

THE DEVELOPMENT OF ASSESSMENT FRAMEWORK FOR CONSTRUCTION SUSTAINABILITY

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Abstract: Sustainability of construction firms is closely linked to its ability to procure projects that will generate sufficient turnover over time. The uncertainty concerning future procurement of projects remains the primary concern of any construction firm. Whilst this factor cannot be overcome in one single effort, there is no certainty that projects can continue to be procured if the construction firm are not well equip to face the challenges to remain competitive, innovative and is capable of strategically positioning itself to remain in business and thus sustaining its presence in the industry. The issue of the firm's sustainability is also closely linked to the general facets of sustainable development may exist in parallel; the main dominant thrust is sustainability and sustainable development may exist in parallel; the main dominant thrust is sustainability. A firm can sustain itself if it wholly adopts the concept of sustainable development; whilst maintaining its relevance in the industry it is operating. The objective of this paper is to analyze the frameworks, concepts and approaches of sustainability of construction firms that are embedded in social, economic and environment. The findings of this paper can provide insights for further research in understanding sustainability of construction firms.

Key words: *Sustainability, Construction Firms.*

Introduction

Over the years, there has been growing recognition among leading scientists and, increasingly, the public and politicians that we are using the planet's resources in ways which exceed its long-term capacity and which are undermining its vital life support systems. In the last decade the difference in living conditions between rich and poor people, both between and within countries, has also widened, exacerbating the environmental damage (TCPA, 2003). This practice is evident in the lack of sustainability into account will result in problems that require a lot of concerted efforts to mitigate the environmental damage. However, dealing effectively with sustainability should consider the need for extra knowledge, identify database knowledge to make easy to use and practice a new skills to support this process. As well as developing the capabilities of management and leadership to support the promises to sustainable development (Gloet, 2006).

Sustainable development is defined as “... *the development that meets the needs of the presents without compromising the ability of future generations to meet their own needs*” (WCED, 1987). This is still the 'benchmark' definition, but is often inadequate, and there are many other definitions, some good and positive misleading (Bentivegna et al., 2002). This definition has become widely known, in particular the words' future generations' (Klostermann & Cramer, 2007). Therefore, Sustainability is one of hot topics these days to be addressed at the local and global levels.

But recent researches on sustainability become more quantitative and include more dimensions of sustainability at the same time, which will allow for more targeted policies to be implemented and closely follow the success (Mayer, 2008). In what ever way, sustainability considers long term behaviour (Brochner, Ang, & Fredriksson, 1999). This means that, the concept of sustainable development is broad (Ding, 2005). Sustainability is a hot issues now a days and one of topic that debatable on local and global context. It seems that the purpose of sustainability is to maintain sustainable development.

Sustainability concept being growing over the past two decades and consider now as one of the cornerstone of most developments and socio-economic activities in built and natural environment (Kululanga et al., 1999). Achieving sustainable development is depending on the protection of environment, social, and economic (WCED, 1987). There is a horrible need for the methods and the techniques that would facilitate the evaluation of sustainability and decision-making in the various level of project they communicate (Ugwu, Kumaraswamy, Wong, & Ng, 2006b). Literature shows that sustainability is a global problem requiring a global solution (Ugwu & Haupt, 2007; Ugwu, Kumaraswamy, Wong, & Ng, 2006b). Therefore, the sustainability concept moves us into a thoughtful of relationship with our 'life support' systems (Reed, 2007). This means that sustainability is very broad issue need international efforts and working together to solve its problems and achieve its objectives.

Most of the sustainability assessment methods developed by previous researchers only concentrated on environmental elements. A recent audit conducted by Ding (2008) on the

building assessment methods used throughout the world, showed that only one out of the twenty methods actually integrate environment, economy and social components in its system. This 'traditional environmentalism' demonstrated by the researchers and practitioners alike could be detrimental towards the implementation of sustainable development policies in construction companies. Long accused as one of the main the perpetrators of environmental problems, the fiercely competitive construction industry may find it difficult to mend their ways. The perception towards sustainability within the industry is that, environmental protection can only drive their costs up, and hence blunt their competitive edge. Because of this, an assessment method integrating environmental, economic and social factors needs to be developed so that the industry could see the benefits of implementing sustainable development strategies and policies.

An audit of more than 20 assessment models developed previously throughout the world revealed that none of them was originally developed for Malaysian use. Kohler (1999) warned that adopting construction sustainability assessment method from another country or region could lead to anomaly for the local use. He argued that regional, social, and cultural variations are complex and the boundaries are difficult to define. These variations include differences in climatic conditions, income level, building materials and techniques, building stocks and appreciation in historic value. Hence, it is imperative to develop a framework specifically tailored to the Malaysian scenario because as a developing country with its own unique characteristics, the newly developed framework could answer a multitude of problems in relation to construction sustainability in the country.

The developed Malaysian framework could be the right impetus to move the current inertia in promoting sustainable development as demonstrated by the country's construction companies. It is hoped that construction companies will not be scared and put off by the term "sustainable development", perceiving it to be cost additions. Rather, with an assessment tool integrating all the pillars of sustainable development, those are, environmental, economic and social, the companies will form a learned judgments towards construction sustainability. Therefore, the paper attempts to review the concept of sustainability issues in the Malaysian construction industry context; and suggest a

framework for sustainability of construction firms in Malaysia. The framework will include an integrated assessment of all main pillars in sustainable development, those are, and environmental, economic and social factors.

The corner stone of sustainability

The term 'sustainable development' has become one of the most debated subjects among politicians, scientists, academics, industrial practitioners and the general public. Following this movement, (TCPA, 2003). It concerns with attitudes and judgment to help insure long-term ecological, social and economic growth in society (G. K. C. Ding, 2007) and can be in policy process and abstract form, but it is never personalized into solid goals, and if does, it facing lacking of the criteria of evaluation and assessment (Van Bueren & De Jong, 2007). Therefore, sustainable development from the construction industry perspective means change (Bourdeau, 1999). There is no doubt that the sustainable development of global and sensitive issues could be discussed topic among a range of stakeholders.

Essentially, sustainable development, is still a public policy perspective, where social and economic conditions do not compromise the validity and the productive capacity of the receiving environment and the availability of natural capital stocks is the lack of prejudice in an irreversible manner either current or future generations (Browne, O'Regan, & Moles, 2005). Moreover, Bentivegna et al. (2002) indicated that to get better at achieving of sustainable development must combine or work together in a way that makes economic, environmental and social factors more effective.

Ecologically sustainable development is a major concern with regards to environment protection and management. In general, however, sustainable development concerns attitudes and judgment to help ensure long-term ecological, social and economic growth in society (Ding, 2005). There are extremely important priorities to improve the capabilities of strategic management and leadership of intra-organizations, for the purpose of dealing with a problem or challenge of promoting economic, social and environmental types of sustainable development (Gloet, 2006). It is clear that the sustainable development concerned with environmental protection and long-term continuous improvement is the

best effect in challenging problems and challenges in the promotion of the basic elements of sustainable development, which focused on the economic, social and environment. To go a long towards sustainable development should have an important effective switch in the future, improving the ability to understand the social responsibility and having good enough awareness toward shareholder and social events (Gloet, 2006). Therefore, there is an increased of environmental awareness come from the social learning (Cashmore, Bond, & Cobb, 2007). Improving health, safety and security is one of the social objectives of sustainable development (Gibberd, 2005) and having the ability to access to good education (Boyko, Cooper, Davey, & Wootton, 2006; Gibberd, 2005). Therefore, sustainability, as a social value, requires consideration of broader economic and social values (Buchholz, Volk, & Luzadis, 2007). Therefore, awareness is one of the important means to achieve sustainable development that serves the present and future generations.

Any negative impact on both the environment and quality of life may or may not be acceptable to the people affected in the short term or long-term future, depending on whether these people are, or feel, and that it benefited the overall (George, 1999). To improve and enhance quality of life, should consider the integration among culture heritage, planning of land-use, using resources, and providing necessary services. Factors affect and threats the sustainable development is noise and natural technological hazards and air pollution (Patermann, 1999). To facilitate the transition to environmental sustainability in the building and construction, and all actors should work together as a choir (Warnock, 2007). Sustainability is concern about helping the individual to increase the feeling of being comfortable, healthy, and happy over the time. To achieve that, should increase feeling of happiness. Well-being is generated by capability that reflected in the assets, or wealth (Pearce, 2006). The goal of sustainability that has been used recently among scholars is to achieve the best expectations of ecosystem to be useful for long-term (WCED, 1987). This paper deduces that the sustainability involves the lives of individuals and groups, in the short term and long term, through constant improvement of the key elements of sustainability.

Issues facing sustainable development

From the point of view of environmental protection and management, ecological sustainable development consider as a main important issue and a very good example of both management and protection of the environment (Ding, 2007). In the reality, it's too difficult to apply sustainability concept by people (Van Bueren & De Jong, 2007). There is three issues can cause failure of sustainability including: lack of agreement on sustainability, lack of information to calculate indices in right way, and lack of desire of policymakers to apply the right advices of indices (Wilson, Tyedmers, & Pelot, 2007). The issues of sustainability dealing with wide range of factors, such as industry sectors, international institution, agencies, national boundaries and across organization (Gloet, 2006).

Sustainability Performance

The measurement can help for planning and control, continuous improvement, resource allocation, motivation and long-term focus judging (Enoma & Allen, 2007). Suitable knowledge and information of sustainability consider very important factor of decision making process for sustainability (Gloet, 2006). Essentially, sustainable development, and recognize that the separation of economic activity and progress of the external pressures on the environment, as the largest consideration of the marginal and marginal social groups, it is necessary for long-term viability of the system (Browne, O'Regan, & Moles, 2005). Sustainable development extremely the most important bottom policies for the future (Kuhtz, 2007). There is a need to ensure wider participation of stakeholders in the process of building and evaluation, through this, the actual building process. Building guide stakeholders in the decision-making by local and global contexts (Kaatz, David, Paul, & Richard, 2006). Therefore, the goals of sustainable development cannot be met without the use of science and technology that supports the principles (Plessis, 2005). As a result, Assessment framework, must recognize and respond is in the context in which it is used (Gibberd, 2005). Develop a standard measure contribute to achieving sustainability in all forms. In addition to providing decision makers of all data and information of interest in drawing plans that would achieve the principle of sustainable development.

Sustainable Development Indicators

The main function of indicators of sustainable development is the translation of the sustainability issues in quantifiable measures of economic, environmental and social performance with the ultimate goal to help address the fundamental concerns (Azapagic, 2004). OECD (2004) defines an indicator as “*a parameter or resulting value of a set of parameters providing information on a phenomenon, and with a wider meaning than that strictly associated with parameter configuration*” (OECD, 2004). Therefore, indicators of the effectiveness of providing more direct comparison of the goals and objectives and measures of the total consumption or community-wide factors (Guy & Kibert, 1998). However, indicators of sustainability are a mixture of several indicators of environment, social and economic one, can give information on a better assess of sustainability (Fricker, 1998). That means, choosing a combination of social, economic and environmental factors represent the best practices of indicators (Guy & Kibert, 1998). These indicators aimed at the promotion and development of sustainability.

The role that sustainable community indicators want to achieve it is creating balancing approach to environment, economics, and social influences (Guy & Kibert, 1998), as well as to raise the awareness and helping the environmental, social and economic and sub-systems clear to citizens and decision-makers (Guy & Kibert, 1998). Index considers a multidimensional method to do evaluation for the complexity and importance of certain projects and facilities to achieve sustainability and profitability. It's the key variables of economic, social and environment criteria to achieve the best option between alternative (Ding, 2005). Using indexes of sustainability have a great effect in simplified measurement of sustainable development. Consequently, this will make a great contribution to find the best design solutions and facility operation (Ding, 2007). Use of a sustainability index will greatly assess the effects of the construction industry to realize sustainable development goals, and thereby make a positive contribution to the identification of optimum design solutions (Ding, 2005). The concept of information can be utilized to develop indicators that bridge the human and natural systems and to make sense of the unlike variables of the state of these systems (Pawlowski, Fath, Mayer, & Cabezas, 2005).

Assessment Method

Assessment tools used to describe all assessment techniques to be used in accomplishing ascertain task (Cole, 2005). Assessment can play a powerful role in offering a means of arranging different parts of environmental data for new design of building and specific renovations. Consequently, the assessment will play a good role in creating the body of knowledge and expertise within the design team of building and building industry as a whole to make it easier to understand of environmental issues into practice (Cole, 1998). The integration of assessment tools has the possibility to include all the dimensions of sustainable development (Lützkendorf & Lorenz, 2006). Therefore, effort should be made to have all contributing factors, such as environmental aspect and the quality of life best component (George, 1999). Therefore, Focus on learning is of great importance in supporting the assessment methods that would contribute to the improvement of the quality of life.

The Importance of Assessment Method

The importance of environmental building assessment methods come out from because the environment issues are urgent and comprehensive to help building performance. The goal of environmental building assessment method is to improve the awareness of environment of building practices, besides, reaching the target of sustainability, and to place down the core direction of building industry to get toward environmental protection (Ding, 2007). This will help to get to structured environmental data, objective assessment of building performance, and the most important issue to measure the progress toward sustainability (Ding, 2007), as the ultimate goal of sustainable development (Gibberd, 2005).

Lutzkendorf & Lorenz (2006) pointed out, that there is an eager for complicated of assessment tools as well as the desire of having simple assessment process and presentation of assessment results. Consequently, professionals lacking of awareness of the techniques such as assessment tools, best practices and technology switch, have a great effects on sustainable development not only as environmental protection criteria and simple economic (Bentivegna et al., 2002). There is a need for a structured methodology, techniques and tools to enable decision support designed to assess the sustainability of design proposals.

This is still a need to address the challenge of sustainability in science (Ugwu & Haupt, 2007). A performance assessment is only a means to an end - it is the ability to make informed decisions based on the results of the evaluation is the most important (Cole, 1998). The term measurement in performance can play an attractive role when dealing such physical flows of water, noise and energy (Brochner, Ang, & Fredriksson, 1999).

One of the powerful roles of building sustainability assessment is to facilitate the integration of stakeholders' their values, their needs, and some prefer with the design, and the last one is the delivery and operation of the built product (Kaatz, David, Paul, & Richard, 2006). By learning from environmental assessment, building evaluation and likewise can become a tool for building capacity of stakeholders involved with providing a platform for the exchange of information and knowledge production through dialogue and mediation (Kaatz, Root, & Bowen, 2005). Moreover, education and training in should provide to the decision-makers and designer in interpreting the building assessment outcomes (Lützkendorf & Lorenz, 2006). Building assessment tools have an important role in the integration of sustainability in the construction practice, because they provide a means to address these issues (Kaatz, Root, & Bowen, 2005).

Limitation of Assessment Tools

Assessment tools are just used to help in decision making process as an instrument (Lutzkendorf & Lorenz, 2006). Therefore, tools are basically tow categories: assessment and rating tools, assessments tools provided quantitative performance indicators for design alternative whiles rating tools determine the performance level of a building in stars (Ding, 2006). Therefore, there is a need of continuous improvement and environmental management system to be included in the assessment process (Lutzkendorf & Lorenz, 2006). Cost is one of the disadvantages of measurement as a form of acquired knowledge, when applying performance concept to construction (Brochner, Ang, & Fredriksson, 1999). Therefore, people involved with building have different interest; investors concentrate on economic performance of the buildings, while the occupants focus on air quality or other characteristics that effect their health and comfort, but operation staff more interested with practical issues such as maintainability (Cole, 1998).

Environmental Building Assessment Method

Environmental Assessment Methods defined by Cole (1998) as "techniques developed to specifically evaluate the performance of building design or completed building across a broad range of environmental consideration". An environmental assessment of a building provides the dual role of identifying success at meeting a level of performance on the one hand and guidance for remedial work and feedback to design on the other. Moreover, to get desired assessment outputs and outcomes, should address social and technical processes (Kaatz, David, Paul, & Richard, 2006). The use of environmental assessment methods as design guide lines can not be sufficient. Consequently, in order for environmental building assessment methods to be useful as a design tools they must be introduced as early as possible to allow for early collaboration between the design and assessment teams (Ding, 2008)

Building environmental assessments role

Building environmental assessment has been accepted by several sectors such as banking, finance, insurance company (Cole, 2005). It enhances the environmental awareness of building practices and lays down the fundamental direction for the building industry to move towards environmental protection and achieving the goal of sustainability, it provides a way of structuring environmental information (Ding, 2008). Consequently, it has contributed to furthering the promotion of higher environmental expectation as well as affecting the performance of building (Cole, 2005), and understand some specific data on the building which can help building management to minimize operating, financing and insurance costs, as well as minimizing vacancy rate, and maximize marketability (Cole, 1998). Therefore there is a need to amend the existing practice to assess the building to respond effectively to new requirements and challenges posed by sustainability agenda, (Kaatz, David, Paul, & Richard, 2006).

Because of their success, building environmental assessment methods have dwarfed all other mechanisms for instilling environmental awareness within the building industry (Cole, 2005). Therefore environmental building assessment methods are most usefully

during the design stage when any improvement for the pre - design criteria can be assessed and incorporated at design development (Ding, 2008). Therefore, the indicators will be based on the environmental and societal impacts of greenhouse gas emissions, depletion of resources, and the availability of renewable energy sources and adds value to the economy (Evans, Strezov, & Evans, 2008). And economic, ethical, legal, technical tools and applied to resolve conflicts or environmental problems in many cases without the underlying theory is able to establish relations between them (Martínez de Anguita, Alonso, & Martín, 2008). Sustainable building assessment method is dealing with a broader set of environmental, social and economic building issues. Also, can assist to support better setting for their physical and that impact in the right way on their socio-economic and environmental context (Kaatz, David, Paul, & Richard, 2006). Promoting the principle of sustainable development consider on of the role played by building sustainability assessment method. Depending on one fixed framework of the assessment issues consider a weakness (Kaatz, David, Paul, & Richard, 2006)

Sustainability Assessment Method

The key role of sustainability assessment methods to improve the decision-making in the building processes. Applying building sustainability assessment methods can achieve several objectives such as collaborative learning, transparency and accessibility, and integration. Some of the weaknesses of building sustainability assessment method are not be able to use as an evaluation of the quality of building performance. The other issues that assessment method has the ability to be one of the main elements of controlling building projects quality (Kaatz, David, Paul, & Richard, 2006). Moreover, the target of the development of building assessment is to increase the effectiveness of building assessment method in assess the sustainability of construction projects and to encourage of sustainable constructions agenda (Kaatz, David, Paul, & Richard, 2006). In addition to that, One of the advantages of building assessment methods is to support delivering suitable to their physical settings which can be positive impact on socio-economic and environment (Kaatz, David, Paul, & Richard, 2006). To improve functionality and quality of life should have integration planning of land use cultural heritage, use of resources, and provision of basic services (Peterman, 1999). Therefore, separate indicators or benchmarks based on a single

criterion , have been developed to monitor specific aspects of environmental building performance (Cole, 1998; G. K. C. Ding, 2008). However the development of indicators has resulted in considerable complexity, which has made it difficult to derive suitable criteria for environmental assessment (George, 1999). There are some of the factors that effect and threats sustainable development such as noise, natural technological hazards, and air pollution, all these factors have impact of sustainable development (Peterman, 1999).

The framework for this study is the adaptation from Azapagic & Perdan (2000) which suits the construction industry. Figure 1.1 represents the framework of the study; choosing the indicators of the framework will depend on number of factors, of which data availability and simplicity of analysis (Azapagic & Perdan, 2000).

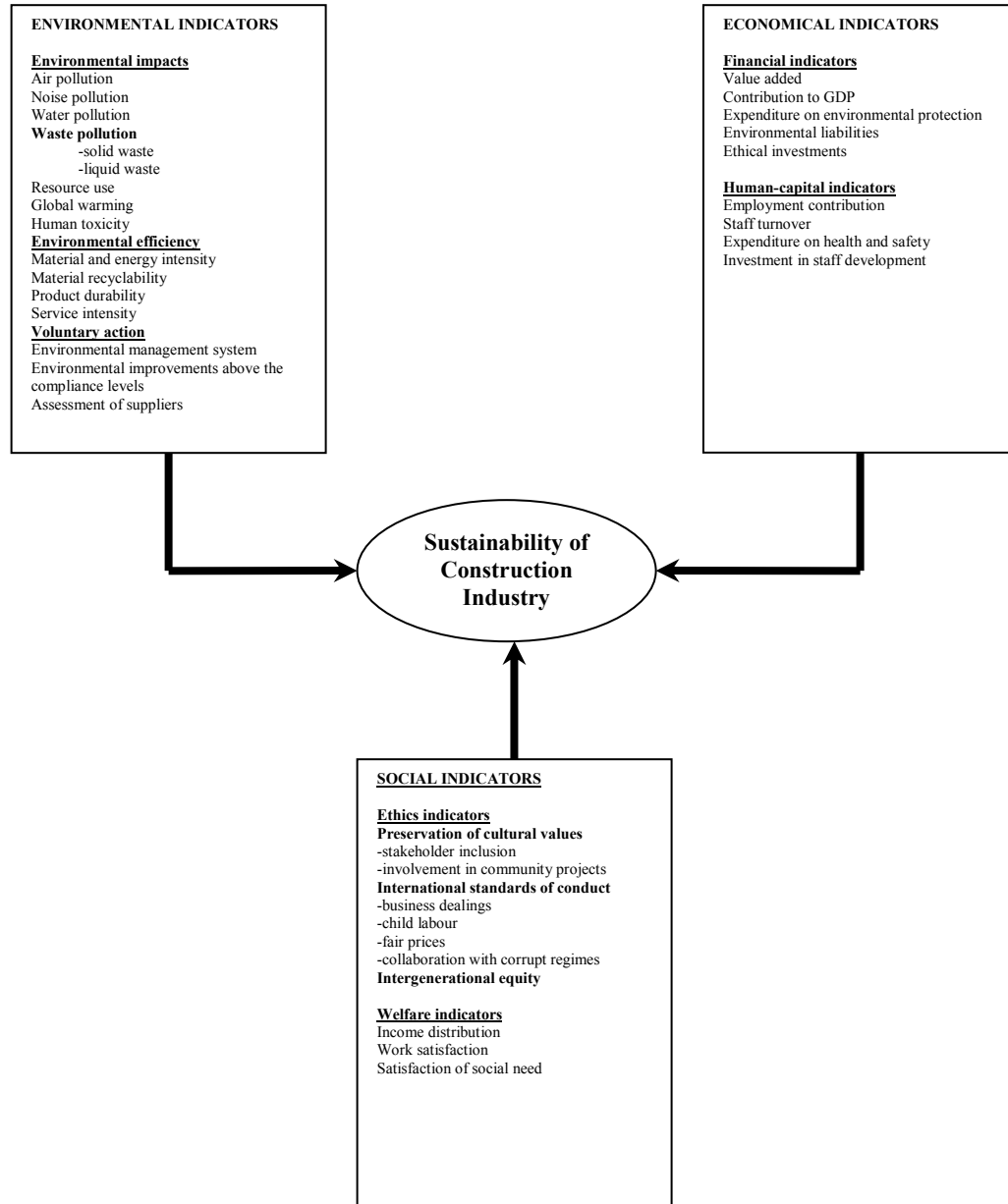


Figure 1.1 : sustainability of construction industry framework adapted from (Azapagic & Perdan, 2000)

Conclusion

Is the world's attention at the present time the preservation of the environment and the life of human societies on earth the most important trends of scientific, philosophical and practical so that leaves most of the studies and research. We note that the rapid developments taking place in the world in terms of population growth and the steady increase in the number of people in addition to the energy crisis and pollution problems

caused by energy consumption significantly and negative effects on the environment, has aroused the interest of various countries around the world, whether exporter or importer of energy.

Sustainability concept being growing over the past two decades and consider now as a cornerstone of most developments and socio-economic activities in built and natural environment. Therefore, the sustainability concept moves us into a thoughtful of relationship with our 'life support' systems. The current initiatives of sustainability, strategies, framework and processes focus in wider national aspirations. Dealing effectively with sustainability should consider the need for extra knowledge, identify database knowledge to make easy to use and practice a new skills to support this process. As well as developing the capabilities of management and leadership to support the promises to sustainable development. Studies indicate that the construction industry alone consumes (40-50%) of the world's energy and more than half of primary natural resources (about three billion tons per year) used in the construction industry and construction. Therefore, the call continues to deal with the environment is more balanced, especially by planners, architects and designers to look for alternatives, planning and design of modern cities and new housing complexes through the use of natural energy sources of new and renewable.

Indicators specifically designed for Malaysian scenario should be formulated and then implemented in the construction industry. This is to ensure a more structured and balanced approach towards achieving sustainability in the construction industry. The developed Malaysian framework could be the right impetus to move the current inertia in promoting sustainable development as demonstrated by the country's construction companies. It is hoped that construction companies will not be scared and put off by the term "sustainable development", perceiving it to be cost additions. Rather, with an assessment tool integrating all the pillars of sustainable development, those are, environmental, economic and social, the companies will form a learned judgments towards construction sustainability.

References

- Azapagic, & Perdan, S. (2000). Indicators of Sustainable Development for Industry: A General Framework. *Process Safety and Environmental Protection*, 78(4), 243-261.
- Bentivegna, V., Curwell, S., Deakin, M., Lombardi, P., Mitchell, G., & Nijkamp, P. (2002). A vision and methodology for integrated sustainable urban development: BEQUEST. *Building Research & Information*, 30(2), 83-94.
- Bourdeau, L. (1999). Sustainable development and the future of construction: a comparison of visions from various countries. *Building Research & Information*, 27(6), 354-366.
- Boyko, C., Cooper, R., Davey, C., & Wootton, A. (2006). Addressing sustainability early in the urban design process. *Management of Environmental Quality: An International Journal*, 17(6), 689-706.
- Brochner, J., Ang, G. K. I., & Fredriksson, G. (1999). Sustainability and the performance concept: encouraging innovative environmental technology in construction. *Building Research & Information*, 27(6), 367-372.
- Browne, D., O'Regan, B., & Moles, R. (2005). A comparative analysis of the application of sustainability metric tools using Tipperary Town, Ireland, as a case study. *Management of Environmental Quality: An International Journal*, 16(1), 37-54.
- Buchholz, T. S., Volk, T. A., & Luzadis, V. A. (2007). A participatory systems approach to modeling social, economic, and ecological components of bioenergy. *Energy Policy*, 35, 6084-6094.
- Cashmore, M., Bond, A., & Cobb, D. (2007). The Contribution of Environmental Assessment to Sustainable Development: Toward a Richer Empirical Understanding. *Environ Manage* 40, 516-530
- Cole, R. J. (1998). Emerging trends in building environmental assessment methods. *Building Research and Information* 26(1), 3-16.
- Cole, R. J. (2005). Building environmental assessment methods: redefining intentions and roles. *Building Research & Information*, 35(5), 455-467.
- Ding. (2005). Developing a multicriteria approach for the measurement of sustainable performance. *Building Research & Information* 33(1), 3-16.
- Ding, G. K. C. (2007). Life cycle energy assessment of Australian secondary schools. *Building Research & Information*, 35(5), 487-500.
- Ding, G. K. C. (2008). Sustainable construction--The role of environmental assessment tools. *Journal of Environmental Management*, 86(3), 451-464.
- Enoma, A., & Allen, S. (2007). Developing key performance indicators for airport safety and security. *Facilities*, 25(7), 296-315.
- Evans, A., Strezov, V., & Evans, T. J. (2008). Assessment of sustainability indicators for renewable energy technologies. *Renewable and Sustainable Energy Reviews*. In Press, Corrected Proof.
- Fricker, A. (1998). Measuring up to sustainability. *Futures*, 30(4), 367-375.
- George, C. (1999). Testing For Sustainable Development through Environmental Assessment. *ENVIRON IMPACT ASSESS REV* 19, 175-200.
- Gibberd, J. (2005). Assessing sustainable buildings in developing countries—the sustainable building assessment tool (SBAT) and the sustainable building lifecycle

- (SBL). In: Proceedings of the 2005 World Sustainable Building Conference, Tokyo, 27–29 September 2005, pp. 1605–1612.
- Gloet, M. (2006). 'knowledge management and the links to hrm developing leadership and management capabilities to support sustainability'. *Management Research News*, 29(7), 402-413.
- Gomes, V., & Silva, M. G. d. (2005). Exploring sustainable construction: implications from Latin America. *Building Research & Information*, 33(5), 428-440.
- Guy, G. B., & Kibert, C. J. (1998). Developing indicators of sustainability: US experience *Building Research & Information*, 39-45(1), 26.
- Kaatz, E., David, S. R., Paul, A. B., & Richard, C. H. (2006). Advancing key outcomes of sustainability building assessment. *BUILDING RESEARCH & INFORMATION* 34(4), 308-320.
- Kaatz, E., Root, D., & Bowen, P. (2005). Broadening project participation through a modified building sustainability assessment. *Building Research & Information*, 33(5), 441-454.
- Klostermann, J. E. M., & Cramer, J. (2007). Social construction of sustainability in water companies in the Dutch coastal zone. *Journal of Cleaner Production*, 15(16), 1573-1584.
- Kuñtz, S. (2007). Adoption of sustainable development schemes and behaviours in Italy Barriers and solutions – what can educators do? *International Journal of Sustainability in Higher Education*, 8(2), 155-169.
- Lützkendorf, T., & Lorenz, D. P. (2006). Using an integrated performance approach in building assessment tools. *Building Research & Information*, 34(4), 334-356.
- Martínez de Anguita, P., Alonso, E., & Martín, M. Á. (2008). Environmental economic, political and ethical integration in a common decision-making framework. *Journal of Environmental Management*, 88(1), 154-164.
- Mayer, A. L. (2008). Strengths and weaknesses of common sustainability indices for multidimensional systems. *Environment International*, 34(2), 277-291.
- OECD. (2004). *KEY ENVIRONMENTAL INDICATORS*. Paris.
- Patermann, C. (1999). The fifth EU framework programme and its consequences for the construction industry. *Building Research & Information*, 27(6), 412-418.
- Pawlowski, C. W., Fath, B. D., Mayer, A. L., & Cabezas, H. (2005). Towards a sustainability index using information theory. *Energy*, 30(8), 1221-1231.
- Pearce, D. (2006). Is the construction sector sustainable? definitions and reflections. *Building Research & Information*, vol. 34(no. 3), pp. 207-201.
- Plessis, C. d. (2005). Action for sustainability: preparing an African plan for sustainable building and construction. *Building Research & Information*, 33(5), 405 - 415.
- Reed, B. (2007). Shifting from 'sustainability' to regeneration. *Building Research & Information*, 35(6), 674-680.
- San-Jose, J. T., Losada, R., Cuadrado, J., & Garrucho, I. (2007). 'Approach to the quantification of the sustainable value in industrial buildings'. *Building and Environment* 42, pp. 3916–3923.
- TCPA. (2003). Town and Country Planning Association. Building sustainability: How to plan and construct new housing for 21st century, TCPA, london, UK.
- Ugwu, & Haupt, T. C. (2007). Key performance indicators and assessment methods for infrastructure sustainability--a South African construction industry perspective. *Building and Environment*, 42(2), 665-680.

- Ugwu, Kumaraswamy, Wong, & Ng. (2006a). Sustainability appraisal in infrastructure projects (SUSAIP): Part 1. Development of indicators and computational methods. *Automation in Construction*, 15(2), 239-251.
- Ugwu, Kumaraswamy, Wong, & Ng. (2006b). Sustainability appraisal in infrastructure projects (SUSAIP): Part 2: A case study in bridge design. *Automation in Construction*, 15(2), 229-238.
- Van Bueren, E., & De Jong, J. (2007). Establishing sustainability: policy successes and failures. *Building Research & Information*, 35(5), 543-556.
- Warnock, A. C. (2007). An overview of integrating instruments to achieve sustainable construction and buildings. *Management of Environmental Quality: An International Journal*, 18(4), 427-441.
- WCED. (1987). *Our Common Future*. Oxford University Press. Oxford and New York.
- Wilson, J., Tyedmers, P., & Pelot, R. (2007). Contrasting and comparing sustainable development indicator metrics. *Ecological Indicators*, 7(2), 299-314.
- World Bank. (1997). *Expanding the measure of wealth, environmentally sustainable development series*. Washington.