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Full Length Research Paper

Managing construction logistics management: Findings from construction contractors and industrialized building system (IBS) manufacturers

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Inability of contractors to foresee materials demand at the right time and material-handling at the right place are identified as one of the most common problems in the construction industry. Therefore, this paper attempts to determine the attitude and pattern of the industrialized building system (IBS) manufacturers and contractors towards logistics management system followed by evaluation of logistics management effectiveness. This research is carried out by way of questionnaire and followed by an in-depth interview with IBS manufacturers and contractors. From the findings of this research, it is revealed that the respondents agree that logistics management is important for production efficiency. Price, quality, and capacity of suppliers are three (3) critical factors that should be considered when purchasing materials. However, contractors tend to be more concerned with profit margin, while the IBS manufacturers are concerned with productivity when they make decision for material-handling equipments. Additionally, there are other problems identified in logistics management, including non-punctuality in materials and components deliveries, inability to foresee the period of activities with accuracy, etc. Majority of the respondents agreed that flow chart is one tool that can improve production efficiency in order to solve the problems in logistics management.

Key words: Construction, logistics management, supply chain, industrialized building system (IBS), manufacturers, contractors.

INTRODUCTION

Logistics management and supply chain management (SCM) is closely related to lean supply (Lamming, 1996 cited in Vrijhoef and Koskela, 1999). Both management theories are key components of lean manufacturing (Industry Canada, 2008). Meanwhile, many researchers argue that the emergence of logistics management and SCM are due to the same shift in 'theoretical concepts' that initiated JIT and lean production (Vrijhoef and Koskela, 2000). Logistics management is the operational aspect of SCM (Vidalakis and Tookey, 2006) and is the part of supply chain process that plans, implements, and controls the efficient flow of goods, services, and related information to fulfill customers' requirements (CLM, 1999 cited in Silva and Cardoso, 1999). The responsibility of logistics would be planning and co-coordinating the materials supply processes at each stage of project, from the initial planning and design to execution and commissioning (Sobotka et al., 2005).

Logistics management is one of the concepts and tools that can achieve competitive advantage by providing costs reduction and better customer satisfaction (Rushton et al., 2000). The implementation of logistics management with just-in-time (JIT) delivery may also be useful in reducing warehouse and storage cost, reducing lead time, improving productivity, and improving quality (Smith, 1977).

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It is important to forecast materials demand before purchasing them from the suppliers in order to make sure that the materials are delivered at the right time and place. Traditionally, the contractor or his purchasing department will be responsible for this task. However, due to the growth of project delivery, project manager or the owner himself will be the decision maker in selecting materials and suppliers (Sobotka et al., 2005). The contractors may also entrust professionals specialized in logistics services, such as logistics centers, to take over supply planning and scheduling. Alternatively, some operational tools can be used to analyze the materials demand, such as process flow chart, special logistics software, etc. (Silva and Cardoso, 1999; Rao et al., 1998). Contractors may also forecast materials demand on the basis of construction progress and their own experience. Once the check list of materials to be purchased is prepared, there are some factors that should be considered in purchasing materials, such as, price, quality, quantity, capacity of suppliers, suppliers' reputation, waiting time, and offer from suppliers (Hines, 2004). These factors are to assure that the purchased materials meet the project iron triangle which consists of cost, quality, and time. Furthermore, there is a need to choose suitable material-handling equipments when the materials have been delivered on site. This is because the productivity and motivation will be influenced by the efficiency of site-handling of materials and equipment (Borcherding and Gamer, 1980; Logcher and Collins, 1978 cited in Proverb et al., 1999). Therefore, the contractors have to consider factors, such as availability of plants, equipment, and labour; building form and location; quantity of materials; relative cost; specification; safety; and speed of production when choosing the suitable material-handling equipments (Proverbs and Holt, 1999).

On the other hand, there are some indications that bad logistics management may become the basis to evaluate the effectiveness of logistics management of a firm. These indications included the non-punctuality in ma-terials and components deliveries, inability in foreseeing with accuracy the periods of activities execution, large storage on site, etc. (Silva and Cardoso, 1999; Bertelsen and Nielsen, 1997). The reasons behind most of these indications are insufficient planning of work and delivery, errors in specification, and other human errors (Bertelsen and Nielsen, 1997). However, there are tools that may be used to optimize production flow in order to improve logistics management efficiency. The tools are supply plan, site layout planning, process flow chart, labour productivity studies and cycle time studies, etc. (Silva and Cardoso, 1999; Ballard and Howell, 1998 cited in Silva and Cardoso, 1999).

RESEARCH METHODOLOGY

Quantitative and qualitative research methods are used in this research in order to achieve the goal and objectives that have been set out in the beginning of the research. The quantitative methodology conducted is questionnaire, while the quantitative methodology is an in-depth interview. A total of 500 questionnaires were distributed to contractors and IBS manufacturers registered under Construction Industry Development Board (CIDB), Malaysia. There are a total of twelve (12) questions in the questionnaire constructed to address the objectives of this research. Two (2) questions were to determine the attitude of the IBS manufacturers and contractors towards logistics management. Their opinion on whether or not logistics management is important to improve productivity and the outcomes of implementation of the logistics management are studied. Meanwhile, there are five (5) questions to explore the pattern on logistics management. The questions are to examine whether the pull concept is applied, to identify who is the decision maker of logistics in the firm, the method used to foresee the materials demand, factors to be considered in purchasing materials, and factors to be considered in choosing material-handling equipments. The next objective is to evaluate the logistics management effectiveness among the IBS manufacturers and contractors. This objective is attained by asking these two following questions: the first question investigates the effectiveness of logistics management and the reason of inaccuracy of materials delivery and the second question is intended to collect recommen-dations and suggestions for tools that may be used to optimize the production flow.

The data from the questionnaires are categorized into two (2) groups; ordinal and nominal. The only parameter of nominal data analyzed is frequency which will lead to the findings of the variable of most frequently occurred among the respondents. For example, 63.60% of IBS manufacturers and 52.70% of contractors' respon-dents are in the managerial position compared to only 36.40% of IBS and 33.30% of contractors in the position of senior managers. This indicates that among the respondents, managers give more response to this questionnaire.

On the other hand, ordinal data is analyzed by using descriptive procedure in order to generate mean value, that is, the average value of data (Lewis-Beck, 1995). In this research, the mean value of less than 3.00 indicates that the factors being studied are of higher priority, more effective, or likely to be most frequently occurred. However, these interpretations varied based on the questions being asked. For example, the results for rank of priority of the factors to be considered when purchasing materials show that for contractors' respondents, price has a mean value of 1.64 while quality has a mean value of 2.14. This indicates that price is in higher priority than quality when purchasing materials. In addition, Crosstab will be used to display the data from one variable against another (for example, professionals against problems faced in logistics management) (McNabb, 2004). This is to make it easier for the reader to compare the trend of answers between the two (2) professions.

Subsequently, the data is analyzed by using Cronbach's alpha as a method to ensure the reliability of data. Reliability is the ability of the questionnaires to measure consistently, the topic of research at different times and across different population (Hinton, 2004). The computed values of Cronbach's alpha range from 0 to 1. The closer the analyzed data value to 0, the more likely the value to be completely unreliable, whereas the closer the data value to 1, the more likely the value to be completely reliable. For example, if Cronbach's alpha value is high, for example 0.80 or higher, the response is consistent and this will indicate that the data is reliable. The data is analyzed further by using One-Sample T-test in order to check whether the data obtained from the questionnaires are significant by comparing the mean value of data with the mean value of the hypothesized population (Morgan, 2004). When the result of the test is obtained, a significant value has to be lower than 0.05 and the t value has to be negative. For example, price has t-value of -7.535 and significant value of 0. This indicates that price is a significant factor to be considered when purchasing materials.

This is because price has fulfilled both requirements, that is, the significant value is lower than 0.05 and t-value is negative.

The qualitative methodology used in this research is an in-depth interview with the respondents. The in-depth interview is conducted after having the trend of answers from the respondents which is made after analyzing the data obtained from the questionnaire. The interview is a semi-structured interview, in which a list of questions is prepared before the interview. The purpose of this qualitative methodology is to explore the underlying reasons of the respondents that contribute to the answers in the questionnaires.

QUESTIONNAIRE SURVEY RESULT

The result of questionnaire regarding the implementation of logistics management among IBS manufacturers and contractors is presented here. The reliability of data obtained from the questionnaires is shown in Table 1. The table shows the tabulation of reliability by using Cronbach's alpha test. The Cronbach's alpha for the data obtained from questionnaires is 0.6272. This indicates that the data obtained from the questionnaires is 62% reliable. This value is closer to Cronbach's alpha value of 1 which means that the test is completely reliable.

Five hundred (500) questionnaires are distributed, and the total number of returned questionnaires is 47 (9.40%). Figure 1 shows that 11 of the 47 returned questionnaires are responses from IBS manufacturers (23.40%) while the other 36 (76.60%) are from contractors.

Figure 2 represents the respondents' years of experience according to their level of career. Majority of the IBS manufacturers respondents have 6 to 10 years of experience. According to this finding, it can be assumed that the data obtained from the questionnaire are reliable due to the high level of experience of the respondents.

From the findings in Figure 3, majority of respondents considers that logistics management is important to improve production efficiency. There are 21.27% of IBS manufacturers and 70.22% of contractors who agree with the importance of logistics management. This may indicate that logistics management is widely implemented among the contractors.

There are seven advantages of logistics management implementation during the construction projects as shown in Figure 4. Majority of respondents from both pro-fessions agree that logistics management may assist in reducing overall construction cost (cost-saving), reducing waiting time between activities, aiding the project to be completed on time, and also reducing multi-handling and repeated moving of materials.

However, 77.78% of contractors agree that materials will be delivered on time, but 63.64% of IBS manu-facturers disagree with this statement. This situation also applies to the findings in materials wastage and storage, in which 63.89% of contractors agree that the wastage and storage is reduced, but 63.64% of IBS manufacturers disagree. The interviewees commented that the reason why IBS manufacturers disagree with these two (2) advantages is because the contractors always make last minute purchasing orders and that they cannot fulfill the request in a short period. However, the majority of IBS manufacturers and contractors are both disagree with the statement of better customer satisfaction as one of the advantages from the implementation of logistics management. This information is contrasts with the finding from literature review. The interviewees thought that customer satisfaction was the secondary outcome from the implementation of logistics management and this outcome would only be achieved when the other advantages had already been accomplished.

The pattern of logistics management among IBS manufacturers and contractors

The majority of respondents, both IBS and contractors, do apply pull concept in their company. There are only 2.13% of IBS manufacturers and 27.18% of contractors that do not apply pull concept. This shows that majority of respondents do not stock materials in their warehouse as pull concept is employed to produce a product when there is needs.

Based on the findings illustrated in Figure 5, various professions have been involved in the logistics decision. It is clearly shown that majority of logistics decision maker among the contractors are project managers, as chosen by 25 out of 47 of contractor respondents. However, the majority of decisions related to logistics are made by the purchasing department, as chosen by 4 out 11 of IBS manufacturers.

However, only 1 out of 36 of the contractors and none of the IBS manufacturers chose external logistics office as the logistics decision maker. This may suggests that contractors and IBS manufacturers are rarely appoint external logistics services purposely to deal with the logistics issues.

From the result illustrated in Figure 6, it is shown that majority of the IBS and contractors determine the amount of materials required for a particular period based on the progress of project. Meanwhile, 6.38% of IBS manufacturers and 21.28% of contractors forecast the materials demand based on their experience. However, there are only 2.13% of contractors and none of the IBS manufacturers use logistics software to forecast the materials demand. This may indicate that the use of ICT among contractors and IBS manufacturers for logistics purposes is not highly practiced.

Referring to Figure 7, from the IBS manufacturers' point of view, price and quality are the highest priority factors to be considered in purchasing materials with a mean value of 1.80. However, from the contractor's point of view, price is the highest priority factor to be considered, followed by quality with a mean value of 1.64 and 2.14, respectively. In the same time, the capacity of the supplier is the third important factor to be considered ranked by the IBS manufacturers and contractors with the

Table 1. The result of reliability test using Cronbach's alpha.

Cronbach's alpha	Cronbach's alpha based on standardized items	Number of item
0.6272	0.6916	32

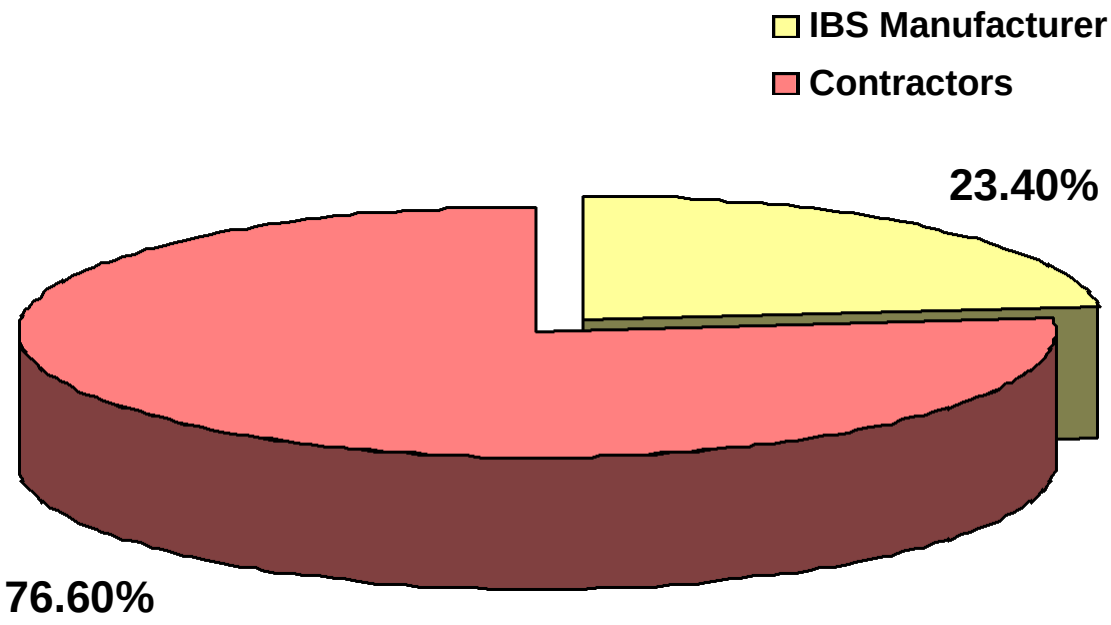

Figure 1. Profession of the respondents.

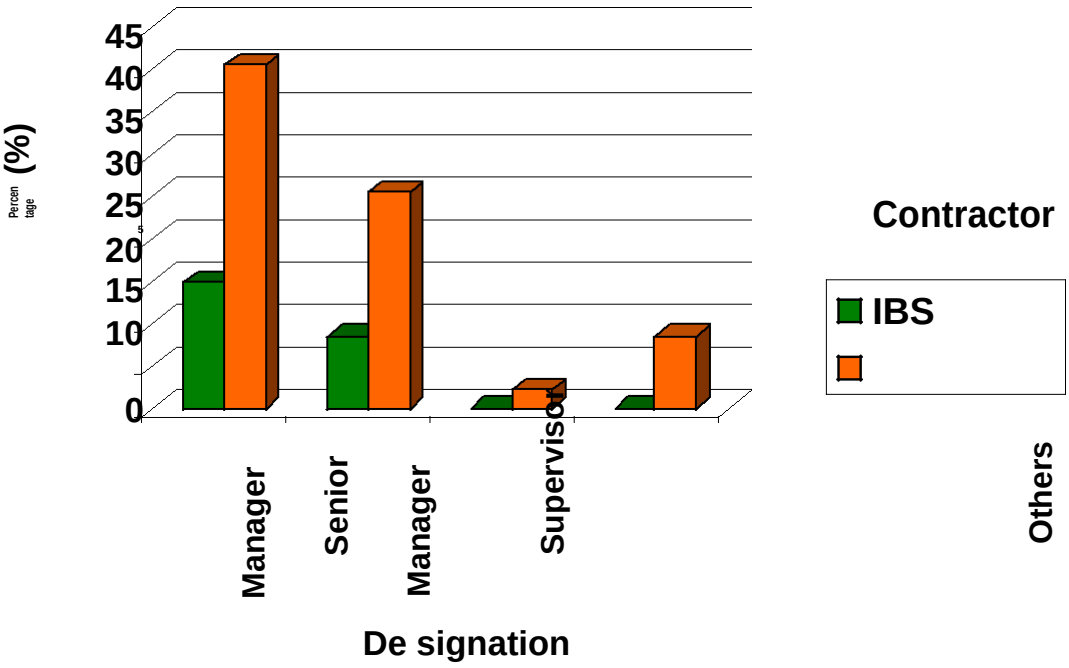

Figure 2. Respondents' years of experience based on level of career.

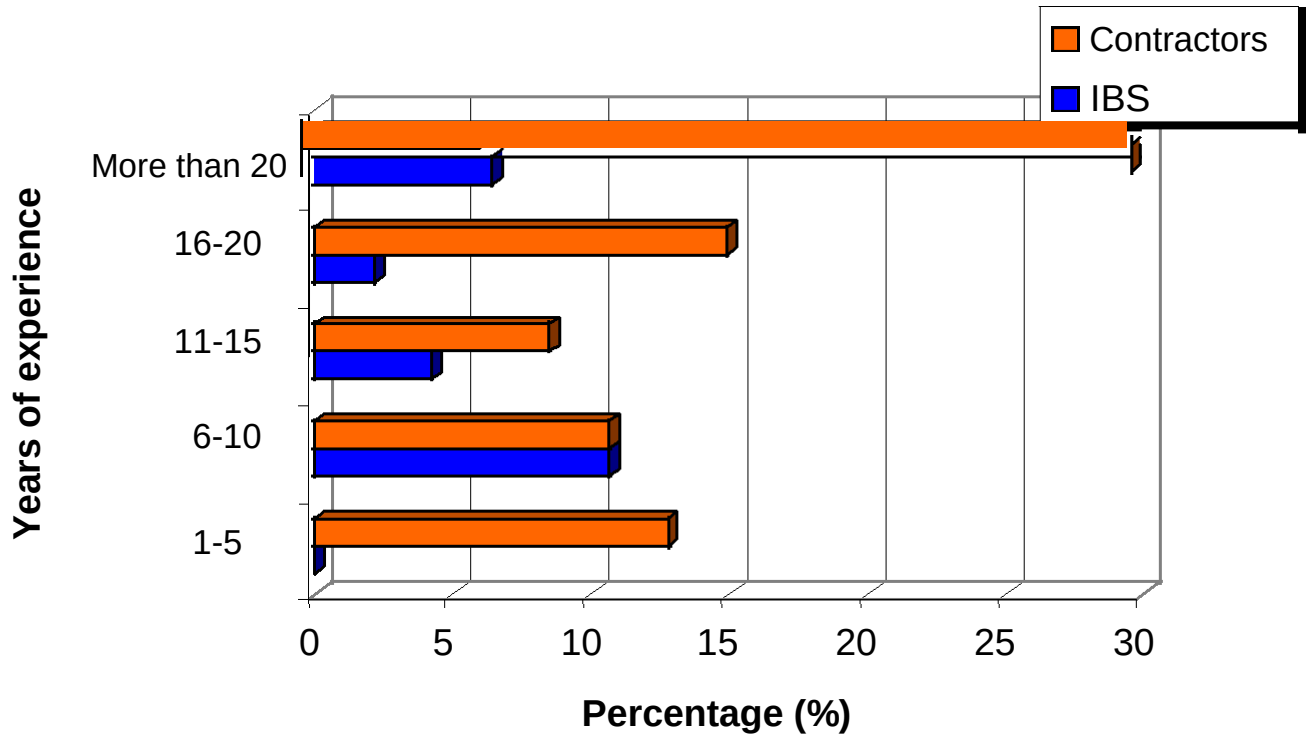

Figure 3. Respondents' level of opinion of towards the importance of logistics management.

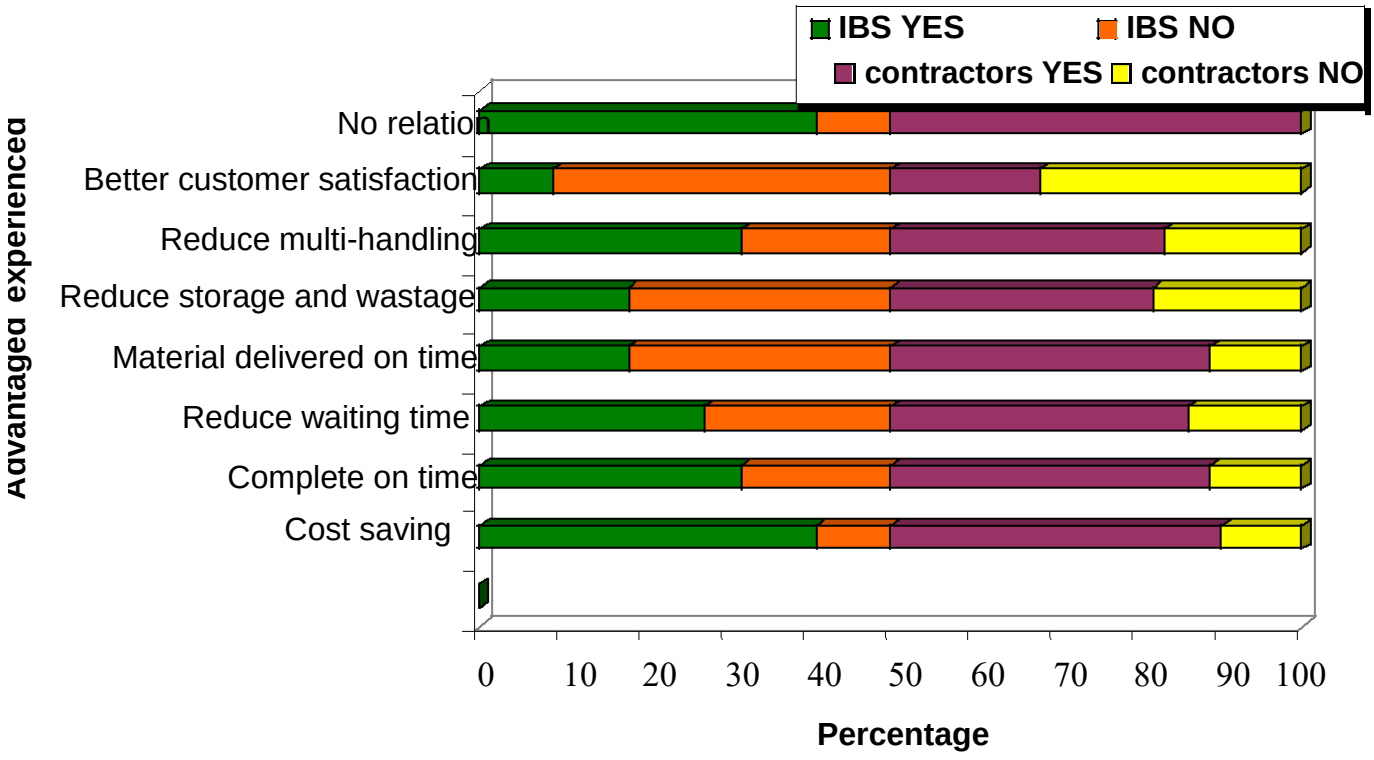

Figure 4. Advantages of logistics management implementation.

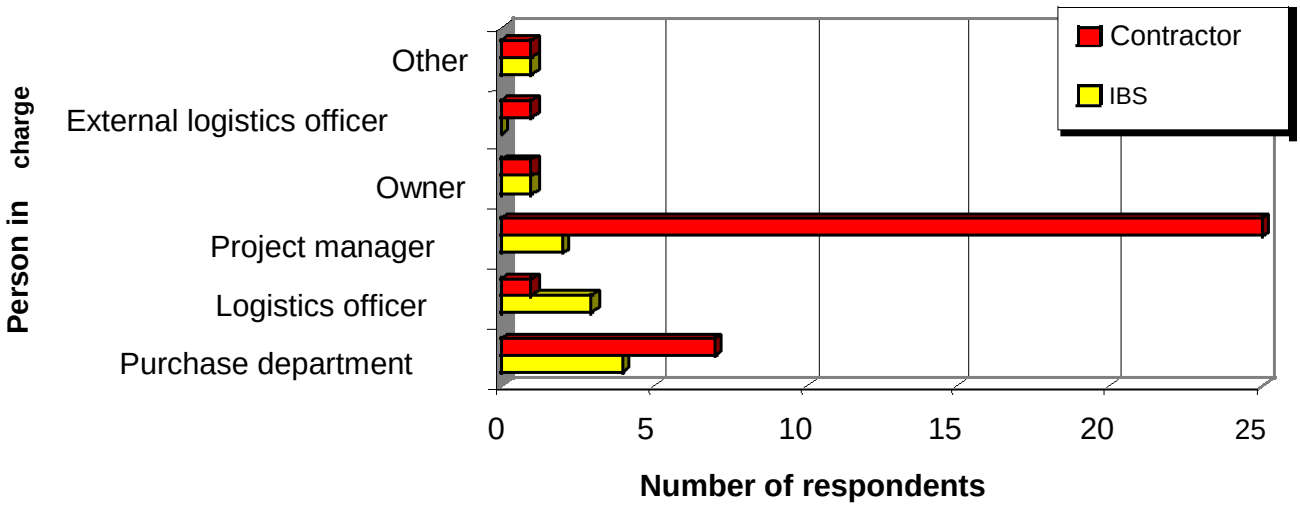

Figure 5. Person in charge for logistics decision.

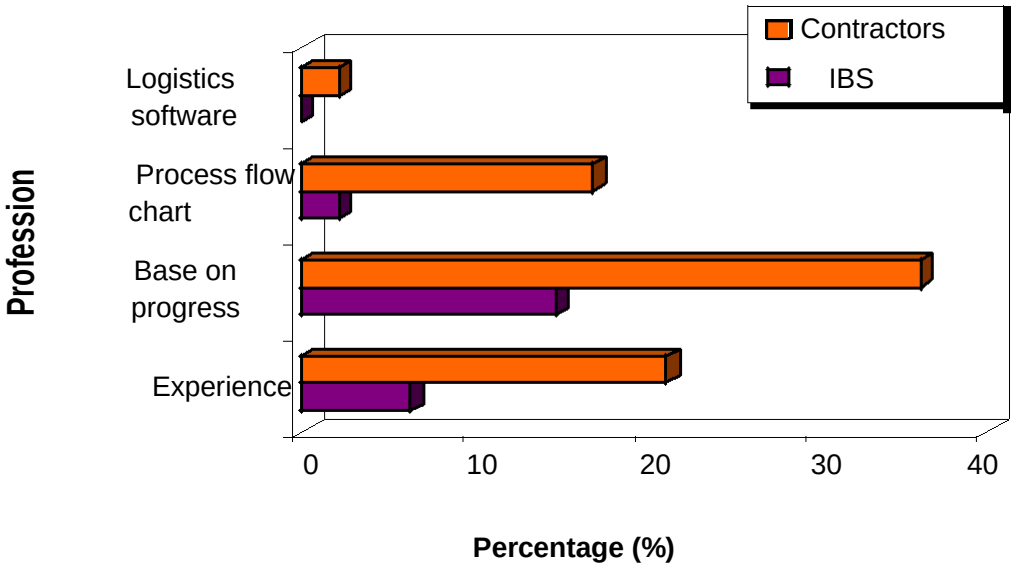

Figure 6. Methods to forecast material demand.

mean value of 3.33 and 3.70, respectively. The interviewees commented on this event that the client of project always expects to have a high quality product with the lowest cost. Therefore, the company will always choose cheaper materials on condition that the quality is assured.

Both IBS manufacturers and contractors think that offer from suppliers is the lowest priority when they have to purchase materials. This can be shown by the mean value of this factor given by IBS manufacturers of 4.78 and the contractors of 4.81. This result confirms that respondents will only purchase materials whenever there is a need. They will not stock the materials even though there is an offer from the supplier.

In addition, one sample T-test was used to identify the significant value of these factors. The results are illustrated in Table 2 and show that price and quality are the significant factors to be considered when purchasing materials. This is shown by the t-Value for price and quality of -7.535 and -4.731, respectively. Moreover, the significant value for both factors is 0.000. These values have fulfilled the requirement of test where the t-value must be of negative value and the significant value is below 0.05.

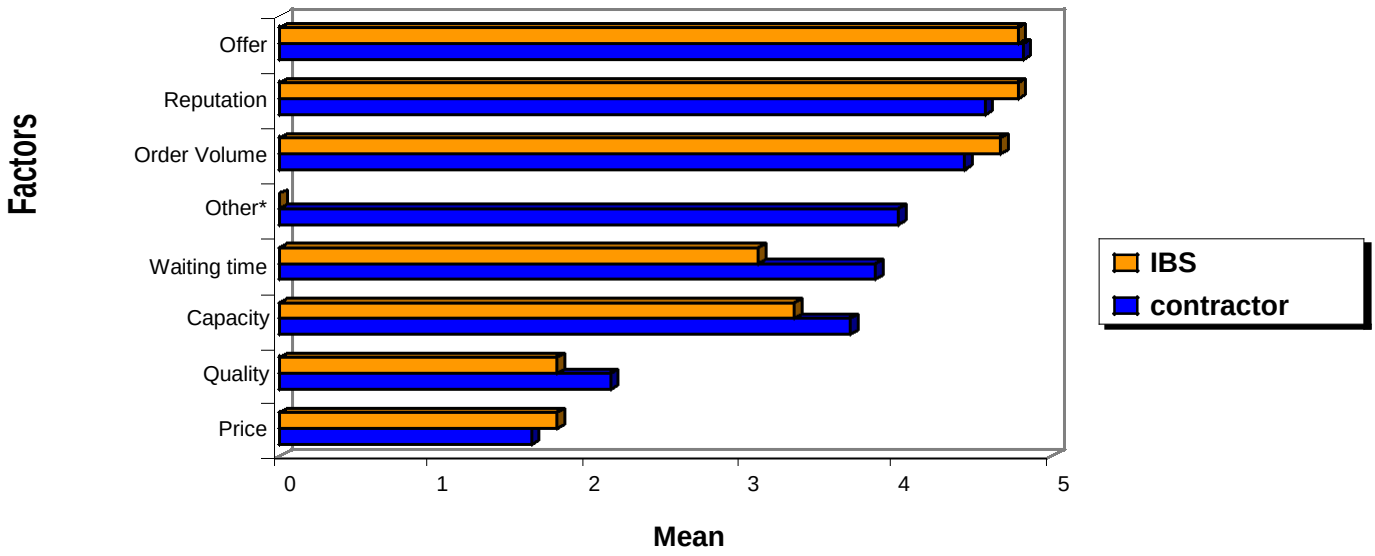

Figure 7. Factors to be considered when purchasing materials (contractors = distance of materials sources and availability for replacement and market information).

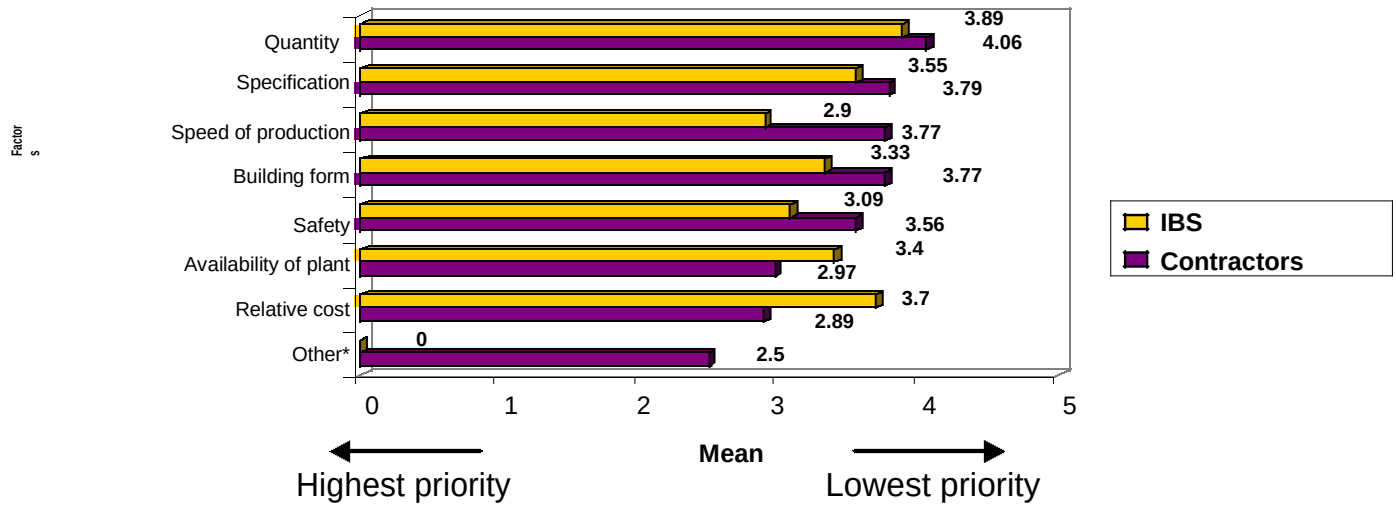

Figure 8. Factors to be considered when choosing material-handling equipments (contractors = brands and reputation, availability of replacement and back up service).

As shown in Figure 8, IBS manufacturers' considers that speed of production, safety, and building form as the three (3) highest priority factors to be considered when choosing material-handling equipments with the mean value of 2.90, 3.09, and 3.33, respectively. Meanwhile, from the point of view of contractors, relative cost has the highest priority when choosing material-handling equipments with the mean value of 2.89. Furthermore, availability of plants and safety are the second and third important factors to be considered when choosing material-handling equipments in which their mean values are 2.97 and 3.56, respectively. The reason for this, as commented by the interviewees, is that it is only normal to look at the relative cost which includes the initial cost (purchase) and the maintenance cost in monetary decision making.

These factors were tested for significant value and the results are shown in Table 3. All of the factors to be considered when choosing material-handling equipments provided by the researcher in the questionnaires are not

Table 2. Result of One Sample t-test for factors to be considered when purchasing materials.

Factors to be considered when purchasing material	Test value = 3			
	Mean	Std. deviation	t-Value	Sig. (2-tailed)
Price	1.67	1.194	-7.535	0.000
Quality	2.07	1.340	-4.731	0.000
Capacity	3.62	1.561	2.57	0.014
Waiting time	3.70	1.848	2.553	0.014
Order volume	4.49	1.748	5.449	0.000
Reputation	4.60	1.866	5.638	0.000
Offer	4.80	2.227	5.189	0.000

Table 3. Result of One Sample t-test for factors to be considered when choosing material-handling equipments.

Factors to be considered when choosing material handling equipment	Test value = 3			
	Mean	Std. deviation	t-Value	Sig. (2-tailed)
Availability	3.07	1.946	0.232	0.817
Relative cost	3.07	1.912	0.234	0.816
Safety	3.44	1.972	1.512	0.138
Speed of production	3.58	1.815	2.135	0.038
Building form	3.68	2.176	2.079	0.044
Specification	3.73	2.306	2.092	0.042
Quantity	4.02	1.911	3.551	0.001

significantly affected by the decision when choosing material-handling equipment. This is because these factors have either a positive value for t-value or a significant value of more than 0.05. This may be due to the small sample size or the low response rate.

From Figure 9, there are five (5) problems faced by majority of respondents, namely: non punctuality in material and components, inability in foreseeing activities period with accuracy, problems in production team's planning, delivery in accuracies, and increase waiting time between activities. However, both IBS manufac-turers and contractors do not face any problems due to large storage on site. Further, there are 15.60% of IBS manufacturers that face the problem of low quality materials and 16.38% of IBS manufactures face the problem of transportation during construction as well. However, both problems are not faced by the contractors. The reason for these problems is explained by interviewees during the in-depth interview. In summary, it is as the consequence of the poor site-logistics management due to lack of competence of the person-in-charge on site.

Figure 10 illustrates that majority of respondents agree that late payment is most likely to be the reason that causes materials delivery inaccuracy. This reason is ranked as the most often occurrence by IBS manufac-turers and contractors with mean values of 3.2 and 3.12, respectively. According to the interviewees, late payment will cause inaccurate delivery because the supplier is worried that they will not get any payment if they continue to supply the materials. Therefore, the supplier will not supply the materials until they get the payment.

On the other hand, uncommon materials and the failure of supplier due to transportation problems are the second and third main causes for delivery inaccuracies. The mean values for these two reasons for IBS manufacturers are 3.5 and 3.56, respectively and for contractors are 3.38 and 3.88, respectively.

Table 4 shows the result of One Sample t-test for the factors causing materials delivery inaccuracy. None of the reasons stated in the questionnaire are significant for materials delivery inaccuracy as the t-Value obtained is of positive values and the significant values are more than 0.05. This is probably due to the small test sample and low response rate.

Interview result

The interviews are summarized in Tables 6 and 7; the summary of the interview with contractors (Table 6), and the interview with IBS manufacturers (Table 7).

Conclusion

The research found that contractors and IBS manufac-turers are applying the pull concept in order to minimize stockpile in storage. This is because their decision makers forecast the materials demand according to the project's progress. Furthermore, these two (2)

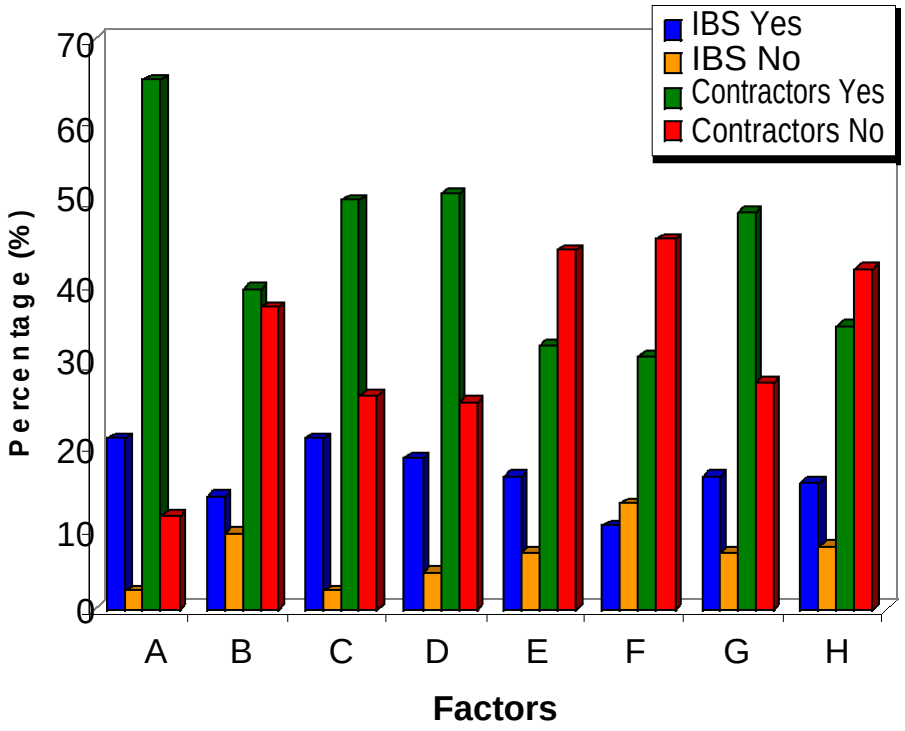

Figure 9. Symptom of logistics management problem. A, non punctuality in materials and components; B, inability in foreseeing activities period with accuracy; C, problem in production team planning; D, delivery inaccuracies; E, transportation; F, large storage on site; G, increase waiting time between activities; H, low quality material.

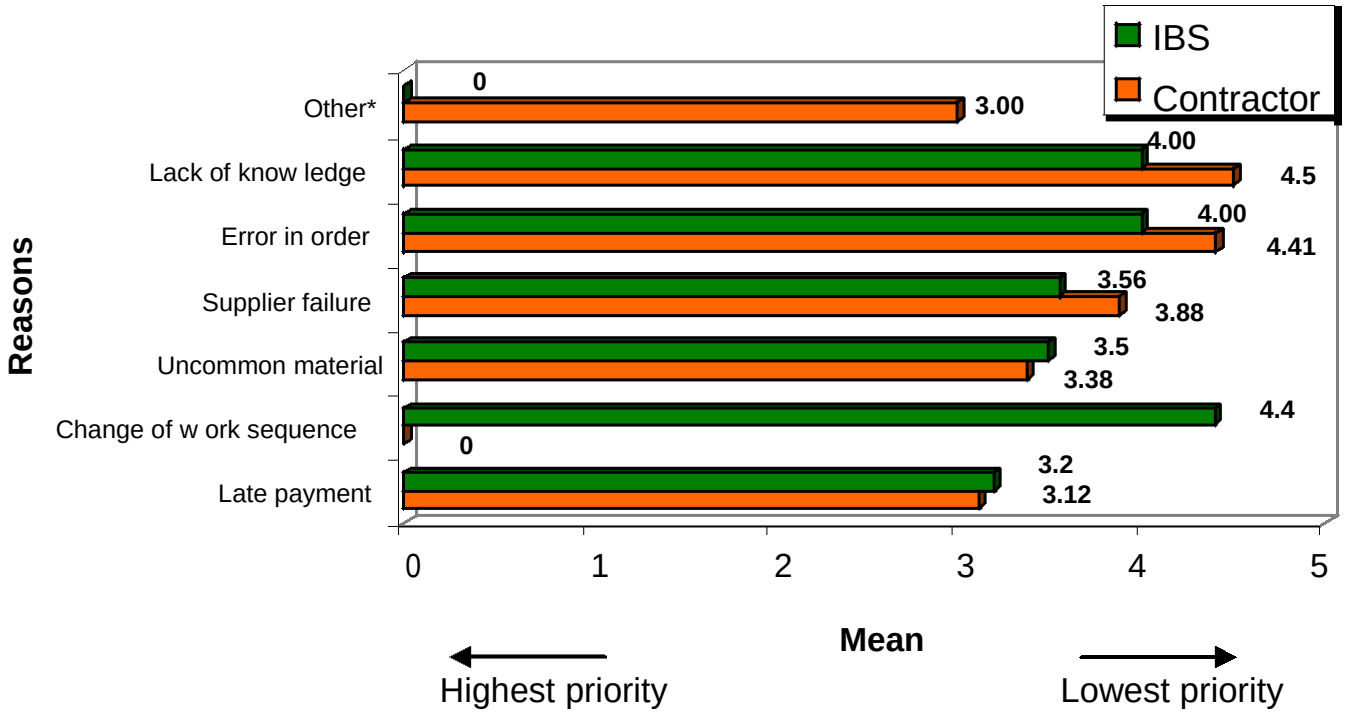

Figure 10. Reason of material delivery inaccuracy (contractors = add specifications).

Table 4. Result of One Sample t-test for reasons of materials delivery inaccuracy.

Reason for inaccuracy material delivery	Test value = 3			
	Mean	Std. deviation	t-Value	Sig. (2-tailed)
Late payment	3.14	1.912	0.473	0.639
Uncommon material	3.41	1.618	1.677	0.101
Change of work	3.48	1.772	1.787	0.081
Supplier	3.81	1.577	3.384	0.002
Error order	4.31	2.055	4.255	0.000
Lack of knowledge	4.40	1.531	5.946	0.000

Table 5. Result of One Sample t-test for tools to improve production efficiency.

Tools to improve production efficiency	Test value = 3			
	Mean	Std. deviation	t-value	Sig. (2-tailed)
Flow chart	2.84	1.829	-0.577	0.012
Cycle time	3.40	1.947	1.378	0.175
Site layout plan	3.57	1.834	2.091	0.042
Supply plan	3.59	2.082	1.912	0.062
Labour productivity	3.61	2.027	2.036	0.048
Checklist	3.76	1.932	2.623	0.012
Information system	4.57	2.117	4.913	0.000

Table 6. Interview content with respondents from contractor's background.

Question	Interview with contractors
Q1 - Why majority of respondents disagree with "better customer satisfaction" as an outcome of logistics management	i. It is very subjective, directly influenced by reputation and after sales services ii. Client emphasizes on output rather than the process iii. Not only about customer satisfaction but completing a project on time, reducing cost, and maintaining quality.
Q2 – Why price, quality, and capacity are the most important factors to be considered when purchasing materials?	**Quality** i. Quality must meet ISO 9000. ii. It is important to draw clients' confidence to return for service iii. Without quality, the cost for re-order is high and time consuming **Price** i. Lower price in order to have higher profit margin as they work for profit ii. It is the major factor in calculating the cost and the expected profit. Capacity i. Capacity of suppliers to fulfill the contractors' order ii. High capacity company will offer lower price and is able to handle emergency order
Q3 – Why cost, safety, and availability of plants, equipments, and labour are the most important factors in choosing material-handling equipments.	**Cost** i. To avoid plant with high spare part and maintenance cost in order to have higher profit margin

Table 6. Contd.

	Safety
	i. As the requirement from the local authority
	ii. It is paramount to prevent any mishap incidents
	iii. Safety to prevent accident which will lead to time and money loss
	Availability of plants, equipments, and labour
	i. Availability of service center in order to save cost and obtain immediate service
	ii. Level of skill possesses by operator that will give contribution to the productivity
Q4 - Reasons contributed to logistics management problems occurred among the contractors	i. Site supervisor with lack of competency for example, prepare project scheduling with no float time given between activities ii. Dishonesty of supplier in order to have sales iii. Late payment iv. Lack of lead time when placing order
Q5 – What are tools or skills that need to be furnished in order to optimize the production flow?	i. On-job training provided to the staffs and workers ii. Avoiding high staff turnover to prevent repetitive of "Learning Curve" iii.Observe new technologies in industry and provide training to staff

Table 7. Interview content with respondents from IBS manufacturer's background.

Question	Interview with IBS manufacturers
Q1 - Why majority of respondents disagree with "better customer satisfaction, materials delivered in time, and reduced materials wastage" as the outcomes of logistics management?	**Better customer satisfaction** i. Customer satisfaction is the resulting outcome from other advantages which depend on the performance of company Materials delivered in time i. Contractors made last minute order and there are other orders made by another person earlier Reduced materials wastage i. Materials are often exposed to risk of damage due to improper care on site
Q2 – Why price, quality, and capacity are the most important factors to be considered when purchasing materials?	**Quality** i. Must be ISO 9000 certified in order to maintain product standard Price i. To gain maximum profit margin Capacity i. Capacity of supplier to provide materials in emergency situation ii. Capacity to provide materials required in sufficient quantity to prevent the increase in waiting time between activities
Q3 – Why speed, safety, and building form and location are cost important factors in choosing material-handling equipments	**Speed** i. May increase productivity and enable project to complete on time or even earlier ii. Avoid increase of waiting time between activities Safety i. To avoid loss in term of cost, time, and human resources Building form and location

Table 7. Contd.

	i. Proper plant to suit the design of site in order to avoid materials damage
	ii. To provide optimum production
Q4 – Reasons contributed to the logistics management problems occurred among contractors	**Poor site management** i. Site supervisor unable to foresee materials demand and place a last minute order ii. Late payment resulting in stoppage of materials supply iii. Maximum load of transportation vehicles is not adequate to carry order in one delivery
Q5 – What are the tools or skills that need to be furnished in order to optimize the production flow?	**Building a good supplier-contractors relationship** i. More transportation vehicles to accommodate demand

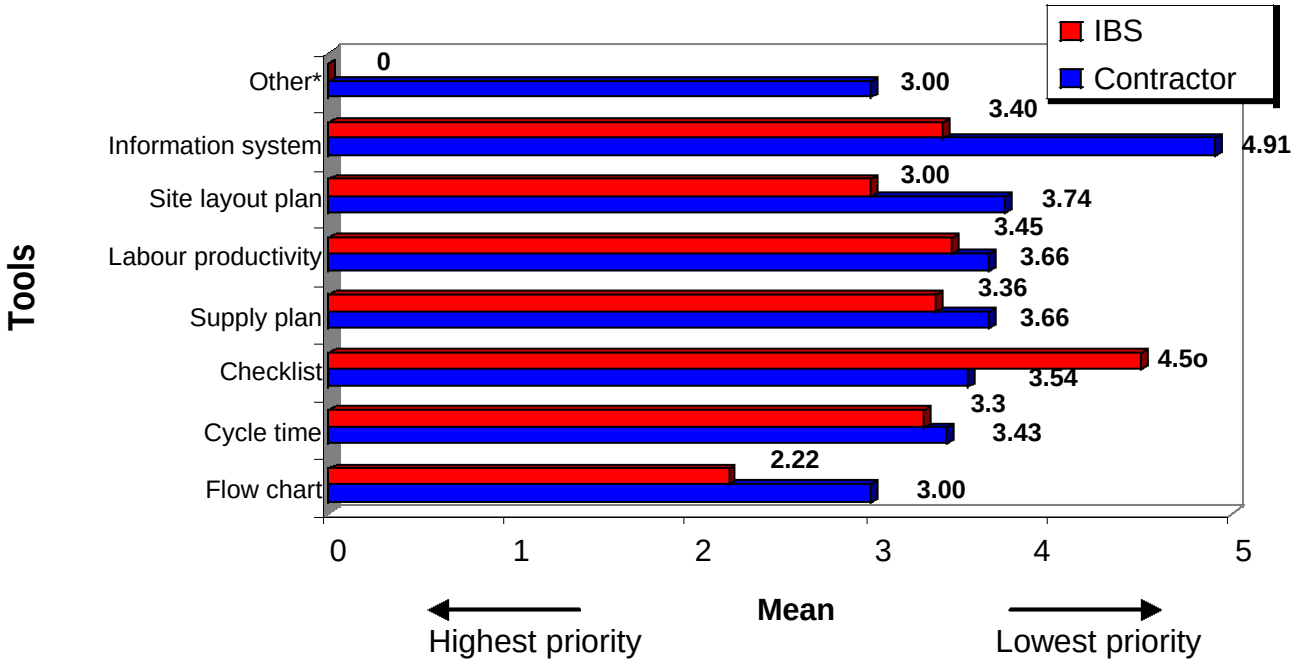

Figure 11. Tools to optimize production flow (contractors = inter-site communication, early confirmation or appointment of sub-contractors).

professions have different perspective in which the contractors tend to be more concerned with the profit margin while the IBS manufacturers are concerned with productivity when making a decision regarding the material-handling equipments.

Furthermore, problems due to poor logistics management are identified among contractors and IBS manufacturers, that is, non-punctuality in materials and components deliveries; inability to foresee period of activities with accuracy; problems in production team planning; delivery inaccuracies; and increase of waiting time between activities. Poor site management is due to the inexperience and incompetence of the person-in-charge on site and these are identified as the root causes of the above-mentioned problems. However, there is always space to improve production efficiency. Majority of respondents agree that flow chart, cycle time, checklist control on site may assist in optimizing production flow. Additionally, providing on-job training to the staffs in order to provide necessary knowledge to handle any situation

during work execution is also suggested.

RECOMMENDATIONS

From the data obtained from the questionnaires, IBS manufacturers' and contractors consider that flow chart is the most effective tool compared to others with mean value of 2.22 and 3.00, respectively as shown in Figure 11. On the other hand, the second and third most effective tools to optimize production flow ranked by IBS manufacturers are site layout planning and cycle time process, while contractors rank cycle time process and checklist for site control as the second and third most effective tools. During the interview session, majority of the interviewees commented that these tools are sufficient to address the logistics management problems that have been identified earlier.

Table 5 shows the significance of these tools in improving production efficiency by using One Sample t-test. Flow chart may become the significant tool to improve production efficiency. The t-Value for flow chart is -0.577 with significant value of 0.012, whereas the other tools that have failed in One Sample t-test can be assumed to be not significant in improving production efficiency from the respondents' point of view.

REFERENCES

Bertelsen S, Neilsen J (1997). Just-in-time logistics in the supply of building materials. International Conference on Construction Industry Development: Building the Future Together. [online]. 9-11December. Available from: http://www.bertelsen.org/strategisk_r%E5dgivning_aps/pdf/Just-In-Time%20Logistics%20in%20the%20Supply%20of%20Building%20Materials.pdf.

Hinton PR (2004). SPSS explained. Routledge.

Hines T (2004). Supply Chain Strategic. Elsevier Butterworth-Heinemann.

Industry Canada (2008). Industry Productivity and Competitiveness via Logistics and SCM. State of Logistics. [online]. 19(16). Available from: http://www.ic.gc.ca/epic/site/dsib-logi.nsf/en/pj00222e.html

Vrijhoef R, Koskela L (1999). Roles of supply chain management in construction. IGLC, (International Group Lean Construction) 7th Logistics and supply chain management. 26-28 July, California, USA.

Vrijhoef R, Koskela L (2000). The four roles of supply chain management in construction. Eur. J. Purch. Supply. Manag., 6(3-4): 169-178.

Lewis-Beck MS (1995). Data analysis: an introduction. Sage.

McNabb DE (2004). Research Methods for Political Science: Quantitative and Qualitative. New York - M.E.Sharpe.

Morgan GA (2004). SPSS for introductory statistics: use and interpretation. Lawrence Erlbaum Associates.

Proverbs DG, Holt GD and Love PED (1999). Logistics of materials handling methods in high rise in-situ construction. Int. J. Phys. Distribution. Logist. Manag., 29(10): 659-675.

Rao K, Stenger AJ, Wu HJ (1998). Integrating the use of computer in logistics education. Int. J. Phys. Distrib. Logist. Manag., 28(4): 302 – 319.

Rushton A, Oxley J, Croucher P (2000). The handbook of logistics and distribution management. Kogan Page..

Silva FBD, Cardoso FF (1999). Applicability of logistics management in lean construction: a case study approach in Brazilian building companies. IGLC, (International Group Lean Construction) 7th Logistics and supply chain management. 26-28 July, California, USA.

Smith TA (1977). Dynamic business strategy: the art of planning for success. Tata McGraw-Hill.

Sobotka A, Czarnigowska A, Stefaniak K (2005). Logistics of construction projects. Foundation of Civil and Environmental Engineering. [online]. Available from:http://www.ikb.poznan.pl/fcee/2005.06/full/fcee_2005-06_203-216_logistics_of_ construction.pdf

Vidalakis C, Tookey JE (2006). Conceptual functions of a simulation model for construction logistics. Joint International Conference on Computing and Decision Making in Civil and Building Engineering. June 14-16, pp. 88-104.