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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 and 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, land sites, labour, resources utilization, safety, work suitability, competition, inter-industry linkage, environmental risk, population and 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 and 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 and 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 and 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 expanding based on the demand 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 and operated a very modern precast manufacturing plant at Shah Alam using belt conveyor and 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 and 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 demand at that time and small market volume in Malaysia. Both high-tech precast manufacturing plant is operated based on project and failed to operate due to the low demand and high maintenance.

Hence, the modern IBS technology could not operate due to high operation cost and a feasibility study is vital to understand the role of government in developing the precast manufacturing plant market as well as

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allocating potential site for precast manufacturing plant to ensure the continuous production demand (Azman *et al.*, 2012). Notwithstanding, the choice of location decision process via Multi Criteria Evaluation (MCE) is vital to understand 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 and the output results or overall choice are based on the combination of varies criteria. Besides, an understanding of the location decision process may improve a local economic activity development and 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), landfill (Şener *et al.*, 2010), supplier selection (Chou and Chang, 2009), hospital (Vahidnia *et al.*, 2009), facility location (Shen and Yu, 2009), eco-industrial park (Fernández and Ruiz, 2009), resort park (Lin and Juan, 2009) and municipal solid waste (Ekmekçioglu *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 and opinions (Keeney Raiffa 1976). The statistical method is preferred in evaluating the criteria and the questionnaire survey will balance the approach and provides a reasonable mechanism for selecting the set of criteria. Therefore, an appropriate study is required to review and 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 and 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 Grand Season Hotel, Kuala Lumpur, Malaysia from 8.00 am until 5.00 pm, with a varied combination of group work, plenary feedback, questionnaires and 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 and had improved based on the literature review (Azman *et al.*, 2013). To enhance the research results, and 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 randomly choose with the appropriate background expert on IBS. The respondents were also are required to rank the criteria and 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 and effective way of obtaining information, insight, experience and knowledge of a large group of industry players in the shortest period of time, and collect data from respondents simultaneously (Wilkison and Birmingham, 2003, Azman *et al.*, 2010). Focus group is a form of group interview that exploits on communication between respondents, asking questions, exchanging anecdotes and commenting on each other's experiences and point of view in order to generate data. This method is particularly to explore the respondent's knowledge and experiences as well as can be used to examine not only what people think but how they think and 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, and validating quantitative results for the site selection criteria precast manufacturing plant, as well as through grounding and 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 and site selection criteria. The second session discussed on the site selection precast manufacturing. Every focus group discussion will have the tape recorder and supported by the note taker.

The workshop 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 and guided by the hand-out where the participants are required to rank the criteria and link the information between criteria and attribute. The main points of discussion were recorded by notes and 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 and 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  $\alpha$  - Cronbachreliability test and 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 and the error is less than one-third (Oppenheim, 1992).

### *Mean Ratings:*

The mean rating analysis for site selection criteria (SSC) was done by sorting and ranking the views of 42 correspondents as in Table 1. The top three criteria on the list are costs, market access and infrastructure. Costs are the major concern in the global industry as the return profits will change based on the number of projects from government and 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 demand of IBS is able to sustain the business for the long term period and received good profits.

Thus, in Table 1, market access ranks as second an importance. The market access criteria is focussed on supply and demand issues of product to consumers or provision of services for long term expansion of construction projects. Notwithstanding, 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 andservices as well as increase the accessibility.

While the other three criteria being environment risk, population, and political and 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 and at the final stage of hand-over of the project. These analysis will inherent the new rank of site selection criteria and 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 and provides a reasonable mechanism for selecting the set of attributes. Conversely, each attribute must be comprehensive andmeasurable, reflects in operational (meaningful in analysis) decomposable characteristic that is able to be broken into parts to simplify the process. On the other hand, 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 and optimum distance (SSC-4), labour (SSC-7), resource and utilisation (SSC-8), safety (SSC-9), environment risk and 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 and optimum distance (SSC-4), and population (SSC-14). Among the attributes have been trade-off from costs criteria are; the initial capital and cheap manpower while initial capital and minimum initial capital is redundant so both is eliminated.

On the other hand, transportation and optimum distance attributes that are involved with reduction are optimum coverage distance travel and 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 and 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 landsites and population criteria.

**Table 1:** Mean Ranking.

Rank	Criteria	Attribute	Rank
1	Costs	C1: Minimum transportation cost	3
		C2: Cheap land	8
		C3: Minimum initial capital	6
		C4: Cheap raw material (cement, sand, 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	Land 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 and 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 demand	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 handling 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 and environment risk which provide an extra filtering mechanism for interrogations. The extra attribute for costs criteria is cheap rental land where not all the manufacturers can afford to purchase the land. 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 land 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 and 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 and 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 and foreign. This is to measure the improvement of IBS in order to reduce the number of foreign workers in construction industry and 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, sand and 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 and at the right time for production according to Just-In-Time (JIT) philosophy (Pheng and 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 land	SSC-1	CS1:Low tax CS2: Minimum transportation cost CS3: Lowest operational costs CS4: Cheap raw material CS5: Cheap land CS6: Cheap rental land (Add)
MA1: Central to major markets of new development area MA2: Area of high purchasing demand	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 and water	SSC-3	IN1, IN2,IN3,IN4,IN5 IN6: Availability of communication, power and 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 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 sand 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	SSC-13	ER1: Nature habitat is protected ER2: Convenience place of handling construction waste ER3: Close to recycling facilities
PP1: Near an urban centre PP2: Nearest to the development area PP3: Suitability to the nearest residential	SSC-14	PP1: Near an urban centre PP2: 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 and workers. Consequently, the 'near to hospital and fire station' need to be included in the attributes and increase the level of security protection enhancement. Therefore the location played important roles to overcome this circumstance if an incident occurred and 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 and establishing the paradigm of safety culture may improve the safety and health level, in line with the requirements of the construction industry in total (Misnan and 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 and 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 and 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 and improve the final version of site selection criteria and attributes for precast manufacturing plant. The mean ranking for attribute is also rank by each theme of the criteria and some of the attributes were eliminated while new attributes were included. Thus, the focus group approach has contributed to the validation process and 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 and the analysis were based on the outcome of the workshop, and validated by the respondents. There are significant difference in the results of ranking the criteria and attributes. The research process approach has contributed to the methodology of the research in validating the criteria.

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### **REFERENCES**

- Azman, M.N.A., M.S.S. Ahamad, T.A. Majid, & M.H. Hanafi, 2010. The common approach in off-site construction industry. *Australian Journal of Basic and Applied Sciences*, 4: 4478-4482.
- Azman, M.N.A., M.S.S. Ahamad, T.A. Majid, & M.H. Hanafi, 2012. A qualitative study of precast plants in Malaysia. *Indian Concrete Journal*, 86: 47-58.
- Azman, M.N.A., M.S.S. Ahamad, T.A. Majid, A.S. Yahaya, & M.H. Hanafi, 2013. Statistical evaluation of pre-selection criteria for industrialized building system (IBS). *Journal of Civil Engineering and Management*, 19: S131-S140.
- Badri, M.A., 2007. Dimension of Industrial Location Factors: Review and Exploration. *Journal of Business and Public Affairs*, 1: 1-26.
- Bbc, 2010. Tata Steel Cuts 180 Jobs as Shotton Building Arm Closes. *BBC News North East Wales*.
- Begum, R.A., C. Siwar, J.J. Pereira, & A.H. Jaafar, 2007. Implementation of waste management and minimisation in the construction industry of Malaysia. *Resources, Conservation and Recycling*, 51: 190-202.
- Bernama, 2009. Shift to IBS Technology, Abdullah Urges Contractors. 19 March 2009.
- Carver, S.J., 1991. Integrating multi-criteria evaluation with geographical information systems. *International Journal of Geographical Information Systems*, 5: 321-339.
- Chou, C.-C. & P.-C. Chang, 2009. A Fuzzy Multiple Criteria Decision Making Model for Selecting the Distribution Center Location in China: A Taiwanese Manufacturer's Perspective Human Interface and the Management of Information. *Information and Interaction*. In: SALVENDY, G. & SMITH, M. (eds.). Springer Berlin / Heidelberg.
- Chou, T.-Y., C.-L. Hsu, & M.-C. Chen, 2008. A fuzzy multi-criteria decision model for international tourist hotels location selection. *International Journal of Hospitality Management*, 27: 293-301.
- Cidb, 2003. Industrialised Building System (IBS) Roadmap 2003-2010 Kuala Lumpur: Construction Industry Development Board (CIDB).

- Cidb, 2010. IBS Info. IBS Centre.
- Ekmekçioglu, M., T. Kaya, & C. Kahraman, 2010. Fuzzy multicriteria disposal method and site selection for municipal solid waste. *Waste Management*, 30: 1729-1736.
- Fernández, I. & M.C. Ruiz, 2009. Descriptive model and evaluation system to locate sustainable industrial areas. *Journal of Cleaner Production*, 17: 87-100.
- Haila, A., 1988. LAND AS A FINANCIAL ASSET: THE THEORY OF URBAN RENT AS A MIRROR OF ECONOMIC TRANSFORMATION\*. *Antipode*, 20, 79-101.
- Hargittai, E., 1999. Weaving the Western Web: explaining differences in Internet connectivity among OECD countries. *Telecommunications Policy*, 23: 701-718.
- Jäger, J., 2003. Urban land rent theory: a regulationist perspective. *International Journal of Urban and Regional Research*, 27: 233-249.
- Kamar, K.A.M., 2011. *Critical Success Factors to Industrialised Building System (IBS) Contractor*. PhD, University of Salford.
- Kitzinger, J., 1995. Qualitative Research: Introducing focus groups. *BMJ*, 311: 299-302.
- Lin, C.-T. & P.-J. Juan, 2009. Developing a hierarchy relation with an expert decision analysis process for selecting the optimal resort type for a Taiwanese international resort park. *Expert Systems with Applications*, 36: 1706-1719.
- Majid, T.A., M.N.A. Azman, S.A.S. Zakaria, A.S. Yahya, S.S. Zaini, M.S.S. Ahamad, & M.H. Hanafi, 2011. Quantitative Analysis on the Level of IBS Acceptance in the Malaysian Construction Industry. *Journal of Engineering Science and Technology*, 6: 179-190.
- Majid, T.A., M.N.A. Azman, S.A.S. Zakaria, S.S. Zaini, A.S. Yahya, M.S.S. Ahamad, & M.H. Hanafi, Year. The Industrialized Building System (IBS) Survey Report 2008--Educating the Malaysian Construction Industry. *In: Computer Research and Development, 2010 Second International Conference on, 7-10 May 2010*. 615-619.
- Malczewski, J., 1999. *GIS and Multicriteria Decision Analysis*, New York, Wiley.
- Misnan, M.S. & A.H. Mohammed, 2007. Year. Development of Safety Culture in the Construction Industry: A Conceptual Framework. *In: Proceedings 23rd Annual ARCOM Conference, 2007 Belfast, UK*. Association of Researchers in Construction Management, pp: 13-22.
- Oppenheim, A.N., 1992. *Questionnaire Design, Interviewing and Attitude Measurement*, Pinter Publishers London and New York.
- Pheng, L.S. & C.J. Chuan, 2001. Just-in-time management in precast concrete construction: a survey of the readiness of main contractors in Singapore. *Integrated Manufacturing Systems*, 12: 416-429.
- Şener, Ş., E. Şener, B. Nas, & R. Karagüzel, 2010. Combining AHP with GIS for landfill site selection: A case study in the Lake Beyşehir catchment area (Konya, Turkey). *Waste Management*, 30: 2037-2046.
- Shen, C.-Y. & K.-T. Yu, 2009. A generalized fuzzy approach for strategic problems: The empirical study on facility location selection of authors' management consultation client as an example. *Expert Systems with Applications*, 36: 4709-4716.
- Shen, G., 2005. Location of manufactured housing and its accessibility to community services: a GIS-assisted spatial analysis. *Socio-Economic Planning Sciences*, 39: 25-41.
- Tabari, M., A. Kaboli, M.B. Aryanezhad, K. Shahanaghi, & A. Siadat, 2008. A new method for location selection: A hybrid analysis. *Applied Mathematics and Computation*, 206: 598-606.
- Vahidnia, M.H., A.A. Alesheikh, & A. Alimohammadi, 2009. Hospital site selection using fuzzy AHP and its derivatives. *Journal of Environmental Management*, 90: 3048-3056.
- Wilkison, D. & P. Birmingham, 2003. *Using Research Instruments. A Guide for Researchers*, London, Routledge Falmer.