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Enhancing Material Tracking Practices of Material Management in Construction Project

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Abstract: Construction materials and equipment on a single project can constitute for up to 70% of the total project cost. It makes the managing of construction materials an important aspect and needed to be highlighted at every phase in construction project. Material tracking practice in material management can helps to provide timely information of the materials availability at the construction site and the storage yard. However, material tracking practice in material management in construction industry have been using manual method and has many drawbacks. Thus in this research, current practices of material tracking were studied, problems of material tracking practices in material management were identified and the key factors for enhancing material tracking in material management for Malaysian construction project were suggested. The study was conducted with 54 individuals that involved from G7 class of contractors within 3 main states which are Johor Bahru, Selangor and Wilayah Persekutuan (Kuala Lumpur and Putrajaya). This research is statistically descriptive orientation and questionnaire is being used as research instrument with respondent rate of 54%. Data collected was analysed using the Statistical Package for the Social Science (SPSS) 24.0 software. The method of analysis that being used in this research are percentage, frequency and mean score value. The results from this study shows that the current practices of material tracking were to track and record the delivery schedule of materials in computerised system. Other than that, the practices used were manual tracking, identification, calculation and documentation of the construction material. The drawbacks of the current practices such as lack of materials tracking in terms of timely ordering, problems in manual material tracking on site and at storage yard, and issues in tracking of the material by construction workers. That is the motivations on why material tracking practices are as important and need to be enhanced as it never been due to the availability and opportunity provided by current technologies to improve the efficiency and to minimize or possibly eliminate the unnecessary problems.

Keywords: Construction project, material management, practices, tracking

1. Introduction

Construction industry comprises 3 main stages in construction which are pre-construction, construction and the maintenance of the project. Normally when the main contractor was entrusted to finish one project, they need to perform the works starting from planning and design, groundwork, substructure and superstructure, external work,

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landscaping and up to the maintenance of the project. In a construction project, completion on time is extremely important because time is essential and time is considered as money. Although timely completion of the construction project is seen as one of the important criteria of the project success, the late completion or delay is seen as a common problem in a construction project. Delay in construction project gives rise to disruption of work and loss of productivity, late completion of projects, increased time-related cost, third party claims, damage of the company reputation, and worst cases of delay can cause abandonment or termination of contract (Divya & Ramya, 2015; Othman & Ismail, 2014). There are many causes of delay, which must be identified to improve the performance of the construction work as well as avoid delay in the project.

Effective of material tracking in material management could benefit construction industry where the project schedule can be improved, the total cost of one project can be reduced and can increase the labour productivity or in other words can improve the completion on time of the project (Okorocha, 2013). Other than that, construction material consists of a large portion of the construction project up to 60% to 70% of the total cost. And each 1% saving from the expenditure corresponding to an approximately 7% increment in profit thus makes material tracking practices in material management as an important element to be efficiently practice (El Ghazali *et al.*, 2011; Akindipe, 2014).

However, Meng (2012) had done research and identified that shortage of materials and material handling was one of the causes to project delay and cost overruns. Material shortage or scarcity was one of the basic factors for construction project delay. This lacking in material handling, storage, and deprivation of inventory controls was mainly due to the convenient ways of material management that are time-consuming and paper-based. When we talked about paper based, there is too much lacking that can be said. First, the material inventory needs to be calculated manually and sometimes we need to face scattered paper and data loss due to the perishable of the paper (Kasim, 2011; Ondiek & Ondera, 2012). The biggest disadvantage of material management using convenient ways was that we need to verify and prove the materials using physical contact which is time-consuming (Véronneau & Roy, 2009).

For a construction project to have high quality and high performance, the construction material needs to be properly be handled at the earliest stage. Hence, material tracking practices in material management will help in enhancing the efficiency of material management activities in the construction site. Therefore, the objectives of this study are; to investigate current practices of material tracking in material management for a construction project, to identify material tracking problems in material management for a construction project, and to suggest key factors for enhancing material tracking in material management for a construction project.

2. Literature Review

Material tracking is a process where the material was track down and monitor the material across the facility. The objective of material tracking is to get on track the material on site, purchasing of the material from the supplier to the contractor and storage. Navon & Berkovich (2006) said that material tracking in the construction industry was not an easy task since it involves a large number of materials. The contractor needs to track construction materials to help in enhancing material management as well as to ensure the resource in line with the work progress.

The most benefit of material tracking in helping material management was to reduce the time wasted by looking for items when they are accurately tracked (Shamsuzzoha & Helo, 2011). Material tracking in material management for construction project is important because of several reasons; (i) to know exactly the location of materials, so workers do not have to waste their time searching for materials, (ii) to make sure jobs and orders are not held up because of lack of materials, (iii) to track the quality and cost of each container of material in order to make sure that the correct materials are received according to purchase orders, (iv) to make sure the manufacturers have shipped the right materials to the customer; and (v) the need for traceability (Green, 2005).

2.1 Material Tracking Practices

Current practices of material tracking in material management for a construction project can be seen were rely greatly on in manual data collection process. This process was known as inefficient and ineffective as the data collected is not reliable and accurate (Sardroud *et al.*, 2010). All the parties in the construction project were concern about the accurate and timely information in order to increase the project control. However, current practices of material tracking in material management for the construction project was still using the conventional method. Table 1 is the summary of material tracking practices in material management for the construction project.

Table 1 - Material tracking practices in material management

No	Author	Year	Material Tracking Practices
1	Grau *et al.*	2009	- Manual tracking of material - The information such as delivery date will be hand mark to the material - The information will be manually recorded in the paper-based form - Then the data will be key in the computer
2	Donyavi & Flanagan	2009	- Tracking of the material at storage yard manually - Tracking of the material at storage by a construction worker
3	Nathan	2010	- Track and calculate the waste material manually and paper-based.
4	Sardroud *et al.*	2010	- Manual data collection process of material
5	Khyomesh	2011	- Track and plan the material to be used for the construction project by using Bill of Quantity (BOQ)
6	Kasim *et al.*	2013	- The manual method of material tracking - Paper-based and calculate one by one
7	Liwan *et al.*	2013	- Calculate the material one-by-one when the material arrived at the construction site with the reference of DO
8	Akinradewo	2016	- Record the information of the supplier using the computerize system - Track and record the delivery schedule of material in the computerized system
Material Tracking Practices with the aid of Technology			
9	Fathi *et al.*	2009	- Development of Context-aware Information System (C-aIS) from GPS technology - Provide project management with real-time information
10	Ren *et al.*	2011	- Material tracking with RFID, PDAs, and laptop - Smoothing the material tracking practices
11	Abdul Kareem & Abu Bakar	2011	- Implementation of ICT in material tracking - Increase the work flexibility
12	Hannure & Kulkani	2014	- Material tracking in inventory stage uses ICT tools which are Microsoft Excel, printer, computer, Microsoft Word, Smart Phone and fax machine.
13	Kasim	2015	- Intelligent Materials Tracking System (I-MATRACS) with the aid of RFID technology help to substitute manual material tracking practices to automated tracking.

Material tracking efficiency can be increased with the help of technology. Abdul Kareem & Abu Bakar (2011) study on the benefit of ICT among Malaysian contractor. It is found that the ICT implementation could help to increase the work flexibility by allowing users to obtain and exchange documents or information, increase the profit and at the same time reducing the costs, and improve management through improving data management, information quality, and competitive advantage and reduce the time of the project. Such technology that can help in efficient material tracking practices are RFID, PDA, and other ICT tools.

2.3 Problems in Material Tracking Practices

The main problems in material tracking practices in material management for the construction project are the usage of manual method system. It is difficult to achieve effective material tracking since the conventional system was being a priority. The reason is that most of the contractor is more comfortable to manage the material using the methods that they are expert (Liwan *et al.*, 2013; Ali *et al.*, 2012). Table 2 is the summaries of material tracking problems in material management. There are 10 major problems in material tracking practices which are; (i) problems in tracking of materials in terms of proper planning and scheduling, (ii) problems in manual material tracking of materials on-site and

at the storage yard, (ii) problems in tracking and updating of materials availability on-site, (iv) problems in tracking of material in terms of timely ordering, (v) problems in tracking the exact location of material delivery, (vi) problems in tracking the exact grid location of material at storage yard, (vii) problems in tracking and identifying the material at the storage, (viii) problems in tracking and identification of materials location by construction worker, (ix) problems in tracking of materials with perishable paper-based do and document, and (x) problems in tracking the missing and stolen materials. Therefore, material tracking practices need to be enhanced in improving the construction project.

Table 2 - Problems of material tracking practices in material management.

Problems in Material Tracking	Jang & Skibniewsk (2008)	Kazak (2008)	Donyavi & Flanagan (2009)	Kasim (2010)	El-Ghazali et al. (2011)	Rivas (2011)	Sardroud et al. (2012)	Kasim et al. (2013)	Liwan et al (2013)	Hannure & Kulkani (2014)	Phu & Cho (2014)	Zeb et al. (2015)	Anwar (2015)	Akinradewo (2016)
1. Problems in tracking of materials in terms of proper planning and scheduling					/						/			/
2. Problems in manual material tracking of materials on-site and at the storage yard		/			/		/	/		/	/	/		
3. Problems in tracking and updating of materials availability on-site.	/						/			/	/	/		
4. Problems in tracking of material in terms of timely ordering.	/		/	/	/		/	/	/					
5. Problems in tracking the exact location of material delivery.						/				/				
6. Problems in tracking the exact grid location of material at storage yard.			/	/										
7. Problems in tracking and identifying the material at the storage.			/	/		/								
8. Problems in tracking and identification of materials location by construction worker.		/					/		/				/	
9. Problems in tracking of materials with perishable paper-based DO and document.			/				/	/	/					
10. Problems in tracking the missing and stolen materials.			/		/		/		/		/			

2.4 Key Factors for Enhancing Material Tracking Practices

In order to have efficient material management in a construction project, as well as reducing the cost of the overall project and have a better quality, material tracking practices need to be enhanced.

(a) *Training for both management and staff:* It is necessary to provide education and training to encourage and promote the benefits in effective material tracking practices that will help to improve the reuse, recycle and reduce the material consumption (Tam, 2008; Akinradewo 2016)

(b) *Detailed planning on the materials*: Normally the material to be used throughout the construction project will be calculated and stated in the Bill of Quantity (BOQ) (Akinradewo, 2016; Mbachu & Nkado, 2006; Magalhães *et al.,* 2012). Therefore, it is necessary to improve the detailed planning of the material at the earliest stage which will helps in improving the tracking of material to be purchasing as well.

(c) *Enhance preparation of a good material tracking (schedule, plan, etc):* Materials tracking can be enhanced by preparation of good scheduling of the material to be used in the construction site in order to the accomplished best utilization of time and materials itself (Kevin, 2012; Magalhães *et al.,* 2012)

(d) *An enhanced computerized system for material tracking (document and record systems):* An effective material tracking using computerized system has the capability to integrate the entire material and supply chain work processes. Project teams will have online access to information during all project phases − from engineering through the complete supply chain to onsite management (Alwood *et al.*, 2011; Benton *et al.*, 2010).

(e)   _Enhance detailed planning of material tracking on the site layout and location of temporary material_: To have an efficient material tracking practices, the site location layout and location of the delivery material either temporary or permanent yard needs to enhance until zero error. Detailed planning of the site layout and location of temporary facilities can enable the management to make considerable improvement by minimizing travel time, waiting for time, and increasing worker morale by showing better and safer work environment (Grau *et al.*, 2009; Almohsen & Ruwanpura 2011; Akinradewo 2016).

(f)   _Enhance proper inventory control of materials tracking on site and in storage yard:_ Material storage on site requires close attention in order to avoid waste, loss and any damage to materials which would affect the operation of the construction project. There must be a proper inventory control provided for materials on site, stored in storage yard or locked up building so that tracking of the material can be made efficiently (Akinradewo, 2016; Almohsen & Ruwanpura 2011; Tam, 2008; Liwan 2013)

(g)   _Enhanced daily update of the material available at a construction site_: Daily updating of material at construction site involves taking note of the use and inventory of materials on site and recordings it such as the loading and off-loading, transit and handling of materials. It is recommended that arrangements be made for materials to arrive on time. improvement in daily updating of the materials will help the personnel in charge of the purchasing to have efficient material purchasing and can have a better Just-In-Time material delivery on site (Tam 2008; Akinradewo 2016)

(h)   _Enhance storage area by providing adequate space for effective material tracking:_ One of the main considerations for enhancing daily storage by providing adequate space for effective material tracking is because of the need to keep the construction work continued by maintaining the access to the site and facilitate the adequate flow of traffic of the materials. Thus preparing a layout plan and enhance the daily storage yard will help in materials tracking on a construction project (Zeb *et al.*, 2015; Almohsen & Ruwanpura 2011)

(i)   _Enhance storekeeper skills in terms of security and material tracking:_ Equipment and material theft is a major source of loss for contractors. The contractor may have lost the ability to track the loss material. Therefore, the storekeeper skills need to be enhanced such as create a job security plan, encourage awareness and etc. (Tam, 2008).

(j)   _Introduce Technology such as barcoding and RFID to help improving material tracking:_ One of the ways to improve the material tracking practices in material management was the implementation of ICT. The implementation of ICT shows an increment of work flexibility by allowing the users to obtain and exchange documents and information, increase profits and reduce the cost. Besides that, it also improves management through improving data management, information quality, and competitive advantage and reduces the time of project work. Example of the technology is Radio Frequency Identification (RFID) and Barcoding (Kareem & Abu Bakar 2011; Molnar *et al.*, 2007).

3. Methodology

This research was aimed to enhance material tracking practices in material management for the construction project. A questionnaire based on material tracking practices, problems in material tracking practices and key factors for enhancing material tracking practices was done. 100 questionnaire were distributed to contractor G7 in 3 main states which are Johor Bahru, Selangor and Wilayah Persekutuan (Kuala Lumpur and Putrajaya). This region of research was selected based on the value of construction work done shows that Johor Bahru recorded the highest work done of RM7.1 billion with 22.3% share among the states and followed by Selangor, RM7.0 billion (21.9%) and Wilayah Persekutuan RM 5.9 billion (18.4%) (Department of Statistic Malaysia, 2016). The target population for this project is contractors Grade 7 which registered with the Construction Industry Development Board (CIDB). Ali & Kamaruzzaman (2010) said that contractor with G7 has more structural management comparing to other Grade that registered with CIDB. Besides that, CIDB (2016) also state that company with G7 have the unlimited tendering capacity and had more experience in developing construction project that cost them multi-million with over 40% construction project was dominated by the G7 contractor. Therefore, only contractors with Grade 7 were selected for this project.

Quantitative research (questionnaire) approach was used to collect data from the respondent that having experienced or involved in materials tracking. The respondent comes from a various backgrounds such as project manager, site manager, site engineer, site coordinator and site supervisor since they are the one that involved in site activities. The analysis method of this research was using IBM SPSS-24.0 and by using a mean value, the ranking of highest and lowest was achieved. The data analysed from the survey conducted was evaluated to determine which are

the most significant using the average mean index scale as in Table 3. The mean ranking of the research objective was determined using the average mean index range as in Table 4.

Table 3 - Average mean index scale.

Average Index	Range
1.0 ≤ Average Index < 1.50	Strongly Disagree
1.50 ≤ Average Index < 2.50	Disagree
2.50 ≤ Average Index < 3.50	Neither Agree nor Disagree
3.50 ≤ Average Index < 4.50	Agree
4.50 ≤ Average Index < 5.00	Strongly Agree

Table 4 is the Alpha coefficient range. The table shows the levels of reliability which very good reliability is in a range of 0.80 to 0.95, and poor reliability has α less than 0.60. Since this questionnaire stand in a very good reliable range, thus the overall reliability test for the survey conducted in the research is acceptable.

Table 4 - Alpha coefficient range.

Levels of Reliability	Alpha Coefficient Range, α
Very good reliability	0.80 to 0.95
Good reliability	0.70 to 0.80
Fair reliability	0.60 to 0.70
Poor reliability	α < 0.60

4. Results and Discussion

4.1 Questionnaire Administration

When a questionnaire was developed, a questionnaire administration should first be structured. It is an important step to guarantee the effectiveness of the questionnaire. Every questionnaire must first get the validation from supervisor and expert in the field which will include lecturers and respondent involved. Table 5 shows the response rate of the questionnaire distributed to contractor G7 that are listed in the Construction Industry Development Board Malaysia (CIDB). From 100 sets of questionnaire distribute, 54 were returned from the respondent and which constitute 54% of the percentage response rate.

Table 5 - Response rate.

Questionnaires	Number of Responses (N)
Number of questionnaires distributed	100
Number of questionnaires collected	54
Number of valid questionnaires collected	54
Percentage of response rate	54%

The sample size is set at 100 since the population is too big. Then, the population is stratified into sub-population where only G7 contractor within the selected states. As for Johor, 12 sample size or questionnaire were distributed randomly and the other for Selangor and Wilayah Persekutuan is 42 and 46 to represent the whole population. After some time, the returned survey from Johor is 12, 18 respondent from Selangor and 24 from Wilayah Persekutuan

(Kuala Lumpur and Putrajaya) (refer Table 6). This method of randomly distribution were chosen because of time constraint and sampling error is minimised and the sample meet the required characteristic of the population.

Table 6 - Total population of G7 contractor in Johor, Selangor and Wilayah Persekutuan.

States	Total Population	Percentage (%)	Sample size	Returned Questionnaire
Johor	495	12%	12	12
Selangor	1689	42%	42	18
Wilayah Persekutuan	1899	46%	46	24
Total	**4017**	**100%**	**100**	**54**

A reliability test was conducted to test either the data in the questionnaire is reliable or not in order to generate accurate results. Cronbach's Alpha Coefficient is a common test that was used in calculating the internal reliability when of a questionnaire that has multiple Likert questions and to determine if the scale is reliable (Vaske *et al.,* 2016). Table 7 is the Cronbach's Alpha result for the research.

Table 7 - Cronbach's alpha coefficient reliability test for the survey

Reliability Statistics		
Cronbach's Alpha	Number of respondents	N of Items
0.889	54	30

From Table 7, reliability. If all of the scale items are entirely independent of one another (i.e., are not correlated or share no covariance), then α = 0, which makes the questionnaire to become unreliable at all. And, if all of the items have high covariance, then α will approach 1. In other words, the higher α coefficient, the more the items have shared covariance and have very good reliability (Adesile *et al.,* 2016).

4.2 Respondent Background

Fig. 1 is the respondent background. From 54 of the respondent, the highest respondent that answered the survey was Site engineer which are 42.56% of the total percentage while the second highest is site supervisor with 20.4% and then project engineer (16.65). Majority of the respondents has been in the construction industry within the range of 0-5 years which 70.4%. Only 5.60% of the respondents have been in the construction industry for more than 21 years and the rest are in the range of 6-10 years with 13 peoples which equivalent to 24.10%. Besides that, from the survey, the highest frequency and percentage is the site manager with frequency 23 (42.55%) as the persons that in charge of construction materials in the construction site.
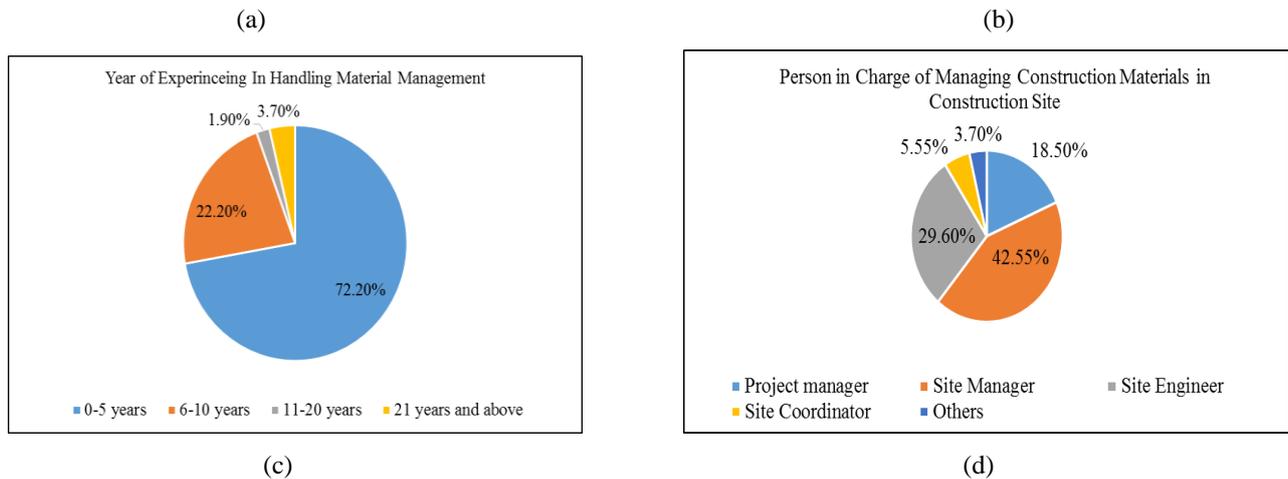
(a)

(b)

(c)

(d)
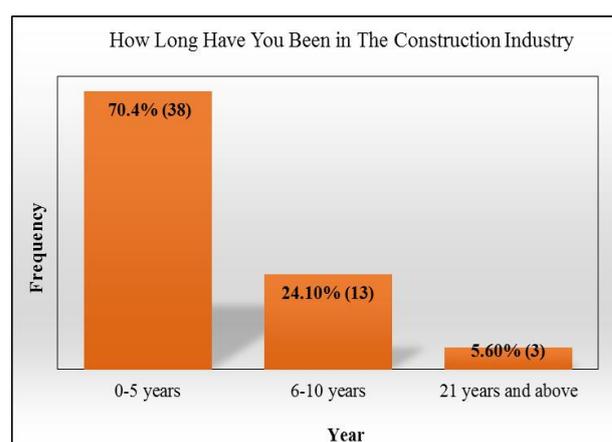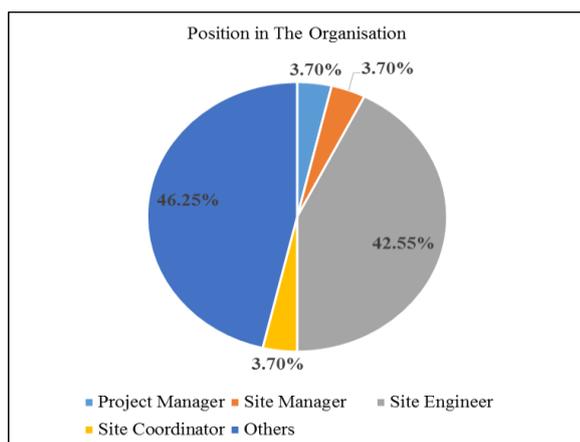
Fig. 1 - Respondent background.

4.3 Current Practices of Material Tracking

The first objective of this research is to study the current practices of material tracking in material management for the construction project. The result of the data analysis was tabulated in Table 4.6 with the ranking of the current practices of material tracking from highest to the lowest mean value. The highest ranking have the mean score value of 4.31 while the lowest ranking is 3.24 with 1.07 difference in mean score value. This ranking provides an indication of material tracking practices in the construction site that were highly used or practices to conduct material tracking in material management for the construction project.

Based on Table 8, the highest ranking of the current material tracking practices in material management for the construction project are tracking and record the delivery schedule of materials in a computerised system, with the mean score value is 4.31. Based on the average mean index (Table 3) this means score value lies in the range of $3.50 \leq$ Average Index < 4.50 which is under agree category. That is mean most of the respondents use tracking and record of the delivery schedule of materials in the computerised system as their current practices of material tracking. Follow the 1st rank with only 0.05 difference, the 2nd rank in the current material tracking practices is the to track and record the information of supplier using computerize system and track and calculate one-by-one of material delivery on-site with reference to Delivery Order (DO). Both of these practices stay in the rank 2 with the average mean score is 4.26.

The 3rd rank of material tracking practices is to track and calculate the material at the storage by a construction worker with the average mean score of 4.10. The 4th rank is track and calculates the material at the storage manually and paper-based which show a large dropping of a differences 0.21 making it 3.89 average mean scores. Even though the average mean score of material tracking practices of tracking and calculating the materials at the storage manually and paper-based had gradually decreased to 3.89, it is still under agree category. Both track and record the grid location of the material on-site manually and paper-based, and track and plan the material to be used for the construction project by using Bill of Quantity (BOQ) are in the 5th and 6th ranking of mean score value. Both 5th and 6th ranking have a slightly different in a number of mean score value which is 3.83 and 3.81. Other than that, the current practices of material tracking that stand in the rank 7th also have 0.1 differences with the number 6th rank which is 3.80. The practices are track and record the waste material manually and paper-based.

Tracking and calculating the required amount of material manually and paper-based stand in the 2nd last of the ranking which ranking number 8th with 3.65 as the average mean score value. The last practices that are the 9th rank are tracking the material by using technology (i.e barcoding, RFID, etc.). These practices have the average mean score value of 3.24. If follow the average index, 3.24 stand in the neither agrees nor disagree category.

Table 8 - Current material tracking practices in material management.

	Current Material Tracking Practices in Material Management For Construction Project	Mean	Category	Ranking
1	Track and record the delivery schedule of material in the computerized system	4.31	Agree	1
2	Track and record the information of supplier using the computerize system.	4.26	Agree	2
3	Track and calculate one-by-one of material delivery on-site with reference of Delivery Order (DO).	4.26	Agree	2

4	Track and calculate the material at the storage by a construction worker.	4.10	Agree	3
5	Track and calculate the material at the storage manually and paper-based.	3.89	Agree	4
6	Track and record the grid location of the material on-site manually and paper-based	3.83	Agree	5
7	Track and plan the material to be used for the construction project by using Bill of Quantity (BOQ).	3.81	Agree	6
8	Track and record the waste material manually and paper-based	3.80	Agree	7
9	Track and calculate the required amount of material manually and paper-based.	3.65	Agree	8
10	Track the material by using technology (i.e barcoding, RFID, etc.)	3.24	Neither Agree nor Disagree	9

4.4 Problems in Material Tracking Practices

Second objectives are to identify the problems of material tracking practices in material management for the construction project. Table 9 is the problems in material tracking practices that have been tabulated follow the rank and mean value score. 10 problems were identified from the literature review and the highest rank was problems in the tracking of materials in terms of timely ordering. This problem is the 1st rank with a mean value of 4.31. Respondent agreed that these problems are the main problems in material tracking practices that can lead to delay in the construction project. Timely ordering means is that the materials are unable to be at the construction site at the exact time when needed. The failure of ordering the materials on time, unavailability of the materials before commencing of the work and lack of timely information regarding of the materials was one of the most problems in material tracking practices (Donyavi & Flanagam, 2009; El-Ghazali *et al.*, 2011; Liwan *et al.*, 2013).

Table 9 - Problems in material tracking practices.

	Problems in Material Tracking Practices	Mean	Category	Ranking
1	Problems in the tracking of material in terms of timely ordering.	4.31	Agree	1
2	Problems in manual material tracking of materials on-site and at the storage yard.	4.26	Agree	2
3	Problems in tracking the exact location of material delivery.	4.26	Agree	2
4	Problems in tracking and identification of materials location by a construction worker.	4.10	Agree	3
5	Problems in tracking and identifying the material at the storage.	3.89	Agree	4
6	Problems in tracking the exact grid location of material at the storage yard.	3.83	Agree	5
7	Problems in the tracking of material in terms of proper planning and scheduling.	3.81	Agree	6
8	Problems in the tracking of materials with perishable paper-based DO and document	3.80	Agree	7
9	Problems in tracking and updating of materials availability on-site.	3.65	Agree	8
10	Problems in tracking the missing and stolen materials.	3.24	Neither agree nor disagree	9

Problems in manual material tracking of materials on-site and at the storage yard, and problems in tracking and identification of materials location by construction worker was in the rank 2nd with mean value 4.26 and under the category of agree. When the material arrives at the construction site, it will be calculated manually and paper-based, the materials were also hand marked for the purpose of identifying the materials. It also has a high tendency to be shifted frequently from one places to another (Grau *et al.*, 2009). It shows that tracking of materials on site and at the storage

yard was using traditional and manual tracking. It also causes problems in tracking the exact location of materials delivery. Since the material inventory was made manually, it is prone to misplace, wrong calculation and so on.

Problems in material tracking practices in material management in rank 3rd, 4th and 5th are problems in tracking and identification of materials location by a construction worker, problems in tracking and identifying the material at the storage, and Problems in tracking the exact grid location of material at the storage yard. All three of these problems have mean value number of 4.10, 3.89 and 3.89 under the category of agree. Most of the tracking of materials on site and at storage yard is relies on construction worker that have a high probability to do error and mistakes. Besides that, it is also labor intensity and inaccurate (Sardroud *et al.*, 2012).

Next, problems in the tracking of material in terms of proper planning and scheduling and problems in the tracking of materials with perishable paper-based DO and the document was in the rank number 6th and 7th with mean value number of 3.81 and 3.80. Most of the contractor in Malaysia is a favour to track the materials using Delivery Order which is in paper-based form. When talking about paper-based, it is perishable and manual tracking using it is inaccurate (Kasim *et al.*, 2013). Besides that, manual material tracking that is paper-based will increase the paperwork if the DO is damaged or the materials are not found. It is also a lengthy process to track the materials (Hannure & Kulkani, 2014).

The last rank is problems in tracking the missing and stolen materials with the mean value of 3.24 and under the category of neither agree nor disagree. This problem occurs when the construction worker was unable to track back the shortage of materials due to being stolen or missing. Materials once arrived at the construction site will always being shifted from one place to another (Anwar, 2015). It is mainly because of the unavailability of spaces at the storage yard, or the location of the working site is quite far from the storage.

4.5 Key Factor for Enhancing Material Tracking Practices

The last objective of this study is to suggest key factors for enhancing material tracking practices in material management for the construction project. In this study, there are 10 factors for enhancing material tracking practices in material management. The 1st rank is to enhance the computerised system to document, record and track of materials with a mean score value of 4.57. Using a computerized system will help to efficiently document, record, and track of the materials either on-site or at the storage yard. The 2nd and 3rd rank have a slight difference in mean score whereas 2nd rank have 4.54 and 3rd rank has 4.52 of the mean score value. The respondent agreed to enhance the preparation of good materials tracking (i.e documentation, scheduling, etc), and enhance the detail planning of materials tracking on the site layout and location of temporary materials. Respondents are strongly agreed that if the preparation of the materials is complete and adequate, thus all the planning can be followed and can reach the time allocated for the construction project. Furthermore, planning of the materials was also mean to monitor and controlling the planned materials towards successful project delivery. Some of the specific activities include the production of a Gantt-chart, network analyses, method statements, resource leveling, progress reports and exception reports (Kevin, 2012).

Both of rank 3rd was to enhance the storage area by providing adequate space for effective material tracking and enhance storekeeper skills in terms of security and material tracking with mean value number of 4.52 and under strongly agree on category. Respondents believed the time of searching for construction materials can be increased effectiveness by enhancing the storage area and storekeeper skills. The enhanced storage area will involve the study, planning, and organization of unused area of the site and the material around the storage yard to accommodate the other materials to be used in the execution of the construction works (Zeb *et al.*, 2015). Besides that, the equipment and materials can be avoided from lost and theft by enhancing the storekeeper skills. Storekeepers are also the construction workers that was normally used to track the materials (Donyavi & Flanagam, 2009). Thus enhancing their skills will help in enhancing the material tracking practices in material management.

Rank no 4 with 4.46 mean value score and under the category of agreeing was to enhance proper inventory control of materials tracking on site and in a storage yard, and enhance daily update of the material tracking availability at a construction site. It is important to enhance the inventory controls of materials on site and at the storage yard as well as the daily material availability at the construction site. A proper inventory and daily updating of materials availability will help the manager to purchase the materials at the exact time and amount which will help to improve the productivity of the construction work (Liwan *et al.*, 2013; Kapot, 2010). It is recommended that arrangements were made for materials to arrive on time.

Rank 5th with the mean value of 4.31 and in the category of agreeing was both enhancing proper training for both management and staff on effective material tracking, and introducing technology such as barcoding and RFID to help improving material tracking. Proper training for both management and staff will help them to understand and practice material tracking practices efficiently and boost up the productivity at the construction site. Besides that, it is more effective to provide training and education among staff and employees in enhancing material tracking practices in material management for the construction project. The technology was proven to enhance the manual material tracking practices in material management for the construction project. Thus introducing technology will improve the time and quality of the construction project. There are many technologies that were designed to improve material tracking practices such as Intelligent Material Tracking Systems (I-MATRACS) or Context-aware Information Systems (C-aIS). This technology helps to track the materials automatically (Kasim, 2015; Fathi *et al.*, 2009).

Enhance detail planning on the materials tracking to be used for the project is in the last rank of factors for improving material tracking practices in material management for the construction project. This factors are in rank 6th and have the mean value score of 4.30. Material planning is a time-phased priority-planning technique that calculates material requirements and schedules supply to meet demand across all products and parts in one or more construction site. Normally the material to be used throughout the construction project will be calculated and stated in the Bill of Quantity (BOQ) (Akinradewo, 2016). Thus, most of the respondents agree that by enhancing the detail planning on material tracking, will help to enhance the material tracking practices in material management (refer Table 9).

Table 9 - Key factors for enhancing material tracking practices.

	Key Factors for Enhancing Material Tracking Practices	Mean	Category	Ranking
1	Enhance computerized system to document, record and track of materials.	4.57	Strongly agree	1
2	Enhance preparation of good materials tracking (i.e documentation, scheduling, etc)	4.54	Strongly agree	2
3	Enhance detail planning of materials tracking on the site layout and location of temporary materials	4.54	Strongly agree	2
4	Enhance storage area by providing adequate space for effective material tracking.	4.52	Strongly agree	3
5	Enhance storekeeper skills in terms of security and material tracking.	4.52	Strongly agree	3
6	Enhance proper inventory control of materials tracking on site and in a storage yard.	4.46	Agree	4
7	Enhance daily update of the material tracking availability at a construction site	4.46	Agree	4
8	Enhance proper training for both management and staff on effective material tracking.	4.31	Agree	5
9	Introduce technology such as barcoding and RFID to help improving material tracking	4.31	Agree	5
10	Enhance detail planning on the materials tracking to be used for the project	4.30	Agree	6

5. Conclusion

In this research, a total of 54% rate of respondent have been collected through the survey of enhancing material tracking practices. The current practices of material tracking practices were using the manual method. A manual material tracking practices has many drawbacks such as lack of timely information on the construction materials, labor-intensive and error-prone. From this research, the main problems in material tracking practices were the problems of tracking the materials in term of timely ordering. This problem can be enhanced through the implementation of key factors to enhance material tracking and implement technologies to help in better practices. The technologies tools that can be used is such as Barcoding, RFID and others. With the improvement of material tracking practices, the productivity at the construction site can be improved, the practice to handling material tracking can be enhanced, the time planning can be improved and eventually the cost of the project can be reduced.

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