 Skilled and Competent Labour within Specific Job Scopes (II = 0.9067)

The second most important factor as decided by the study respondents is skilled and competent labour within specific job scopes. This factor scored an Importance Index of 0.9067 with only a marginal difference of 0.0133 from the first ranked factor of co-ordination between sub-contractors. 60 percent of the study respondents underline that this factor should be given credence if on-site productivity levels are to be increased and continuously maintained. Infrastructure projects are complex, complicated, involve the extensive use of machinery, and, heavily reliant on a highly skilled labour force during the implementation and installations stages at the construction site. Therefore, labour capabilities in the implementation process of the infrastructure projects should and must be given high priority as this element ensures implementation success and effectiveness. The importance of this factor as discovered by this study is akin to the findings of previous similar studies; where Dai *et al.* (2009) pointed out that skilled workers are a valuable asset in propagating an effective and efficient work environment at construction sites. They go on to explain that this factor has to be given due emphasis as it is entirely different from the factor pertaining to the availability of building materials as well as equipment and machineries as these components are more easily managed and controlled.

4.3 Availability of the Latest Updated Construction Drawings (II = 0.8900)

The availability of the latest and most recently updates construction drawings at the construction sites comes in as the third most influential factor, with an Importance Index of 0.8900. If updated drawings are readily available in a timely manner, the implementation of the entire work process and activities may become disrupted and sidelined. The direct effect of this problem would be the inability of the workers to undertake their tasks as scheduled and would eventually give away to the workers becoming idle. This will be further exacerbated if the sub-contractors adhered to the drawings and specifications at hand and not to the most current updated versions of those said drawings and specifications. If this does happen, then the sub-contractors would be required to redo the work already completed in order to fulfil current project requirements; eventually leading to negative side effects such as demotivated and demoralized workers. Therefore, serious attention must be given to ensure the timely availability of current revisions of construction drawings at the project site to fully maximize labour productivity potential. A study conducted by Thomas and Sudhakumar (2014) similarly discovered the importance of this factor as an underlying influence on labour productivity levels at construction sites in India.

4.4 Construction Site Workers Clearly and Precisely Understand Technical Specifications (II = 0.8767)

The factor relating to the comprehension of on-site construction workers towards technical specifications is listed as the fourth most influential factor that affects labour productivity in infrastructure projects sites in Malaysia. Analysis

conducted returned an Importance Index of 0.8767 with 40 percent of the respondents positively identifying this factor as being highly influential and significant in relation to labour productivity. Infrastructure projects are heavily laden with work specifications and require the complete understanding and comprehension of the construction workers at all given times. Workers should clearly be familiar with all the relevant technical specifications, terms, standards and jargon. Failure to either correctly instruct or properly understand requirements will surely be a bane in attaining high labour productivity. This finding shares similarities with the study conducted by Kazaz *et.al.* (2016) which identified that when there are situations where the workforce does not clearly understand the technicalities of the project, there is sure to be a negative impact on the overall labour productivity as discovered in their study on construction sites in Kuwait.

4.5 Efficiency of Machinery at the Construction Sites (II = 0.8600)

The fifth most influential factor that affects infrastructure project labour productivity is the efficiency of machinery at construction sites, with an Importance Index of 0.8600. As much as 40 and 55.67 percent of the study respondents respectively iterate that this factor is important and vital in determining labour productivity rates at construction sites. As infrastructure projects are massive, complex, use large sized building materials, and, involve the use of heavy, suitable and efficient equipment and machinery at the construction sites, any inadequacies in either one of these elements would prove costly towards the overall measure of productivity. This finding has also been verified by previous studies where construction site work environments gradually changed from being labour intensive to more machinery dependent due to advancements in technology. The efficiency of equipment and machinery was found to be the second most important factor in influencing labour productivity especially in projects that significantly utilize industrialized building systems at the construction site (Hanafi *et al.*, 2010).

4.6 Workers Receive Timely Wages and Salaries (II = 0.8600)

The factor relating to the timely payment of due wages and salaries to construction workers comes in as the sixth most important factor to influence labour productivity, although it returned a similar Important Index score of 0.8600, equating it with the factor of machinery efficiency at construction work sites. There is however a discernible difference between the index values of these two factors, thus listing this factor of timely wages slightly lower in terms of importance. A total of 40 and 50 percent respectively of the study respondents agree that this factor should be considered as relatively highly influential towards labour productivity at construction sites. The remainder 10 percent of the study respondents have marked this factor to at a neutral level in terms of influence towards productivity. Failure of top management to make timely payments of all due wages and salaries may create animosity and spell trouble for all parties concerned. This will eventually have a negative impact on the labour productivity as the workers may be both demoralized and demotivated. A disrupted level of worker motivation may take time to return to its original optimal level and this in turn will only cause productivity to dip in the meantime. The importance of timely payments is in fact a key determinant to worker productivity. Razak *et.al.* (2014) emphasized that a majority of workers do not think about work productivity but rather pay more importance to the timely receipt of their due wages. Workers will become unproductive if there is noticeable problem in terms of payment disbursement. This issue may be further worsened if workers somehow deem that the wages received are not commensurate with the workload, they have put in or if there are issues with less than satisfactory remuneration for work overtime.

4.7 Accuracy of Planning and Scheduling Activities at Construction Sites (II = 0.8600)

Planning and scheduling activities at construction sites is listed as the seventh most influential factor in determining labour productivity with an Importance Index value of 0.8600. 33.33 percent of the respondents agree to place this factor relatively high in the list of influencing factors for infrastructure projects. Planning and scheduling of construction activities need to be given due consideration before actual physical implementation is undertaken at the construction sites. This is similar to the findings from the study conducted by Liu and Ballard (2008), where it was discovered that increased project productivity is not only limited to the completion of more tasks in terms of quantity but also corresponds to the accurate and appropriate co-ordination of work arrangements as well as distribution of workloads that need to be implemented at the construction site. Shehata and El-Gohary (2011) share a similar view as they deem work planning and scheduling to be key in determining overall work operations at construction sites.

4.8 Competent and Professional Construction/ Site Managers as Project Team Leaders and Drivers (II = 0.8567)

The role of construction and site managers in leading project teams comes in at eighth place in terms of relative importance in influencing labour productivity in large scale infrastructure projects. 31.67 percent of the study respondents have stressed the importance of this factor where the Importance Index value stands at 0.8567. This is deemed to be one of the more important factors influencing productivity as any setbacks or shortfalls to this element may result in project delay and cost overrun. If the assigned managers are unable or incapable of steering the project team, the issues will have a cascading effect down the hierarchical lines of the project team organization. An incapable

leader will more often than not cause front line workers to become disenfranchised from good work ethics. This is also as demonstrated by a previous study conducted by Fugar and Agyakwah-Baah (2010) which expound the notion that the levels of efficiency and professionalism of a project and site manager leading a project team need to be continuously elevated at construction sites if desirable results pertaining to project performance and productivity are to be achieved.

4.9 Mitigating Miscommunication Issues between Workers at the Construction Site (II = 0.8567)

The factor concerning mitigation of miscommunication between workers at construction sites sits as the ninth most important factor to influence labour productivity. This factor registers an Importance Index value of 0.8567 with 28.33 percent of the respondents affirming the influence of this factor; while 71.67 percent state its importance in determining on-site labour productivity levels of infrastructure projects in Malaysia. The significance of this factor is undeniable as effective communication is key in project implementation as a labour intensive environment will be populated by workers from different background, ethnicities and nationalities. This finding supports an earlier discovery by Dai and Goodrum (2012) whose study denoted that the communication factor is directly able to significantly affect or influence productivity in construction sites based on findings within their study area.

4.10 Electrical, Power and Water Supply at the Construction Sites (II = 0.8500)

Electrical, power and water supply at construction sites rounds up the list of 10 most influential factors affecting on-site labour productivity, coming in at the tenth position. Study respondents have given this factor an Importance Index value of 0.8500 with 40 percent of the overall respondents clearly comfortable with the fact that this factor is relatively important as an influencing element. The difference between this factor and the preceding one is a value of 0.0067 which illustrates an almost equal importance between these two factors. Disruption to electrical, power and water supply at construction sites will negatively impact the project implementation process as a majority of on-site construction work largely depends on the consistent availability of the basic services. As pointed out previously by Muhammad *et al.* (2015), a significant factor that will negatively influence labour productivity at construction sites is disruption to constant and reliable supply of power and water.

The overall findings of this research clearly indicate that there are key issues that need to be addressed, analyzed and mitigated if labour productivity is to be increased on-site. The influencing factors identified by this research all revolve around aspects that are ubiquitously present in all infrastructure projects but may not have been considered to be critically tied into overall productivity without the benefit of the insight that this research now offers. The 10 most significant issues listed here, for instance, concern both the strategic and operational levels involving factors related to human resources, on-site activities, operational management and administration as well as basic support systems. It is through the identification and comprehension of the factors; can the construction industry now move towards increasing labour productivity armed with the knowledge of where efforts and focus should be emphasized on.

5. Conclusion

This study has effectively identified significant factors in the efforts to attain and increase labour productivity levels at construction sites, and in particular, within infrastructure projects in Malaysia. The factor of co-ordination between sub-contractors was discovered to be the topmost influential factor, followed by skilled and competent labour within specific job scopes and the factor relating to the availability of latest updated construction drawings at the project sites. Effective and good co-ordination between the sub-contractors will only create and enhance a smooth workflow in the overall implementation process. Labour productivity levels at construction sites will irrefutably decrease if there is a persistent problem of work overlap and scope creep between the vested sub-contractors of infrastructure project at the construction site. The utilization and application of modern sophisticated technology such as building information modelling (BIM) and Industry 4.0 (IR 4.0) is vital in enabling as well as facilitating a conducive and well co-ordinated work environment for the sub-contractors. At the same time, the element of worker skill and efficiency still needs to be in the forefront of large-scale infrastructure projects. Large-scale labour forces are still required at project sites, especially when there are technically complex tasks and job scopes, although there has been a gradual on-site job replacement by machineries and plants in recent times. Adequate as well as accurate updated information and data is another aspect that required due consideration at construction work sites. As there is little to no downtime or lag for construction activities in terms of implementation, workers will be hard pressed to wait to obtain or access accurate information as it will severely dampen their overall progress. Failure in ensuring the availability of and accessibility to the latest updated construction drawings on-site will have a huge negative impact on labour productivity levels of the construction workers. This is due to the fact that this failure will have spill over and side effects to the motivation levels of the workers involved. As such, ideal work co-ordination by the top management of the project organization, skilled and competent workforce especially within specific job scopes and the accessibility to the latest work specifications are drawn up by the project consultants will undoubtedly act as the key ingredients towards ensuring project success, particularly within the setting and environment of infrastructure projects in Malaysia. All

relevant parties within the project management team need to understand and execute their role by working together towards achieving the project goal and objective. This concerted effort will only spur and increase labour productivity levels at construction sites as the entire project team, from management to operation will seem to act, behave and respond as one cohesive productive work entity.

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