THE IMPORTANCE AND IMPLEMENTATION OF SUSTAINABILITY FACTORS IN MALAYSIAN RAILWAY PROJECTS

Assa Amiril[1], A.H. Nawawi, R.Takim and S.N.F. Ab-Latif

Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA (UiTM), Shah Alam, Malaysia

The growth of global railway infrastructure development has encouraged many countries including Malaysia to develop railway as a key strategy to enhance the national transportation infrastructure and strengthen economic competitiveness. Nevertheless, the development of railway infrastructure projects demands massive land use, high cost, huge resources and time. These demands have great impact on the economy, environment and social wellbeing. Implementation of sustainability factors in transportation infrastructure projects particularly in railway projects has been recognized as an important mechanism to minimize these impacts. Albeit, it is not clear as to what extent do sustainability factors are incorporated in Malaysian railway projects. The objectives of this paper are to identify the importance of sustainability factors in railway projects from the stakeholder's perceptions and to investigate level of its implementation in Malaysian railway projects. A questionnaire-based survey was conducted in Malaysia among the railway projects main stakeholders: the client, consultants and contractors. The data were analyzed by means of statistical analysis i.e. ranking of variables based on the mean values. Paired t-test was then used to identify whether there are any significant differences between the factors perceived as important and actual implemented. The findings show that the level of importance and implementation of sustainability factors in Malaysia railway project is still in moderate level. It is anticipated that the findings reported in this paper could be important for future strategies and guidelines for improving the sustainability performance of railway infrastructure projects development.

Keywords: Malaysian railway project, stakeholder, sustainability factors.

INTRODUCTION

Infrastructure projects include transportation, water supply, solid waste, communication's networks, energy, etc. Such projects always have multiple objectives, involves people with many different perspectives who must come together to complete the projects successfully (Clevenger *et al*. 2013). Hence, infrastructure projects present significant opportunity to promote sustainability since they are large in scope, multidimensional, costly and time consuming (Clevenger *et al*. 2013; Lothe 2006).

Sustainability of infrastructure transportation development is basically defined through its impacts on the economy, environment and social benefits; measured by system efficiency and effectiveness (Jeon and Amekudzi 2005). The greater efficiencies created by sustainable infrastructure will lead to reductions in waste,

[1] assa.amiril@yahoo.com

Amiril, A, Nawawi, A H, Takim, R and Ab-Latif, S N F (2014) The importance and implementation of sustainability factors in Malaysian railway projects *In:* Raiden, A B and Aboagye-Nimo, E (Eds) *Procs 30th Annual ARCOM Conference,* 1-3 September 2014, Portsmouth, UK, Association of Researchers in Construction Management, 73-82.

energy consumption, land degradation, biodiversity loss and minimization in the consumption of non-renewable resources (United Nations ESCAP 2007). Hence, implementation of a sustainable concept in infrastructure projects development has become crucial due to it has a great impact on surroundings and involves many parties (Bueno *et al*. 2013; Litman and Burwell 2006; Jeon and Amekudzi 2005).

In Malaysia, the government has urged construction project key players and developers to be responsive to the need for better environmental and social protection by taking proactive actions to promote and implement sustainability factors (Zainul Abidin 2010). Nevertheless, the weakness in the area of sustainability development still emerged, and it is not clear as to what extent do sustainability factors are incorporated in Malaysia infrastructure sector although its importance has been highlighted (Pereira and Hasan 2004 and Saadatian *et al*. 2012).

According to Naidu (2008), railway system has emerged as a very essential mode of public transportation in Malaysia. However, Malaysian transportation infrastructure projects that proposed by Government agencies and private sectors have often not been subjected to rigorous scrutiny and evaluation, which resulted in poor performance, project delays and stranded facilities (Naidu 2008 and Khalid *et al*. 2012). An example of these issues can be seen from the failures of all three urban rail transit systems in Kuala Lumpur – the STAR and PUTRA lines and the Kuala Lumpur Monorail system that was rendered unsustainable and was rescued by the Government (Naidu 2008). Hence, the purpose of this paper is to examine the level of importance and implementation of sustainability factors in Malaysian railway projects.

SUSTAINABILITY FACTORS OF INFRASTRUCTURE PROJECTS

A number of studies have been conducted reviewing the existing of infrastructure project sustainability factors from different perspectives. For example, Vanegas (2003) presents a sustainable infrastructure project factors in facilities and civil infrastructure projects development. Similarly to CEEQUAL assessment manual that aimed to improve sustainability in infrastructure projects of civil engineering works and public realm project (Lim, 2009). There are 12 key sustainability factors in the CEEQUAL Assessment Manual. Ugwu and Haupt (2007) in their studies have proposed sustainability factors for assessing the sustainability of built infrastructure that grouped under economy, environment, society, resource utilization, project management and, safety and health. On the other hand, Shen *et al*. (2007) developed a framework of sustainability performance checklist to help understanding the major factors affecting a project sustainability performance across its life cycle.

A study by Lim (2009) proposed a set of sustainability factors and its implementation impact particularly on road infrastructure projects. The proposed sustainability factors clustered into environmental, economic, social, engineering, community engagement, relationship management, project management, institutional sustainability, health and safety, resource utilization and management. Besides that, Federal Highway Administration, FHWA also have introduced INVEST to address sustainability throughout the project stages i.e. systems planning, project development, and operations and maintenance (Clevenger *et al*. 2013).

Division of Transport for New South Wales (2012) has developed a Transport Project

Sustainability Framework to ensure that their transportation system is sustainable over time and sustainability performance is continually improved. They focus on the three spheres of sustainability i.e. environmental, social and economic.

The examination on the existing studies of infrastructure projects leads to the formulation of a list 19 sustainability factors for measuring the sustainability performance of railway projects as presented in Table 1.

Table 1: Matrix of sustainability factors of infrastructure projects

Theme	Sustainability factor	New South Wales 2012	Invest 2012	Lim 2009	Ceequal 2008	Ugwu & Haupt 2007	Shen et al. 2007	Vanegas 2003
Environment	Site selection							
	Water quality	√	√	√	√	√	√	√
	Air quality	√		√	√	√	√	
	Noise & vibration	√	√	√	√	√	√	
	Waste management	√	√	√	√	√	√	√
	Ecology & Biodiversity	√	√	√	√	√	√	
	Visual impact		√		√	√		
	Energy & carbon emissions	√	√	√	√		√	√
Project management	Type of contact			√	√	√	√	
	Procurement method			√	√	√		
	Project risk			√				
Economic	Life cycle cost		√	√		√	√	
Social	Cultural heritage	√	√	√	√	√	√	
	Health & safety		√	√	√	√	√	
	Stakeholder relationships	√		√	√			
	Inter modality transport		√	√	√		√	
Engineering/ Resource utilization	Material selection			√	√	√		
	Constructability			√	√	√		
	Functionality performance			√				√
					√	√	√	√

All of these developed sustainability factors reviewed above have a similar aim that is to encourage the organization to include sustainable practices in their company's strategy and daily work practices. The advantage of implementation sustainability factors is that it can affect the project performance (Lim 2009; Transport for New South Wales 2012; Ugwu and Haupt 2007 and Vanegas 2003). Apart of that, sustainability factors also facilitate stakeholders, owners and engineers measuring the progress towards sustainable development by comparing the performance achieved with the intended performance (FIDIC, 2004).

METHODOLOGY

The method adopted for this research was based on the questionnaire survey of three principle target groups within the Malaysian construction industry, focusing on railway projects. A seven-page questionnaire was distributed to the three-targeted groups that involved in the railway projects development (the clients, consultants and contractors) representing a mixture of professional in order to provide a holistic view and enriches the research finding.

Based on the literature review, a list of 19 significant sustainability factors was produced for the respondents to identify their level of (1) perceived importance criticality and (2) actual implementation to the Malaysian railway project. Respondents were required to rate each question on a five-point Likert scale that required a ranking (1-5). The measurement of the Likert scale is translated, as 1 (not important) to 5 (extremely important). The implementation of each factor was rated from 1(not implemented) to 5(essentially implemented).

The purpose of the first question is to identify the awareness of the project clients, consultants and contractors on the importance or needs of these 19 sustainability factors in Malaysian railway projects. Besides, different project key players have their own concerns, priorities and interest which resulting in different expectation in the implementation of sustainable construction project delivery (Lim, 2009 and Lothe, 2006). Thus, investigating the level of importance and implementation of sustainability factors in Malaysian railway projects is crucial.

All of these questions have been tested in a pilot study conducted on 9 respondents (who were representative of each targeted-group). Comments were made about the structure and length of some sentences, ambiguous words and the way the questionnaire was presented. Some of the comments and suggestions from the pilot survey were taken into consideration before actual distribution of the questionnaire to 96 identified respondents. The results of real data collection were analyzed using the Statistical Package for the Social Science (SPSS) software.

DATA ANALYSIS AND RESULTS

The reliability of the 5-point Likert scale measured was determined using Cronbach's alpha coefficient on the variables. The reliability of the perceived importance and level of implementation were found to be 0.912 and 0.928. Since both of the value fall within the acceptance range of above 0.7 (Pallant, 2010), the data collected and used in this study are considered very good internal consistency reliability (Pallant 2010; Leech *et al*. 2011).

In accordance with Pallant (2010) and Leech *et al*. (2011), Paired sample t-tests (also referred to as repeated measures) can be used when to compare the mean scores for the same people on two different occasions. For instant, the use of Paired sample ttests to identify the significant differences between the Knowledge Management

Factors mean score perceived important and actual implementation in

Telecommunications (Chong *et al*., 2006) as well as, in Information and Communication technology (ICT) (Siong, 2006). In this case, the Paired sample ttests were used to compare the variables mean scores to determine any significant differences that occurred between the 19 sustainability factors perceived important and actual implementation in Malaysian railway projects.

Response Rate

A total of 96 questionnaires were sent to a different target groups. Thirty-three questionnaires were returned within two months of being sent out, making the total response rate 34.4 percent. This response rate was finally achieved after several efforts were made in terms of personal contacts and follow-up calls. 6 (30%) respondents were from the clients, followed by 15 (38.5%) from consultants and 12 (32.4%) were from contractors. A response rate of 34.4 percent is acceptable. This in line with the opinions of Takim *et al*. (2008) and Dulami *et al*. (2003) that response rate in the construction industry for postal questionnaires above 20 percent is not uncommon and acceptable.

Respondent's designation and experience

Table 2 shows the profile of the respondents. The survey indicates that, 78% of respondents have more 10 years' experience followed by 21% of them has least 10 years' experience. This shows that the respondents have an extensive experience, which helps to provide this study with reliable data.

Table 2: Respondent's designation and years of experience

Position	Experience			
	Less than 5 years	5 - 10 years	11 - 20 years	More than 20 years
Manager	0	5	11	9
Director	0	0	0	4
Senior engineer	0	2	2	0
Percentage (%)	0	21.2	39.4	39.4

Means factors scores for level of importance and implementation

Table 3 presents the result analysis of 19 sustainability factors considered by the respondents for measuring the sustainability of railway projects. The analysis primary deals with ranking the factors based on their mean score values to determine their level of perceived importance (PI) and actual implementation (AI) in railway projects.

Degree of perceived importance

The average mean score values for level of perceived importance held by respondents (see Table 3) is 3.96 (SD = 0.60) and classified as 'moderate important'. Out of 19 SF, the respondents rated seven SF 'very critical', which classified as 'high important'.

These seven SF are Air Quality, Noise and Vibration, Water quality, Ecology and Biodiversity, Site selection, Project risk and Functionality performance. The remaining 12 SF are also significant and classified as 'moderate important' with the mean scores value ranging from 3.68 to 3.99.

Degree of actual implementation

Similar to the degree of actual implementation for all the 19 SF that was also classified as 'moderate implemented' by the respondents with an average mean score 3.49 and standard deviation is 0.74.

Table 3: Means factor scores for level of importance and implementation of SF

Theme	Sustainability factor (SF)	Perceived Importance (PI)				Actual Implementation (AI)				Dif. PI-AI
		R	Mean	SD	Level	R	Mean	SD	Level	
Environment	Air quality	2	4.21	0.42	High	8	3.55	1.00	Moderate	-0.66
	Noise & vibration	2	4.21	0.42	High	14	3.33	0.48	Moderate	-0.88
	Water quality	4	4.14	0.65	High	1	3.94	0.72	Moderate	-0.20
	Ecology & Biodiversity	5	4.02	0.59	High	12	3.45	0.89	Moderate	-0.57
	Site selection	6	4.03	0.41	High	3	3.84	0.56	Moderate	-0.19
	Visual impact	10	3.91	0.49	Moderate	17	3.13	0.50	Moderate	-0.78
	Waste management	13	3.81	0.66	Moderate	10	3.53	0.71	Moderate	-0.28
	Energy & carbon emissions	14	3.70	0.77	Moderate	18	3.09	1.16	Moderate	-0.61
Project management	Project risk	3	4.17	0.44	High	2	3.85	0.61	Moderate	-0.32
	Procurement method	8	3.96	0.77	Moderate	11	3.47	0.87	Moderate	-0.49
	Type of contact	16	3.68	0.73	Moderate	16	3.21	0.92	Moderate	-0.47
Economic	Life cycle cost	8	3.96	0.61	Moderate	7	3.64	0.69	Moderate	-0.32
Social	Inter modality transport	8	3.96	0.63	Moderate	5	3.70	0.85	Moderate	-0.26
	Stakeholder relationships	9	3.93	0.76	Moderate	9	3.59	0.77	Moderate	-0.34
	Cultural heritage	12	3.82	0.73	Moderate	15	3.30	0.64	Moderate	-0.52
	Health & safety	15	3.69	0.55	Moderate	13	3.39	0.39	Moderate	-0.30
Engineering/ Resource utilization	Functionality performance	1	4.23	0.70	High	4	3.71	0.79	Moderate	-0.52
	Constructability	7	3.99	0.46	Moderate	19	3.02	0.74	Moderate	-0.97
	Material selection	11	3.88	0.58	Moderate	6	3.66	0.72	Moderate	-0.22
	Average Mean		3.96	0.60	Moderate		3.49	0.74	Moderate	-0.47

Key: 1-not important; 2-less important; 3-moderate important; 4-high important; 5-extremely important; 1-not implemented; 2-less implemented; 3-moderate implemented; 4-high implemented; 5-essential implemented; R - rank; Dif. (difference); SD – standard deviation.

Mean difference

Based on the result of Table 3, the average Mean score for Perceived importance is 3.96 (SD=0.60) and the average Mean score for Actual implementation is 3.49 (SD=0.74). These result demonstrates that, there is a significant difference between the sustainability factors of Perceived important (PI) and the Actual implementation (AI) in Malaysian railway infrastructure project, with the average mean decrease of 0.47, t-value = 3.70, and sig. $p<0.009$ (two-tailed) as shown in Table 4.

Table 4: Comparison of level of PI and level of AI of sustainability factors

Theme	Sustainability factor (SF)	Paired sample t-test				Sig (2-tailed)
		Mean	SD	t-value	df	
Environment	Site selection	0.19	0.44	2.45	32	0.020
	Water quality	0.20	0.47	2.46	32	0.019
	Air quality	0.66	0.97	3.60	32	0.001
	Noise & vibration	0.88	0.65	7.77	32	0.000
	Waste management	0.28	0.69	2.35	32	0.025
	Ecology & Biodiversity	0.57	0.79	3.29	32	0.002
	Visual impact	0.78	0.74	6.01	32	0.000
	Energy & carbon emissions	0.61	0.97	3.60	32	0.001
Project management	Type of contact	0.47	0.72	3.76	32	0.001
	Procurement method	0.49	0.91	2.78	32	0.009
	Project risk	0.32	0.46	3.93	32	0.000
Economic	Life cycle cost	0.32	0.67	2.91	32	0.011
Social	Cultural heritage	0.52	1.15	2.58	32	0.015
	Health & safety	0.30	0.34	4.93	32	0.000
	Stakeholder relationships	0.34	0.55	3.53	32	0.001
	Inter modality transport	0.26	0.73	2.03	32	0.048
Engineering/ Resource utilization	Material selection	0.22	0.53	2.37	32	0.024
	Constructability	0.97	0.91	6.12	32	0.000
	Functionality performance	0.52	0.76	3.92	32	0.000
	Average Mean	0.47	0.71	3.70	32	0.009

Key: SD - standard deviation; df - degrees of freedom; sig. - probability (p) value

DISCUSSION

Based on the statistical analyses above, this research has fulfilled its objectives by examining the level of perceived importance of sustainability factors in railway projects and the level of its implementation. For the result of the level of perceived importance, 63% (12 out of 19) sustainability factors were rated as moderate important and 37% (7) sustainability factors were rated as high important. The average means score value is 3.96 (SD = 0.60) and classified as 'moderate important'. Similarly to the level of actual implementation of all the 19 SF that were rated as ‘moderate implemented’ by the respondents during the railway project development with an average mean score is 3.49 (SD=0.74).

A paired-sample t-test was conducted to identify significant differences between factors perceived as important and actual implementation. The findings revealed that, there was a significant decrease between all the level of perceived important (M=3.96, SD=0.60) and the level of actual implementation (M=3.49, SD=0.74) of the sustainability factor in Malaysian railway project with an average mean difference of 0.47, t-value = 3.69, $p < 0.05$ (two-tailed). This indicates that, the key players of

railway project did not implement the sustainability factors to the extent that they were perceived as important. From the findings above, the level of importance and implementation of sustainability factors in Malaysia railway project can be clustered into two types as illustrated in Table 5.

Table 5: Level of PI and AI of sustainability factor in Malaysian railway projects

Cluster type	Level of PI equal to Level of AI	High PI, but moderate AI
Environment	•Visual impact •Energy & Carbon emission •Waste management	•Site selection •Water quality •Air quality •Noise & Vibration •Ecology & Biodiversity
Project management	•Type of contract •Procurement method	•Project risk
Economic	•Life cycle cost	
Social	•Cultural heritage •Health & Safety •Inter modality transport •Stakeholder relationship	
Engineering/ Resource utilization	•Constructability •Material selection	•Functionality performance

Key: PI - perceived importance; AI - actual implementation

The above findings demonstrate that, the awareness on the importance of 19 SF in railway project among the respondents is still at moderate level. This may be due to the lack of awareness on the benefits of SF in railway project. This is supported by research from Idris (2014) and Zainul Abidin (2010) found that there is a lack of awareness on sustainable construction among the key players of the construction project. Although some of the respondents express that they were aware on the importance of sustainability factors, the issue is not in their priority list. One of the reasons is due to lack of precise indication of sustainability clause in project's contract or specification. This can also be due to that they only emphasize on profit, hence, refuses to acknowledge sustainability in the projects (Idris, 2014).

Nevertheless, there are some respondents who wanted to apply these sustainability factors, but the effort was obstructed by financial constraints. These respondents also suggested that the sustainability factors should be considered or incorporated in the early project i.e. planning stage in order to improve the level of its implementation. Zainul Abidin (2010) point out that planning stages are the most critical stage to integrate the sustainability issues in order to have the most effect on the overall pursuit project, whereas integration after that will be seen as a burden and add more cost to the budget. Besides that, the respondents have also highlighted on the need to create awareness on the important of the sustainability concept within entire construction industry in Malaysia, particularly the client. According to most of the respondents, government should take the lead by encouraging the implementation of sustainable practices through the strong enforcement of legislation, tax incentives and funding especially for sustainable construction projects. This is because the public policies, regulatory frameworks, clause in project contract and specification do not encourage the improvement of the construction sector towards sustainability.

CONCLUSION

This paper examines the current views on importance and implementation of sustainability factors in Malaysian railway project. Based on the literature reviews, 19 critical sustainability factors of infrastructure projects have been identified. These 19 sustainability factors were grouped into five themes namely: environment, economic, social, engineering/resource utilization and project management.

The results of the study depict the level of awareness of sustainable factors among project key players is still at moderate level. Similarly to the level of implementation of sustainability factors in Malaysian railway project which also still at moderate level. This demonstrates that, the concept of sustainable factors has not been widely applied in railway projects. This is in line with Zainul Abidin (2010) findings that the implementation of the sustainability concept in Malaysian construction projects is still in the infancy stage.

In relation to the findings of this paper, it can be found that the concept of sustainability factors has not been widely implement in railway projects due to a few impediments such as lack of precise indication of sustainability clause in project's contract/specifications, financial constraint, lack of awareness, lack of enforcement, etc. Hence, those issues will be interrogating further in the next paper.

The above findings help enhancing our understanding on the 19 critical sustainability factors that must be considered or implemented by the stakeholders, particularly the clients, consultants and contractors during the railway project development. It is hoped that the results of the study could provide insight into the Malaysian railway project development as well as provide valuable knowledge and guideline, especially to the stakeholders (client) in improving the sustainability performance of railway projects.

REFERENCES

Bueno, B P C, Vassallo, J M, and Cheung, K (2013) *"Road Infrastructure Design for Optimizing Sustainability - Literature Review"*, TRANSyT working paper 2013-01EN, Spain, Universidad Politecnica de Madrid.

Clevenger, C M, Ozbek, M E, and Simpson, S (2013) Review of sustainability rating systems used for infrastructure projects. In: Sulbaran, T (Ed.), *"49th ASC Annual International Conference Proceedings"*, 10-13 April 2013, California Polytechnic State University. Associated School of Construction.

Dulami, M F, Ling, F Y Y and Bajracharya (2003) Organisational motivation and interorganisational interaction in construction innovation in Singapore. *"Construction Management and Economics"*, **21**(3), 307-318.

FIDIC-International Federation of Consulting Engineers (2004) *"Project Sustainability Management Guidelines"*. Geneva, Switzerland.

Idris, N.H. (2014) *"A Framework for Sustainable Construction Initiatives in Malaysia"*, Unpublished Master thesis, Faculty of Architecture, Planning and Surveying, University Teknologi MARA.

Jeon, C M, and Amekudzi, A. (2005) Addressing Sustainability in Transportation Systems: Definitions, Indicators, and Metrics. *"Journal of Infrastructure Systems"*, **11**(1), 31–50.

Khalid, U A, Bachok, S, and Ibrahim, M (2012) Heavy Rail System Route Extension Seremban - Sg. Gadut and Sentul – Batu Caves: The Case of Greening Trips by Mode

Switching from Private Vehicles Trips to KTM Komuter Services. *"23rd EAROPH World Congress on Green City for Human Betterment"* 17-19 October 2012, Daegu South Korea.

Leech, N L, Barrett K C, Morgan G A. (2011) *"IBM SPSS for intermediate statistic: Use and interpretation"*. 4th ed. New York: Routledge.

Lim, S. K. (2009) *"Framework and processes for enhancing sustainability deliverables in Australian road infrastructure projects"*, Unpublished PhD thesis, Faculty of Built Environment and Engineering, Queensland University of Technology.

Litman, T and Burwell, D (2006) Issues in Sustainable Transportation *"International Journal of Global Environmental Issues"*, **6**(4), 331-347.

Lothe, K (2006) *"An analysis of constructability strategies in project delivery: Making infrastructure construction sustainable in Copán Ruinas, Honduras"*, Unpublished Master thesis, Faculty of Civil and Environmental Engineering, Michigan Technological University.

Naidu, G (2008), Infrastructure Development in Malaysia, In: Kumar, N (ed.), *"International Infrastructure Development in East Asia – Towards Balanced Regional Development and Integration"*, Chiba: IDE-JETRO, ERIA Research Project Report, 204-227.

Pallant, J. (2010) *"SPSS survival manual: A step-by-step guide to data analysis using SPSS"*. 4th ed. Maidenhead: Open University Press/McGraw-Hill.

Pereira, J J and Hasan, M N (2004) Sustainable Development Indicators: An Overview of Ongoing Initiatives in Malaysia. *"Indicators of Sustainable Development, Assessing Changes in Environmental Condition"*, 3-13.

Saadatian, O, Lim, C H, Sohif, M, and Kamaruzzaman, S (2012) Perspective of Sustainable Development in Malaysia. *"International Journal of Energy and Environment"*, **6**(2), 260-267

Shen, L., Hao, J. L., Tam, V., and Yao, H (2007) A checklist for assessing sustainability performance of construction projects. *"Journal of civil engineering and management"*, **13**(4), 273–281.

Takim, R and Adnan, H (2008) Analysis of effectiveness measures of construction project success in Malaysia. *"Asian Social Science"*, **4**(7), 74-91.

Transport for New South Wales (2012) *"Transport Projects Division Sustainability Framework: Key performance indicators and targets"*. Chatswood: New South Wales Government.

Ugwu, O O, and Haupt, T C (2007) Key performance indicators and assessment methods for infrastructure sustainability—a South African construction industry perspective *"Building and Environment"*, **42**(2007), 665–680.

United Nations ESCAP (2007) *"Sustainable Infrastructure in Asia: Overview and Proceedings*

- *Seoul Initiative Policy Forum on Sustainable Infrastructure Seoul"*. Thailand: United Nations Publication.

Vanegas, J A. (2003) Road map and principles for built environment sustainability. *"Environmental science and technology"*, 37(23), 5363–72.

Zainul Abidin, N (2010) Investigating the awareness and application of sustainable construction concept by Malaysian developers.*"Habitat International"*,**34**(4),421–426.