Monetary and Non-Monetary Indicators of Cost-Benefit Analysis in Industrialised Building System Project: An Initial Conceptual Model

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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, Malaysian construction industry still has a low take-up rate on IBS construction. Hence, to promote the project's viability via IBS, ideally, the benefits of IBS are more reliable to be presented in tangible (monetary) value and intangible (non-monetary) basis rather than descriptive benefits. Therefore, Cost-Benefit Analysis (CBA) can be used in order 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 highlight the viability of IBS for construction in more comprehensive criteria of monetary and non-monetary benefits. This paper is a review of previous studies on monetary and non-monetary indicators of CBA that suit with IBS project. The study is supported by existing literature, primarily in the most recent research, which supports the indicators of CBA. From the literature reviews, sets of monetary and non-monetary indicators of CBA that related to IBS is obtained. The result of this study will provide novel ideas to optimize sustainable construction and prolong sustainability in design, financial, buildability, operation, life-cycle and environmental aspects. CBA-IBS model will be introduced as a theoretical basis for decision-makers in adopting IBS for their construction projects.

1 Introduction

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 flagrant benefits of IBS construction includes labour cost reduction, support desirable environment, maximize efficient use of resources and waste minimisation towards sustainable construction. However, Malaysian construction industry still has a low take-up rate on IBS construction. 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. To date, as at May 2016, 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 [1]. Hence, to

promote the project's viability via IBS, ideally, the benefits of IBS are more reliable to be presented intangible 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 IBS industry in Malaysia. Therefore, Cost-Benefit Analysis (CBA) can be used in order 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 [2]. 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

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revenues. and this should be taken into account when preparing them.

2 Problem Statement

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 construction development. Sustainable in construction is achievable by using the 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 [3]. 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
[4]	<ul style="list-style-type: none"> • 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.
[5]	<ul style="list-style-type: none"> • reduction of unskilled worker (in the case of Malaysia, unskilled migrant workers); • fewer 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
[3]	<ul style="list-style-type: none"> • better control human resources and cost, • shorten construction period • increase the quality of buildings, • enhance occupational health and safety • reduced construction waste.
[6]	<ul style="list-style-type: none"> • attaining better construction quality, • efficiency and productivity,

	<ul style="list-style-type: none"> • 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 the manufacturing of multiple repeated units).
[7]	<ul style="list-style-type: none"> • minimising construction time, • increasing the quality of buildings, • reducing construction cost, • enhancing occupational health and safety, • reducing construction waste.
[8]	<ul style="list-style-type: none"> • advantage economic or monetary perspectives • workmanship quality, • speed of construction • cost savings. • reduced 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 [9]. 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. The final printed area will be 172 x 252 mm.

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

SOURCES	THE BENEFITS OF IBS	TYPES OF BENEFITS
[10]	<ul style="list-style-type: none"> • 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

[11]	<ul style="list-style-type: none"> •Material cost •Number of labours 	Monetary benefits
[9]	<ul style="list-style-type: none"> •Generating the total discounted cost of building ownership throughout the building's life (LCC). 	Monetary benefits

Relatively, there is a 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 [12]. 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 [13] 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 [3]. Rough cost evaluation models are found to be established a base on the normal development expense of a unit amount. For an assessment on outline options and quality building at the configuration organize, a more precise expense appraisal model is essential [16]. Precise expense appraisal is essential means that all the possible cost need to take into account not only in terms of monetary, but also non-monetary cost. [8] 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 in order to identify the monetary and non-monetary cost or soft issue or non-direct cost in IBS projects. CBA presents it 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 human capital approach, implicit and explicit valuation approach. The indicators in CBA are usually called the project's 'net benefits' or 'net present value' and is often interpreted as a measure of its social desirability [15]. 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 the different impact of a project. A well-planned CBA can tell a policymaker 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 [2]. 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. white, and this should be taken into account when preparing them.

3 Methodology

This study was done through an analysis of 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 the years 2003 until 2017 in order to ensure that all the information was included. The journal article mostly retrieved from Scopus, Emerald Insight, Researchgate and Google Scholar using keywords "Industrialised Building System" and "Cost-Benefit Analysis". Based on the existing literature, the monetary and non-monetary indicators are then analysed. white, and this should be taken into account when preparing them.

4 Literature Review

4.1 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 [16]. IBS is beneficial to the context of construction objective in delivering efficient building capacity and reduce construction waste [17]. This is supported by [18] that describe 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 [8]. 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 controlled production environment, and ii) waste minimisation and organised logistics [5].

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 [9]. 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 [15].

4.2 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, clients' 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 [19]. CBA is the most comprehensive method for comparing projects because it creates a common measurement for all costs and benefits [2]. 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 [15], the resulting indicator is usually called 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 elicits more transparency, helps in reconciling the CBA technique with the objective of sustainability and may be useful in public decision-making [20].

4.3 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 [15]. 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 assigned as the relevant variables that have impacted 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 [2]. Based on the analytical review on the CBA indicators from previous studies [2]-[3],[8]-[9], 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 sustainable criteria, as presented by [3] in their study. For IBS, the indicators of CBA should emphasize the project's viability in terms of sustainability in cost, time and quality.

4.4 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 IBS project in this study. The initial model was established and compiled from precedent research and studies by [2,3,8,9]. As shown in Figure 1, the indicators were grouped into two (2) main category – 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 cost are initial cost, direct cost, compliance cost, maintenance & repair, replacement cost, operating cost and energy costs. Indicators for financial case are capital revenue income, resale value, return on investment (ROI) and payback period. Indicators for economic value are implicit value, explicit value, buildability, design, decision, sensitivity, quality, time, schedule, efficiency, transportation, production and adaptability and flexibility. Indicators for social value are human capital, individuals' stated preferences, architectural impact, inclusive environment, occupants' comfort and occupants' satisfaction. Indicators for last sub-category which environmental are wastage, preservation, energy consumption, recyclability/renewable and carbon emission. 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.

Fig. 1. Initial conceptual model of monetary and non-monetary indicators of CBA for IBS projects (CBA-IBS model) (compiled from [2,3,8,9]).

After the initial framework is built, confirmation of the criteria will be done via a semi-structured interview with an expert to validate these criteria.

5 Conclusion

IBS method of construction can give lots of benefits to parties involves as 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.

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