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Exploring Economic Impacts of Sustainable Construction Projects on Stakeholders: The Role of Integrated Project Delivery

Cheng Siew Goh1 *, Feizhen Su2; Steve Rowlinson3

1 Heriot-Watt University Malaysia, Putrajaya, Malaysia; c.goh@hw.ac.uk
2 Heriot-Watt University Malaysia, Putrajaya, Malaysia; fs34@hw.ac.uk
3 The University of Hong Kong, Hong Kong; hrecsmr@hku.hk

* Corresponding author
Abstract

Climate urgency has driven sustainability and the circular economy into the agenda of the construction industry. Despite growing efforts to promote sustainability, there is still a lack of a widespread implementation of sustainability in construction projects. Cost is often viewed as a main barrier to increasing the adoption of sustainable development in construction projects. Seeking cost efficiency appears as one of the central concerns of construction stakeholders in their sustainability moves. This paper presents an assessment of economic impacts of developing sustainability in construction projects. A questionnaire survey was adopted in the study to collect views of professionals on the economic implications of sustainable construction projects. The results reveal that energy cost saving and green subsidies are the main economic benefits derived from sustainable construction projects. Economic risks such as cost overrun and risks of not meeting the expected rate of return are primary factors hindering the development of sustainable construction practice. The study however found that, in general, construction stakeholders perceived sustainable construction to bring more positive economic impacts than negative economic impacts for most construction stakeholders. The economic value of sustainable construction project can benefit the construction industry value chain from clients to suppliers and end-users, following an increasing demand for sustainability in the construction sector. This paper offers insights into understanding the economic implications of sustainable construction projects. Thinking around economic impacts that span the entire building life cycle is essential to reveal the true economic value of sustainable construction projects. The authors indicate how construction stakeholders, by taking an integrated project delivery (IPD) perspective, can develop a more
holistic view that allows them to gauge the underlying economic value of sustainable construction projects by incorporating long term cost efficiency in the decision making.
Introduction

Global climate change and environmental issues have brought devastating consequences to the world that call for immediate actions to mitigate carbon emissions. The urgent need to reduce rising emissions in the buildings and construction sector is also undeniable. UNEP (2020) reported that energy-related carbon emission increased to a new high - 9.95 GtCO₂ in 2019 due to a shift from direct use of fossil fuels towards electricity. The building and construction sectors accounted for 38% of total global energy related carbon emissions by taking into account operational emissions (UNEP, 2020). The consumption of natural resources in construction increased by 23 times in between 1900 and 2010 and the trend is set to continue (Warr et al., 2010). Therefore, climate urgency has driven sustainability and the circular economy into the agenda of the construction industry.

Sustainability in construction is the integration of sustainable development principles into building and construction practice throughout the life cycle, from planning, construction, operation, demolish, and waste management (Yilmaz and Bakis, 2015). It is a process aiming to create suitable settlements for human and economic development without harming natural environment. The United Nations developed 17 Sustainable Development Goals (SDGs) as the blueprint to achieve a more sustainable future to address the global climate change challenges. There are several front sustainable construction can contribute towards meeting the SDGs identified by United Nations and the SDGs include SDG 3 (good health and wellbeing), SDG 6 (clean water and sanitation), SDG 7 (affordable and clean energy), SDG 8 (decent work and economic growth), SDG 9 (industry, innovation and infrastructure), SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), SDG 13 (climate action), SDG 15 (life on land)
and SDG 17 (partnership for the goals). The alignment of sustainable construction to these SDGs suggests that a more holistic and balanced approach should be taken in the quest to create a sustainable built environment. Sustainable construction emphasizes a balanced development between the triple bottom line – environment, society and economy. It offers not only environmental protection solutions to construction practice but an all-round formula for making the built environment a more environmentally, socially and economically viable.

Despite of growing efforts to promote sustainability, there is a lack of a widespread implementation of sustainability in construction projects. Cost is often viewed as a main barrier to the uptake of sustainable development in construction projects. Cost is regarded as one of the most crucial barriers to sustainable construction in China, Hong Kong, Singapore, United States, and Malaysia (Deng & Wu, 2014; Dwaikat & Ali, 2018; Fan et al., 2018; Hwang et al., 2017; Robichaud & Anantatmula, 2011; Zhang et al., 2018). The misconception of high capital cost has been regarded as a key factor affecting the demand for sustainable construction projects in the market. As described by Zhang et al. (2018), the narrow understanding of economic viability remains controversial since business sectors have a concern that increased cost involved would erode financial performance, thus undermining the adoption of sustainability in construction.

Seeking cost efficiency appears to be a central concern of construction stakeholders in their sustainability moves.

Higher upfront cost is normally incurred in sustainable construction projects to incorporate innovative sustainability initiatives into practice. Zhang et al. (2018) reported that certified sustainable buildings have an incremental cost of -0.4% to 11% depending on the rating level
achieved and the certification system. A LEED certified project was reported to incur 1.84% more
cost, while a LEED platinum building increased the construction cost by a minimum of 6.5% (Lu
et al., 2013). The additional costs involve soft cost and hard cost. Soft cost refers to expenses
associated with intangible items or services that do not form part of built assets such as design and
simulation fees, green certification fees, cost of adapting existing processes, modelling integration,
management and consultant fees (Deng & Wu, 2014). Hard costs are incurred associated with
tangible items such as the cost of building structure, materials, equipment, landscape, etc.

On the other hand, cost was also chosen as the main reason of building sustainable by more than
half of construction stakeholders in a survey involved over 400,000 architects, engineers and
contractors due to the potential energy cost reduction (McGraw-Hill Construction, 2006). The
economic impact assessment of sustainable construction should not be considered from a short-
term perspective. With proper measures, the upfront cost can be offset or even outweighed by the
long-term economic gains offered by sustainable solutions. The initial incremental cost of going
sustainable can be counteracted by tangible cost benefits (cost savings through lower energy, water,
waste disposal costs; lower operation and maintenance cost) and intangible economic gains
(increased productivity and health; lower environmental impacts and emissions) over the life span
of built assets (Zhang et al., 2018). Lu et al. (2013) described that sustainable commercial buildings
use 26% less energy, reduce 13% maintenance costs, produce 33% less greenhouse gas emissions,
increase occupancy ratio by 3.5%, raise return on investment by 6.6%, increase 7.5% building
values and boost 27% higher occupant satisfaction. Several empirical studies (Deng and Wu, 2014;
Zhang et al., 2018) also suggested that sustainable buildings can generate green price premia in
rental and sale markets, hence offering a positive economic return to investors.
As exemplified above, there could be conflicting economic results of adopting sustainable construction practice. Embracing sustainability in construction projects can generate economic values, with an increase in the upfront costs. Despite numerous efforts made on establishing the cost and benefits of sustainability construction projects (Deng & Wu, 2014; Dwaikat and Ali, 2018; Lu et al., 2013; McGraw-Hill Construction, 2006; Zhang et al., 2018), there is still a gap that provides a clear picture of how construction stakeholders are impacted by sustainable construction projects. It is evident that more studies are required to reveal economic implications of sustainable construction projects by examining the trade-off relationships of various economic performance variables on stakeholders. A full glance of economic impacts should be provided by comparing the cost and revenues throughout the life cycle to determine if the investment can be financially sustainable if the green price premium can be large enough to compensate the additional costs for a meaningful return. It is therefore of great importance to explore economic impacts of sustainable construction projects from the perspectives of different stakeholders throughout the life span of built assets.

Although past studies attempted to establish the economic implications of the adoption and diffusion of sustainability in the construction sector (Deng and Wu, 2014; Lu et al., 2013; Ries et al., 2006; Tan et al., 2011; Zhang et al.; 2018), few studies evaluate economic implications from various perspectives of construction stakeholders. Several researchers look into financial or economic impacts of sustainable construction on the project team but their studies give specific focus on certain stakeholder groups. For instance, Lu et al. (2013) analysed economic performance between green and conventional engineering and construction firms. Deng and Wu (2014) examined the economic viability of investment in energy efficiency from the perspective of
developers. Meanwhile, Zhang et al. (2018) conducted a study of economic viability of sustainable building by focusing on developers and occupants as their main market participants. There is still a need to have a more integrated evaluation of economic implications of sustainable construction for varying construction stakeholder groups.

Understanding economic implications of sustainable construction projects is of importance to assist construction stakeholders in making more informed decisions for sustainable construction initiatives (Lu et al., 2013). Clients and occupants who are always laymen have a low literacy of the economic viability of sustainable buildings. A lack of understanding of the true values and costs of sustainability in construction makes key stakeholders uncertain about the benefits of going sustainable. Construction teams and project clients became skeptical about financial returns and ownership costs of sustainable built assets (Hu & Skibniewski, 2021; Lu et al. 2013). The public are also concerned of economic risks of sustainable built assets and reluctant to support the paradigm of sustainable development in construction (Deng & Wu, 2014). With the scarce public awareness, there would be more challenges to reap the benefits of sustainable investments in construction due to slow development of relevant supporting markets in sustainable technologies.

With the intent to fill the gaps, the primary objectives of this paper are to investigate economic impacts of sustainable construction projects and the level of economic impacts on various stakeholders. This study is guided by the following research questions.

i. Do construction stakeholders perceive that sustainable construction brings more positive economic impacts than negative economic impacts?
ii. Which stakeholders experienced the most significant economic implications brought by sustainable construction projects?

ii. What are positive and negative impacts of sustainable construction projects to construction stakeholders?

The paper is structured into the following sections. The next section draws on literature to examine economic impacts of sustainable construction projects in general as well as economic impacts of various key stakeholders including clients and end users. This is followed by the research method and results and analysis. Thereafter, a discussion is made on the potential of integrated project delivery as an approach of reducing economic risks and improving financial performance of sustainable construction project. The paper concludes with the implications and contributions.

Economic Impacts of Sustainable Construction Projects

Sustainable construction projects have economic impacts on both external and internal project stakeholders. Assessing economic impacts of sustainable construction projects can help identify how well construction stakeholders are affected financially by the shift of sustainability in a positive and/or negative manner. Key stakeholders such as developers and investors are anxious to structurally and monetarily understand sustainable building metrics to make the case for the transition toward sustainability (Ries et al. 2006). According to Azapagic (2003), economic viability is at the heart of developing sustainable construction because it generates profits and creates employment which consequently contributes to the general social welfare. However, the costs and benefits of sustainable construction do not necessarily coincide with monetary outflow and inflows, especially when there are intangible costs and benefit. A more thorough analysis
between initial cost against the recurring or long-term benefits and cost savings is necessitated to
reveal the relationship between sustainable building, business performance, financial return and
market mechanism (Ries et al. 2006).

There are numerous stakeholders to be impacted by a sustainable construction project, from top of
the supply chain of project initiators down to end users. Economic aspect is generally the primary
concern of most construction project stakeholders ranging from clients and employers to
competitors, shareholders, suppliers, contractors, consultants and occupants. As highlighted by
Zhang et al. (2018), the existence of multi-stakeholders in sustainable construction may result in a
split incentive and principal agent problems. Developers, clients and end users are key decision
makers in the sustainable building supply and demand but there has been a mismatch of cost and
benefits to be encountered among the stakeholders (Deng and Wu, 2014). It is crucial to reach a
consensus among all stakeholders about financial feasibility of sustainable construction practice
to boost its application in the market. Therefore, this paper examines the economic impacts from
the perspective of different stakeholder groups and offers a measure to making sustainable
construction practice more cost efficient using the Integrated Project Delivery approach.

Economic Impacts on Clients

One of the major economic advantages of sustainable buildings for clients is that buildings are
likely to have longer economic life span and higher exchange values compared to conventional
buildings. Sustainable buildings have low risks in terms of potential energy cost escalations and
stricter government environmental regulations such as carbon emission tax (Reichardt, 2015).
Some potential risks can be avoided and mitigated and these include regulatory risks from
mandatory emission reduction target, supply chain risks due to transferred environmental costs, product and technology risks resulted from competitor innovations, litigation risks associated with environmental lawsuits and financial risks from reputation damage and deteriorating asset quality (Lash & Wellington, 2007).

Project clients can also benefit from operational and maintenance savings throughout life span of sustainable buildings. It is possible for clients to receive payback within a short period with lower operating costs. Moreover, sustainable building may bring enhanced image to the client’s corporation as it shows environmental and social responsibility of the company to public which may indirectly help in improving client’s business in the long-term. As stated by Lu et al. (2013), being sustainable offers corporate benefits and green competitive advantages as it creates the shared value that would enhance corporate competitiveness and simultaneously yield productivity.

Economic Impacts on Developers
Investment in sustainability would bring potential financial benefits to developers such as an improved public profile by showing their environmental commitment and social responsibility. Sustainable construction projects help promotes goodwill of the developers which in turn bring more business opportunities. One of the biggest economic benefits is that developers are entitled to command a premium in sale price for sustainability features (Urbecon, 2008). According to a report published by Dodge Data and Analysis (2018), more than half of the respondents from 4 countries agreed that sustainable buildings create higher value at point of sale. Besides, developers are normally the beneficiaries of the government economic incentive scheme in promoting
sustainable development, in which they are provided with rewards, subsidies, capital allowance, rebates, low-cost loan or tax reduction (Fan, Chan and Chau, 2018).

Nonetheless, Deng and Wu (2014) found that residential developers have to pay all the cost of sustainability investment and the developers do not obtain all of the corresponding benefits when sustainable houses are sold to households in the presale stage. Their study indicated that developers can only reap part of the benefits from their sustainability investment and achieve a lower economic return, as the results found no evidence that sustainability investment significantly improves the financial performance of residential developers. Developers would not gain benefits during the resale stage, particularly when sufficient financial benefits cannot be captured from the lump sum amount transferring during the presale stage (Deng and Wu, 2014). Robichaud and Anantatmula (2011) also held the similar view and stated that a speculative developer does not have long term interest in operating or leasing a sustainable building and the benefits of operational saving become less important to them.

Economic Impacts on Project Team

Sustainable construction can also bring economic gains to the involved project team. As indicated by Tan, Shen, and Yao (2011), there is relationship between contractors’ competitiveness and sustainability performance and adopting sustainable practices in construction process assists contractors to grow their businesses. The sustainability concept promotes resource efficiency to lowers costs of production while maintaining profit margins and project values, thus increases contractors’ competitiveness (Porter and Linde, 1995). For instance, using local materials instead of imported materials can save the overall construction cost due to reduced transportation cost.
Project clients are more aware of benefits of sustainability nowadays and sustainability requirements are included in the project brief. The project team is also subject to environmental pressure from the clients or developers to implement sustainability in construction. Construction professionals should also equip themselves with good knowledge of sustainability in order to satisfy the client requirements, otherwise being incompetent in managing sustainable construction projects.

In Lu et al. (2013)’s study, sustainable companies within the engineering and construction industry demonstrated better profitability and productivity through efficient operation and asset management. Sustainable firms can earn return on equity of 17.4% - one time higher than the conventional firms in 2007-2009 which is on average of 8.2% (Lu et al., 2013). The authors also found that sustainable firms outperform the others by gaining incremental positive values in economic profit and revenue growth, although sustainable moves have not been paid off in the financial market. The same study attributed the better financial performance of sustainable firms to strong asset turnover and favourable debt terms in supporting high financial leverage.

**Economic Impacts on End-users**

End users are occupants, owners, tenants, facilities managers, visitors, and others who use buildings for intended purposes. End users are greatly impacted by the design and development of construction projects as they normally spend the longest durations in managing and using the built assets. The most obvious and direct economic advantage of end users is operational savings (ASBC, 2016) in which there could be up to 30% cost savings from energy in commercial building (Kibert, 2016). Furthermore, end users also gain savings from lower maintenance, repair and
miscellaneous cost from sustainable buildings. Low maintenance and repair costs of sustainable built assets could be resulted from using more efficient and durable materials such as using LED and fluorescent lighting system instead of incandescent lights, and using fly ash concrete rather than conventional concrete mix.

Additionally, sustainable building also has indirect economic benefits as it promotes healthier and safer spaces to users. For example, the use of green materials in internal finishes such as wall painting would emit less toxic emission to the environment and this promoting good health and lowering health care expenditure and claims, while giving higher productivity/staff attendance and lowering insurance premiums (ASBC, 2016; Urbecon, 2008). On one hand, sustainable buildings are also associated with rent premium in which building owners could receive more rental compared to non-certified sustainable buildings. Research found that ENERGY STAR and LEED certified buildings attract an average rent premium of 2.5% and 2.9% respectively over a five-year study period of 2004 -2009 (Reichardt, 2015)

**Research Method**

A questionnaire survey was used to examine the economic impacts of sustainable construction projects on various stakeholder groups. The questionnaire survey method is useful to collect objective data and deal with research questions of “what”, “when” and “where”. It also allows data collection over a large number of respondents. The study intended to investigate the wider economic implications of sustainable construction projects, with no focus on any project types. The questionnaire was therefore designed in a general way to make it applicable to different types of sustainable construction projects including new construction, existing built assets, fit-out,
neighbourhood, and cities. Because this study aimed to collect data from varying stakeholder
groups to examine economic impacts of sustainable construction projects, questionnaire survey is
a systematic and convenient method to retrieve data from respondents within a short timeframe.

The questionnaire was developed based on a comprehensive literature review. It contains closed
ended questions and few open-ended questions for commentary and suggestions. Likert scale
questions and yes-no question were adopted in the survey to allow respondents to choose options
that reflect their experience and opinions the best. The target respondents included developers,
consultants, engineers, and constructors who possess knowledge in life cycle costing or sustainable
development in construction. A total of 107 responses were distributed to the targeted respondents
in Malaysia in between 6 February to 1 March 2019. As presented in Figure 1, 42 valid responses
were received out of the total surveys, contributing to the response rate of 39.25%. The response
rate is deemed sufficient as the general accepted rule shows that the central limit theorem still
holds true with a sample size of not less than 30 (Hwang et al., 2017). There were 45% contractors
and developers, 29% architectural and engineering consultants and 26% quantity surveyors.

Result and Analysis

The following sections provide the results of economic impacts of adopting sustainable
construction projects on construction stakeholders and the extent of their possible positive and
negative impacts. A discussion is then made to examine the results and compare the findings with
other studies. The next section presents how taking the perspective of Integrated Project Delivery
(IPD) can assist construction stakeholders to gauge economic impacts of sustainable construction for decision making.

**Economic Impacts on Construction Stakeholders**

From Figure 2, the results suggested that project clients, developers and end users are recognized to receive the most significant economic impacts from the adoption of sustainable construction projects. Amongst construction stakeholders, clients obtained the highest score with over 92% of votes for the most significant impacts and high impacts, with 36 valid responses received in rating the economic impacts on clients. End users are ranked the second most affected stakeholder groups, with around 88% of votes (with 34 valid responses received) for high impacts or the most significant impacts. Construction professionals including project managers and suppliers are perceived to be affected moderately by sustainable construction projects from the economic perspective. Sustainable construction is regarded to give the least economic impacts to local community. The investigation of studied economic impacts however takes into account both positive and negative economic impacts of sustainable construction projects.

**The Extent of Possible Positive or Negative Impacts**

To further identify varying economic impacts of sustainable construction projects, respondents were asked to consider the scale of economic impacts from different stakeholder perspectives. As presented in Figure 3, majority respondents perceived that sustainable construction projects bring more positive impacts to end users, followed by clients, developers, suppliers, local community and construction professionals. are greater than negative impacts or vice versa. The results suggest sustainable construction may bring no significant impacts (neither positive impacts nor negative
impacts) to construction professional and local communities. Sustainable construction is perceived to give more negative impacts to certain stakeholder groups such as developers and clients, though the percentage remain low. The results show that developers and clients could also be subject to certain degrees of financial losses, in addition to receiving potential economic benefits from their involvement in sustainable construction projects. The potential financial losses could be linked to economic risks associated with sustainable construction projects such as high upfront costs, long payback period, low return on investment, and improper life cycle costing practice. In addition to the incremental cost, developers and clients also need to bear the research and development cost and technical risks (which will be translated to cost) during the development stage of sustainable buildings (Zhang et al., 2018). However, the study found that construction stakeholders generally perceived sustainable construction to bring more positive economic impacts than negative economic impacts for the majority of construction stakeholders.

Positive Impacts

Sustainable construction projects have given rise to some potential positive economic impacts to construction stakeholders. According to Figure 4, cost saving from energy consumption is recognised to be the most significant positive economic impacts of sustainable construction projects. Energy savings can be reflected directly on utility bills for tenants and end users and reduce operational and maintenance costs of sustainable buildings in a long run. This result concurs with the previous findings (ASBC, 2016 Kibert, 2016; Zhang et al., 2018) since energy efficiency is one of the main defining features of sustainable built assets. McGraw-Hill Construction (2006) described that identified energy cost saving as the main driver of sustainable practice and extensive efforts have been made to reduce operation and maintenance costs. The adoption of sustainable
construction principles in projects can also help to boost the demands of sustainable related materials and equipment in the market, hence resulting in a more competitive market throughout the construction supply chain. Construction stakeholders are perceived to receive positive financial gains by obtaining sustainability related subsidies, tax allowances, and loan from authorities and professional bodies. Building developers can benefit from sustainable construction by lower construction cost and increased property values, considering increasing awareness of climate change. Entitlement of a premium in sale price or rents and high exchange values are considered to improve economic performance of sustainable construction with a moderate impact.

Negative Impacts

Figure 5 shows potential negative economic impacts of sustainable construction and their level of impacts. Cost overrun was viewed as a main negative economic impact to be incurred from sustainable construction projects, with over 83% respondents considering it as high or maximal impacts. There are also concerns over sustainable construction projects that may fail to meet the expected return on investment within a predefined period. Failing to meet the expected return on investments was regarded to have high and maximal negative impacts by 61% respondents. About 54% respondents viewed limited profit margins as a potential negative impact, though the impact being moderate.

Discussion

The study found that specific stakeholder groups such as clients, developers and end users are subject to more economic risks than other stakeholders in sustainable construction practice. This
finding is aligned with previous studies, where developers or clients are often the only party bearing most of the economic risks of going sustainable in construction. As described by Deng and Wu (2014), residential developers bear all the investment costs of sustainable houses and there is no evidence showing that sustainability investment can significantly boost the financial performance of residential developers, particularly if sustainable houses are sold in the presale stage. Hu and Skibniewski (2021) also pointed out that the developers bear the incremental capital cost solely in most times, while environmental benefits and other benefits of sustainable projects are split among owners, operators and occupants. This finding suggests that there is a principal-agent problem associated with the current delivery approach of sustainable construction projects. More attention shall be paid to improve the traditional management structure for the sustainability reform in construction.

The results reveal that energy cost saving and green subsidies are the main economic benefits derived from sustainable construction projects. This is in line with the previous studies findings such as Dwaikat and Ali (2018) and Ries et al. (2006). Dwaikat and Ali (2018)’s empirical results suggested that sustainable buildings can save energy cost corresponding to 71.1% in comparison to the industry baseline which amounted to 2,887,728 kWh. Ries et al. (2006) also found that sustainable facilities certified by Leadership in Energy and Environmental Buildings (LEED) decreased energy consumption by 30% and increased productivity by 25%. The study findings also concurred with McGraw-Hill Construction (2006) that showed potential of energy cost reductions was the main reason for building green or sustainable. The potential financial gain from energy costs has now become a main motivator to promote wide sustainable practice in construction. Green incentives and subsidies are provided by local governments or financial
institutions to promote the uptake of sustainability in the construction industry. The result indicated that construction stakeholders appreciate the incentives as an economic support to finance their sustainable projects and consider them as an added value of sustainable construction. These incentives successfully increase the stakeholder motivation to implement sustainable practice by compensating them the additional cost of incorporating sustainable innovations into projects. Additionally, the economic value of sustainable construction projects can also benefit the construction value chain from clients to suppliers and end-users, following an increasing demand for sustainability in the construction sector. Suppliers of green materials and equipment are still scarce (Zhang et al., 2018), and evidence of ample demand would jump-start the development of specific markets of sustainable related products.

Economic risks such as cost overrun and risks of not meeting the expected rate of return are identified as the primary factors hindering the widespread adoption of sustainable construction practice. Cost efficiency appears to be the mainstream attention of the applications of sustainable construction projects for a variety of construction stakeholders in the past few decades. The most affected stakeholder groups are clients, developers and end users considering their direct involvement or interest in the project over a long period such as operational and maintenance stages. As a project initiator, the project capital cost is of concern to clients or developers. To incorporate innovative sustainable features into the building systems, initial costs of sustainable construction could be higher than conventional projects. The higher upfront cost of sustainable construction is supported by Hu and Skibniewski (2021)’s findings. By reviewing over 1,300 buildings across 11 countries, Hu and Skibniewski (2021) found that the mean cost surcharge of green construction is about 7% for all building types across different countries.
However, the long-term economic values brought by sustainable construction can recover it over a medium or long term. Torcellini et al. (2015) explained that there is a long way to make the business case of sustainable buildings because the long-term economic benefits of sustained utility cost savings, higher rent and increased occupancy, and greater availability of equity funding of sustainable built assets take time for materialisation. This may result in hesitation or reluctance to invest in sustainability for some speculative investors or developers who look for recovering their returns within a short time. Economic impacts of sustainable construction should be considered the whole life span of a built asset, as determined by the service life. Numerous studies (Dwaikat and Ali, 2018; McGraw-Hill Construction, 2006; Robichaud and Anantatmula, 2011) demonstrated that life cycle economic values of sustainable construction can bring greater benefits that outweigh the investment in the project capital costs. Considering energy inflation rates (at an exponential rate, as witnessed in the current 2022 energy crises), the economic benefits make sustainable construction a worthwhile investment alternative for project owners, clients and investors.

**Integrated Project Delivery**

The most critical challenge to delivering an economically successful sustainable construction project is communication and coordination across a multidisciplinary team (Robichaud & Anantatmula, 2011). Sustainable construction projects are different from their conventional counterparts from the technical and management aspects, and adjustments shall be made to the traditional management practices to optimise the delivery of sustainability practice in construction (within acceptable costs) (Robichaud & Anantatmula, 2011). More intense upfront planning and
communication across the project team are essential. There is an increasing need for cross-
discipline coordination on site selections, construction materials and techniques, building systems
and subsystems as well as commissioning and decommissioning of sustainable built assets.
Traditional construction management approaches which are often linear and fragmented may give
more risks to sustainable construction projects, hence resulting in cost inefficiency. In addition,
the traditional unit cost model does not offer enough flexibility to account for life cycle costing or
assembling different combinations of professionals to accommodate the project’s specific skills
and service needs for sustainability (Robichaud & Anantatmula, 2011). Therefore, it calls for a
more integrated design and construction team that works together throughout the project for
incorporating the sustainable development goals within the acceptable financial parameters.
Integrated Project Delivery approach would help provide a resolution to overcome the silo effect
in the construction industry where the project team members are splintered by functional areas.

Integrated Project Delivery (IPD) is an innovative collaborative approach to construction project
delivery by integrating people, systems, business structure and practices into a process for
collaboration. In IPD, close collaboration between the project parties (e.g. owner, design team,
users and contractors) is anticipated and IPD can improve the project performance in seven areas:
quality, schedule, project changes, communication among stakeholders, environmental and
financial and facility management performance (De Marco & Karzouna, 2018; Atkin & Rowlinson,
2019). The project owner sets sustainable goals and priorities at the project onset and establish the
framework in which all future decisions are made to avoid unnecessary design modifications or
change orders. The project team members are put together early in the project life cycle to cultivate
long term support and ensure sustainable goals are met in all the phases of the project. Unlike the
conventional practice that hires the key project team members in chronological phases, IPD can avoid precluding builders or design professionals from the involvement in the sustainable site line items such as transportation, open spaces site context, building orientations, community connectivity (Robichaud & Anantatmula, 2011).

The principles of IPD are important in enabling sustainable construction projects to offer a more collaborative environment by streamlining the flow of information and the project workflows. Architects, engineers and contactors have an instrumental role in determining the cost surcharge of sustainable buildings via optimised design and construction methods (Hu & Skibniewski, 2021). Due to the interconnectedness of sustainable building design, design professionals, builders and other team members have to work together during the feasibility and briefing stages to maximise sustainable practices at the most efficient cost (Robichaud & Anantatmula, 2011). Adopting an integrated delivery approach allows early integration of specific design factors of sustainable buildings and facilitates early involvement of construction teams for improved productivity (Hwang et al., 2017). Because a high level of interactions between building systems and the environment is necessitated, the traditional procurement practice struggles to handle the complexity of sustainable building projects (Hwang et al., 2017). In addition, stakeholder partnerships in IPD can also foster buy-in, which is crucial for a sustainable construction project that cannot afford to absorb changes, cost increase or delays in the subsequent process (Robichaud & Anantatmula, 2011). Securing buy-in from project decision makers is critical to make sustainable construction a business case, and soft benefits (e.g. favourable life cycle cost projections and contribution to the building mission) are often the key in obtaining buy-in from decision makers (Torcellini et al., 2015).
As shown in the results, economic risks of sustainable construction projects are found to be more associated with specific stakeholder groups such as clients, developers and end users. As highlighted by Zhang et al. (2018), there is a split-incentive dilemma with the existing contract structure. The existence of multiple stakeholders in the process of developing sustainable construction may lead to principal-agent problems (Zhang et al., 2018). The potential economic risks could however diminish if all stakeholders are placed in the same position within the project for gain/pain sharing. The alignment of interest and risk/rewards of project stakeholders with the overall objectives fosters trust and team working (De Marco & Karzouna, 2018). With IPD, construction stakeholders who are in alliance would consider the value proposition of sustainable construction projects from an integrated view – the lens that can bring the most benefits to all. A broader economic profile of sustainable construction projects is examined in IPD to seek not only the immediate cost efficiency but also competitive advantages in the long run.

Torcellini et al. (2015) demonstrated the deployment of a set of successful strategies through a more integrated approach for sustainable procurement, design and construction in net zero energy buildings. Stakeholders can employ more integrated ways to cost justification and capital cost control that leverage innovative strategies in procurement, integrated design, streamlined construction and operational accountability for sustainable buildings (Torcellini et al., 2015). Their work illustrates the importance of having an integrated delivery approach to integrate contractors and trade partners into decision making for delivering cost effective acquisition and delivery for sustainable construction.
Sustainable construction projects can be delivered with economic success on the premise that a shared vision and goals for sustainability have been embedded in the project early stage for all stakeholders. The inputs from external stakeholder groups such as end users, facilities management team, local government and regulatory bodies, surrounding neighbourhood, and communities are recommended to be taken into account in the planning stage as sustainable construction project impacts great land uses and building patterns in a neighbourhood and surrounding. Involving stakeholders early in the project stage using IPD can assure the key groups understand and support the project sustainability goals, thus making the financial sense for sustainable construction.

Conclusion

Climate change and net zero are main challenges that the construction industry is facing in view of its great implications on the environment. To transition to sustainable built environment successfully, it is critical to make the sustainability moves in construction a great financial sense to all construction stakeholders. Economic sustainability is a key pillar of sustainability, and the development of economic sustainability should work in tandem with the other two pillars – environmental and social sustainability. Embracing economic implications of sustainable construction projects are therefore essential to assist construction stakeholders to reconcile the value and cost of sustainable built environments, hence making sustainable construction more cost efficient.
This study seeks to comprehend multifaceted aspects of economic implications brought by sustainable construction projects that could impact construction stakeholders in various capacities. By gauging the positive and negative implications on different stakeholders, this study could help identify contextual factors affecting economic viability of sustainable construction, which is recognised as the main barriers of a wider implementation of sustainable construction practice.

This study makes contributions in three aspects. Firstly, this study contributes to existing body of literature in relation to economic sustainability by offering empirical evidence that address economic impacts of sustainable construction projects. Both positive and negative economic impacts of sustainable construction on different stakeholders are gauged in the study. Secondly, the results of this study enrich the sustainability research by revealing stakeholders’ perceptions of economic impacts of sustainability practice that are attributed to barriers of greater uptake of sustainability in the built environment. Thirdly, this study advocated taking an integrated project delivery (IPD) approach to stimulate an institutional arrangement co-sharing costs and benefits of sustainable construction among key stakeholders.

This paper offers insights into understanding the economic implications of sustainable construction projects. Thinking around economic impacts that span the entire building life cycle is essential to reveal the true economic values of sustainable construction projects. The economic values of sustainable construction shall be appreciated in a medium and long term. The authors also indicate how construction stakeholders, by taking an integrated project delivery (IPD) perspective, can develop a more holistic view that allows them to gauge the underlying economic value of
sustainable construction projects by incorporating long term cost efficiency in the decision making.

Sustainable construction is expected to bring more positive outcomes than negative results, particularly considering the increasing oil price and diminishing non-renewable energy sources on the earth.

Economic sustainability is crucial to justify the worthwhileness of sustainable construction to attract stakeholders to voluntarily adopt sustainability in their practice. It is a promising research area to investigate the use of integrated project delivery approach for improving the economic profile of sustainable construction projects. Future studies can also be carried out to examine the heterogeneity of economic impacts of sustainable construction practice on stakeholders across regions. It is also valuable to investigate economic internalities and externalities of sustainable construction projects by taking into account long-term and intangible economic factors.

Research Limitations

The research has some limitations. The sample size of the study was small. The responses were collected from construction stakeholders in Malaysia. The results may not be representative for other geographical contexts. This study focuses on the building construction sector only, and infrastructure construction is not considered. Nevertheless, the results still offer an insight into understanding the economic implications of sustainable construction projects on various groups of construction stakeholders, hence providing better measures to tackle economic challenges for the transformation of a sustainable and resilient world. Future research is required to be conducted
with a larger sample size and in different geographical contexts to see whether the results would
differ from the findings reported above.

Data Availability
Some data, models, or code generated or used during the study are proprietary or confidential in
nature and may only be provided with restrictions (e.g. anonymized respondents and the survey
data).

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