CONCEPTUAL MODEL OF COST-BENEFIT ANALYSIS FOR MONETARY AND NON-MONETARY ITEMS IN INDUSTRIALISED BUILDING SYSTEM (IBS) PROJECT

Siti Nur Atikah Abd Rashid[1], Natasha Khalil[2]*, Haryati Mohd Isa[3]
[1] Postgraduate Centre, *Universiti Teknologi MARA, Perak Branch, 32610 Seri Iskandar, Perak, Malaysia*
[2 3] *Department of Quantity Surveying, Universiti Teknologi MARA, Perak Branch, 32610 Seri Iskandar, Perak, Malaysia*
*Corresponding author: natas582@perak.uitm.edu.my

Abstract

Industrialised Building System (IBS) is known as a construction system that consists of a combination of components manufactured either on-site or off-site then positioned and assembled into structures. Among the benefits of IBS construction includes labour cost reduction, support desirable environment; maximize efficient use of resources and waste minimisation towards sustainable construction. However, the Malaysian construction industry still has a low take-up rate on IBS construction. The benefits of IBS are more reliable to be presented in a tangible (monetary) value and intangible (non-monetary) basis rather than descriptive benefits. Hence, to promote the project's viability via IBS, Cost-Benefit Analysis (CBA) can be used to identify the soft issue or non-direct cost and elicits more transparency in IBS projects. This paper presents the conceptual review of the fundamental theory of CBA on the measurement of cost and benefits that can be converted as a weighing impact for an IBS project. An initial conceptual model known as CBA-IBS model is proposed as an approach that a decision maker can use to find the balance between the amount of effort invested in the initial cost of IBS construction and the realised revenues. This study concluded that CBA is able to foster the viability of IBS in more comprehensive criteria of monetary and non-monetary benefits.

Keywords: Cost-Benefit Analysis, Industrialised Building System, Monetary Benefit, Non-Monetary Benefits

Article history:
Submitted: 12/02/2019; Revised: 07/06/2019; Accepted: 11/06/2019; Online: 01/10/2019

INTRODUCTION

IBS is a technique of construction whereby components are manufactured in a controlled environment, either on- site or off- site, placed and assembled into construction works. As supported by Jabar et al (2013), IBS is a process of producing building components off-site in a large-scale production, delivered and installed into a structure at the site with minimum site work. Among the flagrant benefits of IBS construction includes labour cost reduction, support a desirable environment, maximize efficient use of resources and waste minimisation towards sustainable construction.

IBS construction method was not new to Malaysia as it was introduced in the 90s. According to Mohd Nawi et al (2015), the history of IBS's implementation in Malaysia has begun with two pilot projects by government where the first project was located at Jalan Pekeliling which involved the consist of 7 blocks of 17 storey flats, and 4 blocks of 4-storey flats and 40 storey shops lots. However, despite early implementation and numerous benefits of IBS, the Malaysian construction industry still has a low take-up rate on IBS construction. As retrieved from Bernama (2018), the Construction Industry Development Board (CIDB) Malaysia Chairman revealed that Malaysia is still 20 years behind in the adoption of IBS due to high costs, technical issues, standardisation of components size and economies of scale. Only 24% of public projects that worth above RM10 million achieved IBS score of 70 and this is beyond the targeted of 100% take-up rate. As at May 2016, Malaysian Works Minister, Datuk Fadillah Yusof said that about 69% of government projects used IBS, while the adoption rate by the private sector is still low around 14%, according to CIDB's study in 2014 (Idris, 2017). It is also revealed by Abd Hamid et al. (2008) that one of the major reasons for reluctance in using IBS for construction is the construction companies find it hard to foresee the benefits of IBS due to insufficient information to support feasibility for change.

To promote the project's viability via IBS, the benefits are more reliable to be presented in tangible value and intangible basis rather than descriptive benefits. Monetary (tangible) and non-monetary (intangible) criteria are significant to establish a more precise expense appraisal model for the IBS industry in Malaysia. Therefore, Cost -Benefit Analysis (CBA) can be used to identify the soft issue or non-direct cost and elicits more transparency in IBS projects. CBA provides a comprehensive set of information by breaking down the relevant indicators and stating clearly the degree of intergenerational equity implicit in a project (Williams, 2008). This study is aimed to develop a model of monetary and non-monetary indicators of CBA for IBS projects, or known as CBA-IBS model. CBA-IBS model is proposed as an approach that a decision maker can use to find the balance between the amount of effort invested in the initial cost of IBS construction and the realised revenues.

ISSUE STATEMENT: BENEFITS AND VIABILITY OF IBS

Awareness in the field of green and sustainability in the Malaysian construction industry is staggering as it helps to reduce the adverse impact on the environment and natural resources. Greater attention among stakeholders, developers, building owners, manufacturers and investors in public or private sectors have allocated the criteria of sustainability as a high priority in the construction development. Sustainable in construction is achievable by using Industrialised Building System (IBS) method. IBS can be considered as one of the most appropriate ways to serve sustainable building projects and provides advantageous solutions to reduced construction waste (Yunus & Yang, 2011). Several benefits of IBS that contributed to the aspects of sustainable development by previous researchers are summarised in Table 1.

Table 1: Summary of IBS's benefits in the construction industry

SOURCE(S)	BENEFITS OF IBS
(Ahmad Bari et al., 2012)	• Better supervision on maintaining the quality of prefabricated products, • reduced overall construction costs, • shortened construction time, • improved environmental performance due to waste minimization, and • better building design and construction integrity.
(Mohammad, 2013)	• reduction of unskilled worker (in the case of Malaysia, unskilled migrant workers); • less wastages • less volume of site materials • increased environmental and construction site cleanliness • better quality control • promote safer and organised construction site, • reduce the completion time of construction
(Yunus & Yang, 2011)	• better control human resources and cost, • shorten construction period • increase the quality of buildings, • enhance occupational health and safety • reduced construction waste.
(Musa et al., 2014)	• attaining better construction quality, • efficiency and productivity, • reducing risks related to occupational safety and health, • speed up project duration, flexible (reuse, movable, deconstruction and refurbishment) • Achieving the ultimate goal of reducing the overall cost of construction (economy of scale in manufacturing of multiple repeated units).
Yunus and Yang, 2015	• minimising construction time, • increasing the quality of buildings, • reducing construction cost, • enhancing occupational health and safety, • reducing construction waste.
(Shamsuddin et al., 2013)	• advantage economic or monetary perspectives • workmanship quality, • speed of construction • cost savings. • reduce maintenance and operation cost.

The summary of benefits in Table 1 shows that IBS is beneficial to the project owner, developers, contractors, and other parties in various forms and aspects. These benefits were justified as descriptive benefits and advantages of IBS application. In the recent context, the market in the construction industry needs to respond to the greater demand for social, economic and environmental improvements of the industry. It is essential to create a built environment that is both sustainable and economically viable if sustainable design and construction are approached holistically (Shamsuddin et al., 2017). Ideally, the benefits of IBS are more reliable to be presented in economic aspects that highlight the monetary and tangible value. Table 2 shows several studies on IBS that present the outcome of monetary benefits.

Table 2: Monetary benefits of IBS from the previous studies.

SOURCES	THE BENEFITS OF IBS	TYPES OF BENEFITS
Abdul Kadir, et al., 2006	•Impact of quantity (number houses per project) on actual labour productivity •Impact of workers' daily salary on actual labour productivity •Overall construction cost	Monetary benefits
Majid et al, 2011	•Material cost •Number of labours	Monetary benefits
Shamsuddin et al., 2017	•Generating the total discounted cost of building ownership throughout the building's life (LCC).	Monetary benefits

Relatively, there is little attempt of studies that measure the non-monetary criteria related to the benefits of IBS. Many academic studies on IBS in the Malaysian construction industry have merely focused on technical issues (hard issues) such as design structure, material testing, and product development (Mohd Nawi et al., 2015). The primary benefits of IBS are still lacking in the field of economics specifically on the intangible or non-monetary indicators. It is significant to present the indirect costs and non-measurable items contributed to the benefits of IBS to foster the transition towards sustainable construction and green purchasing processes. This is also supported by Ahmad Bari (2011) that described the main benefits of IBS are from indirect cost savings and non-cost value adding items although off-site production offers direct cost benefits. Moreover, other costs related items that perceived as insignificant such as life cycle, health and safety and effects on energy consumption are often disregarded (Yunus & Yang, 2011). Rough cost evaluation models are found to be established a base on the normal development expense of a unit amount. For assessment on outline options and quality building at the configuration organizes, a more precise expense appraisal model is essential (CIDB, 2013). Precise expense appraisal is essential means that all the possible costs need to take into account not only in terms of monetary, but also non-monetary cost. (Shamsuddin et al., 2013) also stated that intangible cost is difficult to quantify and do not have firm value. Estimations of value are based on experience and assumption.

Hence, a uniform indicator is needed in order to standardize the measurement of intangible cost for IBS projects. Therefore, Cost- Benefit Analysis (CBA) can be used to identify the monetary and non-monetary cost or soft issue or non-direct cost in IBS projects. CBA presents its fundamental theory on the measurement of cost and benefits that can be converted as a weighing impact for a project. The theory of CBA also suggests that the evaluation or measurements on the impact using the human capital approach, implicit and explicit valuation approach. The indicators in CBA are usually called as the projects 'net benefits' or 'net present value' and is often interpreted as a measure of its social desirability (Nyborg, 2014). CBA can convert its "benefit" and "cost" from nonmonetary to monetary where it can provide a quantifiable, objective, balanced and impartial framework in weighing up different impact of a project. A well-planned CBA can tell a policy maker everything they need to know about a project, breaking down the relevant costs and benefits in such a way as to give the decision maker the most comprehensive set of information (Williams, 2008). There are some "benefits" and "cost" that may be difficult to estimate with precision but CBA is still useful in providing a clear and result driven decision making a framework with quantitative and qualitative information.

METHODOLOGY

This study was done through an analysis of the literature review on the monetary and non-monetary indicators of CBA that related to the IBS method of construction. The resources of the study are mostly from the secondary data which is journals and articles, conference proceedings, and also a guideline form Construction Industry Development Board (CIDB) related to IBS. The resources were taken between years 2003 until 2018 in order to ensure that all the information was included. The articles were mostly retrieved from Scopus, Emerald, Ebscohost, Science Direct and Google Scholar using keywords "Industrialised Building System", "Cost-Benefit Analysis", "Monetary Benefit" "Monetary Value", "Non-Monetary Value" and "Life Cycle Cost". For this review paper, more than 24 articles are included in the review analysis.

LITERATURE REVIEW

Overview of IBS in the Construction Industry

Industrialised Building System (IBS) as a construction system with a combination of components manufactured either on or off-site then positioned and assembled into structures (CIDB, 2003). IBS is beneficial to the context of construction objective in delivering efficient building capacity and reduce construction waste (Bonev et al, 2015). This is supported by Jailon (2009) that describes the average wastage reduction level through the implementation of IBS achieves 52% in their study findings. The IBS method also promotes the current state in the industry on the growth towards sustainable construction. IBS is a sustainable construction that able to deliver built-up assets that enhance the quality of life, fulfils customer's satisfaction and maximise the efficient use of resources (Shamsuddin et al., 2013). This is a rather remarkable rate compared to constructions without IBS operation. Several aspects of the IBS that have the potential of contributing to different aspects of sustainable development and construction includes i) Sustainability from a controlled production environment, and ii) waste minimisation and organised logistics (Mohammad, 2013)

In outlining the benefits of IBS, typically the lists of advantages are clearly described in various aspects. To cater the trend in the construction industry, the relevant stakeholders need to respond to the greater demand for social, economic and environmental improvements of the industry, the price or cost to adhere such project, somehow is a burden to the contractor. If sustainable design and construction are approached holistically, using integrated design with modern materials and systems, it is entirely possible to create a built environment that is both sustainable and economically viable (Shamsuddin et al., 2017). Therefore, Cost-Benefit Analysis (CBA) is introduced as the approach to presents the marginal benefits of IBS in both measureable (cost) and non-measureable attributes. In this context, "marginal" means that the project's impacts on market values, as well as marginal non-market values including individuals' marginal utility of income, are small enough to be disregarded (Nyborg, 2014).

Overview of Cost-Benefit Analysis (CBA) Method

CBA is the most comprehensive method for comparing projects because it creates a common measurement for all costs and benefits. CBA is useful in deciding whether or not to make a large capital expenditure, for instance, the client's decision whether to purchase a particular machine or to lease it. Another example would be in choosing between two similar devices to purchase when one costs more and is expected to last a few years longer than the other. Hence, CBA would help a manager make an informed decision in these situations (Mott Lin, 2010). CBA is the most comprehensive method for comparing projects because it creates a common measurement for all costs and benefits (Williams, 2008). It also gives the decision maker the most comprehensive set of information as not only the cost of the method will be count, but also the cost of benefit gains from the method used from the outlined criteria or indicators in CBA. As described by (Nyborg, 2014), the resulting indicator is usually called as the project's 'net benefits' or 'net present value' and is often interpreted as a measure of its social desirability. By quantifying and stating clearly the degree of intergenerational equity implicit in an environmental project, the indicators of environmental profitability proposed elicit more transparency, helps in reconciling the CBA technique with the objective of sustainability and may be useful in public decision-making (Sáez & Requena, 2007)

Rationale of CBA in IBS

A common approach to public project evaluation is thus to estimate people's willingness to pay for changed public good provision, use this as a measure of the social benefits of the environmental change at hand, and then compare these benefits to project costs and other social impacts through CBA (Nyborg, 2014). In CBA, there are sets of parameters, criteria, attributes of indicators acted as the benchmark of measurement on how to calculate the cost and the benefits gains from certain project, including IBS projects. To measure a cost or benefit, the price should be assign as the relevant variables that has impacted to the projects. As such, the price used in a CBA could be the price given after adjusting for this distortion, also known as the 'shadow price' of the benefit (Williams, 2008). Based on the analytical review on the CBA indicators from previous studies (Shamsuddin et al., 2017; Shamsuddin et al., 2013, 2015; Williams, 2008; Yunus & Yang, 2011), it was found that the indicators are generally divided into monetary (tangible) and non-monetary (intangible) benefits. However, there is no standard of criteria or indicators that are specifically allocated in accordance to the project category. The CBA indicators are also called as sustainable criteria, as presented by (Yunus & Yang,

2011) in their study. For IBS, the indicators of CBA should emphasize the project's viability in terms of sustainability in cost, time and quality.

INITIAL CONCEPTUAL MODEL OF THE CBA INDICATORS AND IBS (CBA-IBS MODEL)

The summary of the CBA indicators is depicted in Figure 1 as an initial conceptual model for the IBS project in this study. The initial model was established and compiled from precedent research and studies by Shamsuddin et al., (2017); Shamsuddin et al., (2013); Shamsuddin et al., (2015); Williams, (2008) and Yunus & Yang,(2011). As shown in Figure 1, the indicators were grouped into two (2) main categories – monetary indicators and non-monetary indicators. The category is further divided into five (5) sub-category, i) cost, ii) financial case, iii) economic value, iv) social value, and v) environmental. The indicators for monetary for cost are *initial cost, direct cost, compliance cost, maintenance and repair, replacement cost, operating cost and energy cost*. Indicators for the financial cases are *capital revenue income, resale value, return on investment (ROI) and payback period*. The indicators for non-monetary for economic value are *buildability, design, decision, sensitivity, quality, time, schedule, efficiency, transportation, and production.* For social value, the indicators are *human capital, architectural impact, inclusive environment, occupants' comfort and occupants' satisfaction*. Lastly, the Indicators for environmental benefits are *wastage, preservation, energy consumption, recyclability/ renewable and carbon emission.*

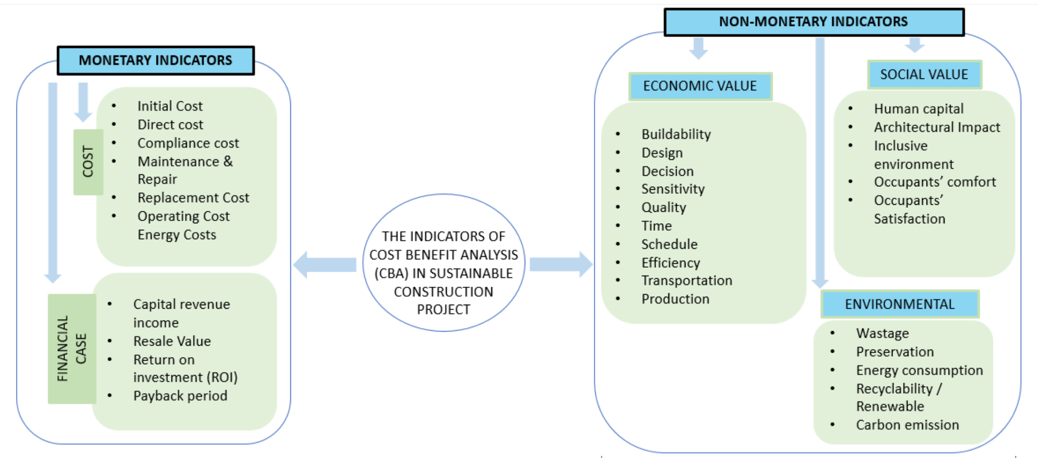

Figure 1: Initial conceptual model of monetary and non-monetary indicators of CBA for IBS projects (CBA-IBS model)
(compiled from Shamsuddin et al., (2017); Shamsuddin et al., (2013); Shamsuddin et al., (2015); Williams, (2008) and Yunus & Yang,(2011))

From the initial conceptual model, the confirmed indicators should be matched to the context of IBS construction and will be a theoretical basis for decision-makers in adopting IBS for their construction projects. To enhance understanding on the terms, the definition of each indicators are compiled from various articles such as Shamsuddin et al., (2017); Shamsuddin et al., (2013); Shamsuddin et al., (2015); Williams, (2008) and Yunus & Yang,(2011); Ali et al. (2012); Jabar et al., (2013); Mohd Nawi et al., (2015); Mohd Nawi et al., (2014); Ogunde et al., (2018) and others. Table 3 and Table 4 summarised the definition of each indicator in the monetary and non-monetary benefits:

Table 3: Description of Monetary Indicators

CATEGORY	INDICATORS	DESCRIPTION
Cost	Initial Cost	A cost included during the design and construction process (Samaras et al.,2013)
	Direct cost	A cost that attributed completely to the production of service or goods (David, 2007)
	Compliance cost	Expenses that a firm adhere with government requirement such as regulation or legislation (Mansor, Saad, & Ibrahim, 2004)
	Maintenance & Repair	A cost incurred for maintenance and repair works (Phillips & Phillips, 2009)
	Replacement Cost	A cost to replace an asset at the present time, according to its current worth (Wyatt, 2009)
	Operating Cost	A cost involved in the general running operation day-to-day basis (Samaras et al.,2013)
	Energy Costs	Cost of energy or power used (Samaras et al.,2013)

Financial	Capital revenue income	Income gains from the asset and sale (Gordon & Slemrod, 1988)
	Resale Value	Expected amount the sale back in the future (Sreekumar, 2015)
	Return on investment (ROI)	A profitable measure the evaluates the performance of a business (Phillips & Phillips, 2009)
	Payback period	The amount of time taken for a project to recover its initial cost (Samaras et al.,2013)

Table 4: Description of Non-Monetary Indicators

CATEGORY	INDICATORS	DESCRIPTION
Economic value	Buildability	Architectural design that ease in constructing the structure (Yusof et al., 2016)
	Design	A plan to show the shape or function of the building or structure (Hamzah, 2014)
	Decision	The judgement made after making several considerations (Heralova, 2014)
	Sensitivity	Understand what other people need regarding their conditions (Williams, 2008)
	Quality	Degree of excellence of the building or structure (Mohd Nawi et al., 2014)
	Time	Periods of time in completing the project (Ahmad Bari et al., 2012)
	Schedule	A plan in carrying out the program by showing the time and dates (Mohd Nawi et al., 2014)
	Efficiency	Ability to produce quality structure without wasting materials, energy and time (Majid et al., 2011)
	Transportation	Plant and machineries used while moving the structure from one place to another (Shamsuddin et al., 2013)
	Production	Process of turning raw material into a structure (Shamsuddin et al., 2013)
Social value	Human capital	Knowledge, skills and experience that human or labour possess which make them valuable (Williams, 2008)
	Architectural Impact	Shape and design of the building or structure can affect an individual's behaviour, mood, and perception (Yunus & Yang, 2011)
	Inclusive environment	Environment where people connect and respect each other (Yunus & Yang, 2011)
	Occupants' comfort	The feel of ease towards the people who live there (Shamsuddin et al., 2013)
	Occupants' satisfaction	Fulfilment of expectation towards the people who live there (Shamsuddin et al., 2013)
Environmental value	Wastage	Waste that generate during construction (Ahmad Bari et al., 2012)
	Preservation	Protect and prolonged and heritage building (Shamsuddin et al., 2013)
	Energy consumption	Amount of power or energy used (Motawa & Oladokun, 2015)
	Recyclability / Renewable	Process of waste material and used again (Yunus & Yang, 2015)
	Carbon emission	Carbon dioxide that released into the atmosphere (Motawa & Oladokun, 2015)

CONCLUSION

IBS method of construction can give lots of benefits to parties involves as it also produces a sustainable construction which can improve the environment into a better one. Nevertheless, the IBS method of construction in Malaysia still low in its adoption. This study proposes a basic study in determining the Cost-Benefit Analysis (CBA) indicators in monetary and non-monetary aspects. As described in this study, CBA is able to highlight the viability of IBS for construction in more comprehensive criteria of monetary and non-monetary benefits. Hence, initial conceptual model of monetary and non-monetary indicators of CBA for IBS projects or CBA-IBS model is proposed as an approach that a decision maker can use to find the balance between the amount of effort invested in the initial cost of IBS construction and the revenues as a theoretical basis for decision-makers in adopting IBS for their construction projects.

Acknowledgment

The authors wish to acknowledge the support and fund by Pusat Pengajian Siswazah UiTM Perak for submission of this research paper.

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