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Validating Site Selection Criteria for Precast Manufacturing Plant in Malaysia

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ABSTRACT

The Malaysian Government has endorsed the usage of Industrialised Building System (IBS) in domestic projects none of the studies have contributed to the location decision for precast manufacturing plant which required proper location to improve the local economic activity development. The study in this research determines the precast manufacturing plant site selection criteria from literature review. The 15 site selection criteria 47 attributes were validated by conducting a workshop where the participants were from academicians, manufacturers, policy makers contractors. Statistical tests for coefficient of reliability, Cronbach's alpha shows 0.877 acceptance level. The criteria attributes were rank based on the respondents. The new preference ranking criteria by the respondents are costs, economy markets, infrastructure, transportation optimum distance, capacity, 1 sites, labour, resources utilization, safety, work suitability, competition, inter-industry linkage, environmental risk, population political criteria.

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INTRODUCTION

The trend of the construction industry has moved from wet trades to the manufacturing floor as well as transforms the productivity from project based to product based. The current system consists of precast component systems, formworks systems, steel framing systems, prefabricated timber framing systems, block work systems innovative systems (CIDB, 2010). Industrialized building system (IBS) in Malaysia is defined as a construction system where components are manufactured at factories on or off site, transported then assembled into a structure with minimum work (CIDB, 2003). IBS is also known as off-site construction or prefabrication. Azman *et al.* (2010) reported that the term IBS have similarity with the US, UK Australia. The government researchers have promoted the IBS to break the 'traditional technology' as well as to educate the construction industry (Majid *et al.*, 2011).

Although, the development of the precast manufacturing plant is exping based on the dem the contract value based on the project but there are some cases of failure in continuity of the IBS production shutdown of the factory. There are two cases of precast manufacturing plants closed in United Kingdom Malaysia (Kamar, 2011, BBC, 2010). In 2003, Living Solutions (IBS manufacturing) was owned by Tata the company has supplied buildings for an upgrade of the Ministry of Defence garrisons at Aldershot around Salisbury Plain as part of a six-year £92m contract. In 2010, the weak building industry "the continuing weak construction market" ended Living Solutions long-term supply contract to supply accommodation for the defence industry. Tata made a decision to close down the factory concentrate on core business, where since then had never been profitable.

A similar situation occurred in Malaysia. From 1981 until 1991, Praton Haus's built operated a very modern precast manufacturing plant at Shah Alam using belt conveyor semi-automatic precast production. The overall investment was worth about RM 12.0 million (£3 million) which was considered a relatively huge upfront investment at that time. The company struggled to deal with the operation of the factory which needs high investment in terms of maintenance factory equipment. The board of management has made the same decision as Tata to close the factory sold it to a local company due to the unstable dem at that time small market volume in Malaysia. Both high-tech precast manufacturing plant is operated based on project failed to operate due to the low dem high maintenance.

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Hence, the modern IBS technology could not operate due to high operation cost a feasibility study is vital to underst the role of government in developing the precast manufacturing plant market as well as allocating potential site for precast manufacturing plant to ensure the continuous production dem(Azman *et al.*, 2012). Notwithsting, the choice of location decision process via Multi Criteria Evaluation (MCE) is vital to underst the site selection criteria by comparing the level of importance in defining the final decision measurement. Similarly, MCE is an expression for the reflection of many inputs or influence in the derivation of an output, which is used in analyzing the trade-offs between choice alternatives with different impacts (Carver, 1991). In addition, the term is frequently applied to the decision making process the output results or overall choice are based on the combination of varies criteria. Besides, an understing of the location decision process may improve a local economic activity development generate the sustainable business environment (Badri, 2007).

Most of the studies in site selection criteria is focussed on ware-house (Tabari *et al.*, 2008), hotel (Chou *et al.*, 2008), Ifill (Şener *et al.*, 2010), supplier selection (Chou Chang, 2009), hospital (Vahidnia *et al.*, 2009), facility location (Shen Yu, 2009), eco-industrial park (Fernández Ruiz, 2009), resort park (Lin Juan, 2009) municipal solid waste (Ekmekçioğlu *et al.*, 2010). None of the study has covered the site selection criteria for precast manufacturing plant except for the slight similar case study in United States where Shen (2005) has proposed that the manufactured housing (MH) should be built up near to centre of city by using zoning approach agreed that policy plays an important role in driving the development of construction industry.

However, the scope of this research did not involve MCE analysis. Only the term multiple criteria are used to define the sets of criteria for precast manufacturing plant site selection purposes. The initial stage of the work statistically identifies the significance of the multiple criteria proposed for precast manufacturing plant site. Moreover, there are no universal techniques available for selecting a set of evaluation criteria but the set of evaluation criteria can be obtained through an investigation of the relevant literature, analysis study opinions (Keeney Raiffa 1976). The statistical method is preferred in evaluating the criteria the questionnaire survey will balance the approach provides a reasonable mechanism for selecting the set of criteria. Therefore, an appropriate study is required to review validate the multiple criteria through decision makers directly involved in IBS.

Methodology:

In order to validate the criteria of setting up new IBS manufacturing site; a workshop was conducted with 42 participants consist of manufacturing players, academician, contractors government agencies as shown in Figure 1. The participants were allocated in the form of eight groups for discussions the number of member in each group varied from 5-6 people. The focus group workshop was conducted at the Gr Season Hotel, Kuala Lumpur, Malaysia from 8.00 am until 5.00 pm, with a varied combination of group work, plenary feedback, questionnaires discussions. All the groups are mixed together to ensure that all the groups have the four different types of background involved in the focus group discussion.



Fig. 1: Number of Focus Group Correspondents.

The questionnaires were based on the preliminary study had improved based on the literature review. To enhance the research results, to further extent the research, the quantitative approach was used to cover a wider range of data scope but with a shallow depth. This research used the three-point Likert scales. Flynn *et al.* (1990) indicated that interval measures may be added or subtracted at points where it is compatible with various statistics. All the sampling groups had been romly choose with the appropriate background expert on IBS. The respondents were also are required to rank the criteria attributes as well as suggest new attributes to be added under the theme of criteria.

The focus group workshop which is part of the qualitative method; the most appropriate effective way of obtaining information, insight, experience knowledge of a large group of industry players in the shortest period of time, collect data from respondents simultaneously (Wilkison Birmingham, 2003, Azman *et al.*, 2010). Focus group is a form of group interview that exploits on communication between respondents, asking questions, exchanging anecdotes commenting on each other's experiences point of view in order to generate

data. This method is particularly to explore the respondent's knowledge experiences as well as can be used to examine not only what people think but how they think why they think that way (Kitzinger, 1995).

The input of focus group, during the data analysis stage, qualitative data can play an important role by interpreting, clarifying, describing, validating quantitative results for the site selection criteria precast manufacturing plant, as well as through grounding modifying. The focus group session was divided into two; starting with the overview important issues of precast manufacturing plant on the aspect of setting up site selection criteria. The second session discussed on the site selection precast manufacturing. Every focus group discussion will have the tape recorder supported by the note taker.

The work shop began with an initial introduction, with a short presentation on 'Spatial Statistical Study on the Appropriateness of IBS Towards Establishing the Locational Attributes for New Precast Manufacturing Plant' for 30 minutes. There were two open discussion session guided by the h-out where the participants are required to rank the criteria link the information between criteria attribute. The main points of discussion were recorded by notes digital audio. The workshop was facilitated by the researcher. Professor Ir. Dr. Zuhairi who was the Executive Director of CREAM was also present in the workshop guided the researcher throughout the workshop in terms of research methodology.

RESULTS AND DISCUSSION

As a further support to the study, all the data obtained from the 42 respondents had been tested by α - Cronbach reliability test the mean value is 0.877 which is generated by using Statistical Package for Social Sciences (SPSS) software. This value is significantly high, demonstrating that the data can be used to analyse the importance of the relevant criteria. As a rule of thumb, if $\alpha \geq 0.8$ then the common variance will cover more than 64% of the same ground the error is less than one-third (Oppenheim, 1992).

Mean Ratings:

The mean rating analysis for site selection criteria (SSC) was done by sorting ranking the views of 42 correspondents as in Table 1. The top three criteria on the list are costs, market access infrastructure. Costs are the major concern in the global industry as the return profits will change based on the number of projects from government private sector. The setting up of an IBS manufacturing plant requires a strong financial planning to ensure that it will have a good cash flow where it will be able to involve in many IBS projects simultaneously in order to have good payback periods. The high dem of IBS is able to sustain the business for the long term period received good profits.

Thus, in Table 1, market access ranks as second an importance. The market access criteria is focussed on supply dem issues of product to consumers or provision of services for long term expansion of construction projects. Notwithsting, the infrastructure criterion is rank in the third order of importance as shown in Table 1. The higher service facilities of infrastructure will enhance the production of goods services as well as increase the accessibility.

While the other three criteria being environment risk, population, political regulation falls in the bottom rank of Table 1. The environment risk is rank less of importance due to non-profit investment to the industry. The population criterion refers to demographic data as well as collection of gross domestic product (GDP) per capita in a potential region for future development, is also rank as less of importance. This is due to the stable growth population in Malaysia. Political regulation criteria is ranked last as it is seem not vital as the government involvement is in the early stage of project at the final stage of h-over of the project. These analysis will inherent the new rank of site selection criteria that have been validated by the decision makers.

Analysis of Attributes:

In addition, the rank order of the criteria is actually depended on the attributes descriptions which cover the particular decision problem. The responsibility of the survey is that it will be able to balance the approach between the set of evaluation criteria provides a reasonable mechanism for selecting the set of attributes. Conversely, each attribute must be comprehensive measurable, reflects in operational (meaningful in analysis) decomposable characteristic that is able to be broken into parts to simplify the process. On the other h, the attribute should not be redundant in the counting analysis the best size of attributes is to keep as minimal as possible (Malczewski, 1999). Through the analysis process of attributes, there are some of the attributes which is dropped due to the overlapping attributes. The final version of the process attributes is shown in Table 2.

The descriptions of attributes have made some changes to eight criteria including costs (SSC-1), infrastructures (SSC-3), transportation optimum distance (SSC-4), labour (SSC-7), resource utilisation (SSC-8), safety (SSC-9), environment risk population (SSC-13) while the other criteria remained unchanged. There are three criteria involving elimination of attributes due to the redundant process; costs (SSC-1), transportation optimum distance (SSC-4), population (SSC-14). Among the attributes have been trade-off from costs criteria

are; the initial capital cheap manpower while initial capital minimum initial capital is redundant so both is eliminated.

On the other h, transportation optimum distance attributes that are involved with reduction are optimum coverage distance travel near to the potential development area where both attributes is also overlapping with others attributes. The optimum coverage distance travel is similar to maximum coverage to access to construction sites. Equally occurred is the attribute of 'near to the potential development area', where the attribute is under the same category for l sites population criteria.

Table 1: Mean Ranking.

Rank	Criteria	Attribute	Rank
1	Costs	C1: Minimum transportation cost	3
		C2: Cheap l	8
		C3: Minimum initial capital	6
		C4: Cheap raw material (cement, s, steel)	7
		C5: Lowest operational costs	5
		C6: Cheap manpower	4
		C7: Low tax	1
		C8: Initial capital	2
4	Transportation Optimum Distance	T1: Maximum coverage to access to construction sites	3
		T2: Minimum distance travel to construction sites	6
		T3: Good access federal roads to the construction sites	4
		T4: Good access highway roads to the construction sites	1
		T5: Good access roads to the construction sites	7
		T6: Near to the potential development area	2
		T7: Optimum coverage distance travel	5
6	L Sites	L1: Relatively the potential prefab manufacturing have many alternative transportation access to the construction sites	2
		L2: Near to development areas	1
8	Resource Utilization	R1: Close to raw materials	2
		R2: Ready supply of abundant quantities	1
3	Infrastructure	I1: Benefits from the industrial estate	5
		I2: Benefits from the free-trade zones	4
		I3: Availability of power water	6
		I4: Proximity to airport	1
		I5: Proximity to railways	3
		I6: Proximity to sea port	2
2	Market Access	M1: Central to major markets of new development area	1
		M2: Area of high purchasing dem	2
7	Labor	L1: Availability of labor	3
		L2: Quality manpower	1
		L3: Required skilled worker	2
12	Inter-industry Linkage	I1: Forward industrial linkage with other firms in Malaysia	1
13	Environment Risk	E1: Nature habitat is protected	1
		E2: Convenience place of hling construction waste	2
11	Competition	C1: Number of competitor	1
		C2: Intensity of competition	2
10	Work Suitability	W1: Attractive to environment	1
		W2: Ideal location	4
		W3: Social facilities for workers	2
		W4: Good public transport for workers	3
14	Population	P1: Suitability to the nearest residential	3
		P2: Nearest to the development area	2
		P3: Near an urban centre	1
5	Capacity	C1: Site capacity	1
		C2: Volume product capacity	2
15	Political	P1: Proximity to the Ministry offices for quick execution	1
9	Safety	S1: Near with police station	2
		S2: Design safety property is important	1

In contrast, the criteria employed in additional attributes are costs, infrastructures, labour, resource utilisation, safety environment risk which provide an extra filtering mechanism for interrogations. The extra attribute for costs criteria is cheap rental l where not all the manufacturers can afford to purchase the l. According to Haila(1988), rental approach especially for urbanisation process will be able to transform the economic drive. Hence, it offered an innovative way out to a more systematically developed integrated view on structure agency in the context of urban l contribute to the expansion of the business of the manufacturing industry (Jäger, 2003).

As for the infrastructures criteria, the telecommunication phrase in the 'availability of power water' is added where this factor is important to ensure the enhancement of economic activity by exploring the spread of

the business networking (Hargittai, 1999). As an example, the internet created new economic activities jobs as well allow for potential improvements in international business networking.

The improvement has been made for the labour criteria by including the detailed type of preferences labour; local foreign. This is to measure the improvement of IBS in order to reduce the number of foreign workers in construction industry IBS manufacturing plant. Moreover, the government will establish new policy to reduce 50% of the current 320,000 foreign workers registered with sectors CIDB has been allocated RM100 million to train skilled workers in IBS (BERNAMA, 2009).

Apart of the decision maker recommendation, the 'close to raw materials' have been extended into three major resources for precast manufacturing plant; cement, s steel. The availability of resources close to precast manufacturing plant can reduced the number of raw materials for stocked up purposes in order to utilise space consumed in the manufacturing plant. Instead, the supplier can deliver the raw materials in the right quantities, in the right condition, to the right place at the right time for production according to Just-In-Time (JIT) philosophy (Pheng Chuan, 2001).

Table 2: Modification of Attributes.

Attributes		Modification
CS1: Low tax CS2: Initial capital CS3: Minimum transportation cost CS4: Cheap manpower CS5: Lowest operational costs CS6: Minimum initial capital CS7: Cheap raw material CS8: Cheap l	SSC-1	CS1:Low tax CS2: Minimum transportation cost CS3: Lowest operational costs CS4: Cheap raw material CS5: Cheap l CS6: Cheap rental l (Add)
MA1: Central to major markets of new development area MA2: Area of high purchasing dem	SSC-2	Unchanged
IN1: Proximity to airport IN2: Proximity to sea port IN3: Proximity to railways IN4: Benefits from the free-trade zones IN5: Benefits from the industrial estate IN6: Availability of power water	SSC-3	IN1, IN2,IN3,IN4,IN5 IN6: Availability of communication, power water (Add)
TD1: Good access highway roads to the construction sites TD2: Minimum distance travel to construction sites TD3: Maximum coverage to access to construction sites TD4: Good access federal roads to the construction sites TD5: Optimum coverage distance travel TD6: Near to the potential development area TD7: Good access roads to the construction sites	SSC-4	TD1: Good access highway roads to the construction sites TD2: Minimum distance travel to construction sites TD3: Maximum coverage to access to construction sites TD4: Good access federal roads to the construction sites TD5: Good access roads to the construction sites
CA1: Site capacity CA2: Volume product capacity	SSC-5	Unchanged
LS1: Near to development areas LS2: Relatively the potential prefab manufacturing have many alternative transportation access to the construction sites	SSC-6	Unchanged
LB1: Quality manpower LB2: Required skilled worker LB3: Availability of labour	SSC-7	LB1,LB2,LB3 LB4: Most preferable local worker LB5: Most preferable foreign
RU1: Ready supply of abundant quantities RU2: Close to raw materials	SSC-8	RU1: Ready supply of abundant quantities RU2: Close to cement suppliers RU3: Close to s suppliers RU4: Close to steel suppliers
SF1: Design safety property is important SF2: Near with police station	SSC-9	SF1: Design safety property is important SF2: Near to police station SF3: Near to hospital SF4: Near to fire station
WS1: Attractive to environment WS2: Social facilities for workers WS3: Good public transport for workers WS4: Ideal location	SSC-10	Unchanged
CM1: Number of competitor CM2: Intensity of competition	SSC-11	Unchanged
IL1: Forward industrial linkage with other firms in Malaysia	SSC-12	Unchanged
ER1: Nature habitat is protected ER2: Convenience place of hling construction waste ER3: Close to recycling facilities	SSC-13	ER1: Nature habitat is protected ER2: Convenience place of hling construction waste ER3: Close to recycling facilities
PP1: Near an urban centre PP2: Nearest to the development area	SSC-14	PP1: Near an urban centre PP2: Suitability to the nearest residential

PP3: Suitability to the nearest residential		
PR1: Proximity to the Ministry Offices for quick execution	SSC-15	Unchanged

In essence, a safety criteria is crucial for protecting the property workers. Consequently, the 'near to hospital fire station' need to be included in the attributes increase the level of security protection enhancement. Therefore the location played an important roles to overcome this circumstance if an incident occurred also as a basic step of precaution to reduce the major risk. For an instance, if the precast manufacturing plant is on fire; an appropriate selection of location will be able to reduce the total damage of the plant. Besides, improving the safety at work establishing the paradigm of safety culture may improve the safety health level, in line with the requirements of the construction industry in total (Misnan Mohammed, 2007).

The last part of the environment risk criteria required to add the 'close to recycling facilities' attribute to contribute to the sustainable value added to protect the environment. Existing publications have discussed many different waste minimisation options or practice but Begum *et al* (2007) have studied the 12 waste minimisation factors (WMF) in implementing construction waste management in the Malaysia construction industry the respondents are from contractors (G1-G7) who are registered with Construction Industry Development Board (CIDB). Among the factors involved is 'facilities reusing or recycling for sorting different types of waste (WMF-7)' which has been rank 6th of the level of practice hence this attribute is required to be included in the final version of the questionnaire.

A workshop was conducted in order to validate improve the final version of site selection criteria attributes for precast manufacturing plant. The mean ranking for attribute is also rank by each theme of the criteria some of the attributes were eliminated while new attributes were included. Thus, the focus group approach has contributed to the validation process strengthened the final version of the site selection criteria.

Conclusion:

This paper presents a snapshot of four groups of respondents to the main criteria for the selection of new precast manufacturing plant site. A workshop was conducted in order to validate the criteria of setting up a new precast manufacturing plant site the analysis were based on the outcome of the workshop, validated by the respondents. There are significant difference in the results of ranking the criteria attributes. The research process approach has contributed to the methodology of the research in validating the criteria.

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