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Integrated Project Delivery (IPD): An Innovative Approach for Achieving Sustainability in Construction Projects



Ghada Adel, Ayman Ahmed Ezzat Othman, and Nishani Harinarain

Abstract In spite of the positive impact construction can have on the economy and society in general, the industry is being blamed for the negative impact it has on the environment. This problem can be attributed to traditional procurement approaches adopted in construction industry and the inability to handle the different challenges regarding waste generation and pollution of the environment. This paper focused on the role of construction procurement as a method to achieving sustainability. This paper aims to investigate the role of integrated project delivery (IPD) in achieving sustainability in construction projects. In order to achieve this, aim the research method consisted of an in-depth literature review and case studies. Firstly, the literature review was used to identify and categorise the principles of integrated project delivery and their importance in achieving sustainability in construction. Secondly, two case studies were analysed to investigate the benefits of the using of integrated project delivery in construction projects. It was found that the usage of the integrated project delivery results in meeting the goals of sustainability. The two case studies examined showed that IPD had a positive outcome in regards to economic, social and environmental aspects because it reduced the cost and time of the construction of the project, as well as having a positive effect on the community.

Keywords Sustainability · Traditional procurement · Integrated project delivery (IPD) · Construction industry

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1 Introduction

The construction industry is one of the main sectors affecting the economy of any country. The influence of the construction industry is not only on the economy but also on the social aspects of life, through creating, modifying, and improving the living environment. Simultaneously, the construction industry has a noteworthy impact on the environment throughout the whole life cycle of a building, starting with the mining of raw materials until the end of life of the building, i.e., its demolition [1]. Nowadays, the construction industry is facing some major challenges in maintaining the balance between environmental, social, and economic aspects, and the manner in which the construction process is realized [2]. Knowing that the choice of procurement selected affects the whole construction process, it is important to note that the traditional procurement approaches have proven to be great sources of waste, disputes and time consumption due to the separation between its parties. Various nontraditional approaches have been introduced to solve these issues. One of these approaches is the integrated project delivery (IPD). Therefore, this research aims to investigate the role of IPD in achieving sustainability in construction projects.

2 The Nature of the Construction Industry

The construction industry is one of the largest industries worldwide. It provides the community with high living standards through socio-economic projects and infrastructure facilities such as roads, hospitals, and schools. It also plays key role in generating income in both formal and informal sector. It supplements the foreign exchange earnings derived from trade in construction material and engineering services [3]. Construction industries in developing countries are a major stakeholder in the economy. It is also a source of employment at various levels of skills from manual labour to semi-skilled, skilled and specialist workforce. Experience shows that it is one of the foremost industries in any developing country whose upward activity is related to the economy of the country. In addition, any crash in the construction industry could potentially lead to the fall of the economy [4]. In spite of the flourishing of construction and its positive impact on the economy, the industry is being blamed for the negative impact it has on the environment. This problem could be attributed to traditional procurement approaches adopted in construction industry and the inability to handle the different challenges regarding waste generation and pollution of the environment. This is a call for the construction industry to be more innovative and to consider sustainable solutions [5].

3 Sustainability

The principle of sustainability was inspired from the Brundtland Report of 1987, when the United Nations appointed Gro Harlem Brundtland the former prime minister of Norway to head the new World Commission on Environment and Development. It has found that countries were suffering from extreme poverty despite all the devoted efforts to increase the living standards. This led to the need of balancing resources and consumption. The Brundtland Report defined the sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs [6]. This definition has developed over the years. Raynsford defined the sustainability, to be:

- Reducing material consumption;
- Minimising waste;
- Using recycled materials;
- Energy efficiency; and
- Avoiding pollution [7].

Sustainability is also defined as the distribution of resources efficiently and equitably through the generations with consideration of the finite eco-system [8]. In 2015, Ben-Eli sees sustainability as a dynamic equilibrium between the people and the capacity of the environment where the people achieve their full potential without negatively affecting their environment [9]. Moreover, Mensah & Enu-Kwesi define sustainability as an application of a concept of improving and nourishing a strong social, economic and ecological system [10].

Sustainability, aims to allow the existence of upcoming generations through protecting the natural and built environment, in addition to the natural resources and human beings [11]. Sustainability is a multi-dimensional system that concentrates on the quality of life of all people through making bonds between the social aspects and economic besides the environmental aspect [12, 13]. There are 3 main dimensions for sustainability showed in Fig. 1, which are environmental, social and

Fig. 1 Sustainability dimensions



economic [14].

The environmental aspect is described as reducing the waste impact and emissions in the long term with caution in the natural resource usage. The economic aspect is defined as “*an economic assessment of competing design alternatives, considering all significant costs over the economic life of each alternative, expressed in equivalent dollars*” [14]. Basically, it is related to the efficient use of resources leading to an increase in profit [15]. Besides, the consideration of the life cycle costs, the social aspect is also incorporated, which takes into consideration all the needs of the workforce and the people throughout the life cycle of the project [15].

4 Construction Procurement

Procurement is derived from the word procure, which means “*to get possession of something*” and “*to obtain by care or effort*”. This term has various definitions within literature. One of which is that it is a process of providing a service from different parties such as contractor, consultant and designer in order to ensure that the project is delivered to the client [16]. Procurement also defined as a process of obtaining services and goods from others with return [16]. Construction procurement is seen as a complex network of relationships between contractor, consultant and client in order to form a building project [17].

4.1 Traditional Procurement Methods

The traditional procurement method is a method in which the design phase occurs before assigning a contractor to the project. This method results in a separation between the design and construction professionals which leads to difficulty in communication and does not foster innovation and creativity, resulting in reducing the value of the project [18]. Types of contracts that are usually used under traditional procurement include fixed price contract, unit price contract, cost reimbursement contract and cost target contract [19].

4.2 Non-traditional Procurement Methods

Different non-traditional procurement methods have been invented since the early 1960s, focusing on the reduction of consumed time in the design and tender processes which gives the ability to proceed to the construction work sooner. In addition, it also emphasizes engaging with the contractor in the early stages of the project (design phase). This cooperation is in the interest of the client which reduces

conflicts occurring during the construction work. Moreover, it helps in sharing experiences which increases the quality of the product [20]. Types of contracts that are usually used under the non-traditional procurement include design and build contract, management-based contracts and partnering contracts [19].

5 Integrated Project Delivery (IPD)

The IPD is defined by the American institute of Architects (2007) as an approach that integrates the people, business structures, systems and practices into a method that connects talents and visions of all parties in order to boost the project outcome, increase value for the client and reduce the waste through all the building processes (design, fabrication, construction). Integrated project delivery has offered a great deal of improvement by maximising value and reducing waste through the early collaboration of cross-functional teams to align goals and share risks and rewards through a relational contracting approach [21]. The IPD agreements set rules to limit liability and improve the information and creativity flow. Therefore, the integrated project delivery is considered a whole building design [20] as IPD aims to reduce waste in construction projects which leads to optimal improvement in schedule, cost and quality [21, 22]. In this approach all parties are working together as a team with one goal which is in the best interest of the project. In addition, the profits and losses are shared between the project parties [21].

IPD was introduced to overcome the inadequacies encountered in the traditional procurement approach. Though it has been increasingly adopted in the USA and other parts of the world, its application in the Middle East and Egypt has not commenced yet. Despite the numerous advantages that this new method provides, its application in the Middle East is still marginal because of the required prerequisites for its implementation (i.e. technological, legal, and cultural); therefore the number of projects adopting IPD remains relatively small [23, 24].

5.1 Principles of Integrated Project Delivery (IPD)

The main concern of IPD is to eliminate waste through early collaboration between parties, risk sharing and planning. In order to achieve the benefits of IPD, all parties need to follow the IPD principles. The American Institution of Architects guide book in addition to the AEC have set the principles of the IPD in the recent years as follows:

- Mutual respect and trust: All parties understand and respect the value of partnership and are devoted to team work for the best interest of the project.
- Mutual benefit and reward: The benefit from IPD is reflected on all the team members as the process entails the involvement of all parties at early stages. The compensation in IPD is related to the value added to the interest of the project.

- Collaborative innovation and decision making: The innovation is fostered by free exchange of ideas among parties. In the IPD, the ideas are rated by their impact on the project not by the originator of the idea.
- Early involvement of key participants: In the IPD all parties are involved in the early stages of the project which enriches the flow of information and the sharing of experiences and creative ideas.
- Early goal definition: The goal of the project is set in early stages, which promotes the innovation and outstanding performance.
- Intensified planning: IPD believes that the more effort exerted in planning, the more efficient the execution process will be.
- Open communication: The focus of the IPD on team work is achieved through honest, open and direct communication between all parties. The responsibilities are defined and all parties are concerned with finding solutions and resolving problems rather than determining the liability and blaming each other.
- Appropriate technology: “*Integrated projects often rely on cutting-edge technologies*”. These technologies are specified at the start of the project in order to maximise functionality, generality and interoperability. Open and interoperable data exchange is essential to support IPD because open standards best enable communication among all participants. This means that technology that complies with open standards should be used whenever available.
- Organisation and leadership: In IPD, the project team is considered an organisation in its own and all team members are dedicated to the goals and values of the project.

5.2 *Difference Between Traditional Procurement Methods and IPD*

Table 1 shows the differences between the IPD and traditional procurement methods.

As shown in Table 1, the traditional procurement methods are transactional contracts that require each party to finish its role and then the other party would start. Whereas in the IPD, the contract is relational and all parties are involved in the project from early phases which increases the feeling of ownership.

The team structure in the traditional procurement is hierarchical. Meanwhile, in the IPD, it is flat as all parties are partners. The contracts in the traditional procurement are separate as each party has its separate contract with the owner. However, in the IPD, the contracts are interlocking and all parties work as partners after signing the Integrated Form of Agreement.

The risk in the traditional procurement is allocated to the parties and the reward is for the owner only. On the other hand, in IPD, the risk is shared and there is no concept of blaming or disputes. Besides the reward is distributed to the team.

The decision making in the traditional procurement is through the top management only and from the concerned party only. Meanwhile, in the IPD, the decisions are made jointly between the parties and the major decisions are taken by the primary members (core team).

Table 1 Difference between traditional procurement and IPD

	Traditional procurement	IPD
Type	Transactional	Relational
Team structure	Hierarchical	Flat
Contracts	Separate contracts Setup detailing how to sue and claim for compensation	Interlocking contracts Legally: direct and blind team activity Eliminate and reduce the ability to sue and claim compensation
Risk and reward	Risk is primary allocated Reward payment is based on delivery	Risk is primary shared Reward: pooled profit distribution is based on team success in achieving project goal Owner pays for additional extras
Decision control	Hierarchical	Joint decision making Major project decisions are taken by primary team members
Process	Linear information	Cross sharing of information “Best for project” mentality

The process in the traditional procurement is linear and the flow of information is linear which hinders innovation and flow of ideas and creativity. In contrast, in IPD, there is flow of information between all parties sharing experiences and finding what is best for the project.

5.3 IPD and Sustainability

IPD principles serve the sustainability dimensions as shown in Table 2. The mutual respect and trust between parties helps in achieving the project’s goals, fosters creativity, and allows the ideas to flow. This, in turn, will reflect in the economic dimension of the project and help in exploring new ideas for energy saving and reducing pollution in order to save the environment. It will also allow for the existence of more projects, thereby socially helping people.

The mutual benefit and reward help increase the feeling that the project is owned by all parties, which, in turn, will make all parties concentrate on early delivery of the project, cost reduction and increase of quality. Moreover, all parties will be dedicated to increase the value of the project through considering the environmental impact of this construction.

The collaborative innovation and decision-making results in all parties making decisions together and agree on risk taking, which allows for the consideration of all ideas on table. That will result in permanent decisions which were discussed by the experts in their respective fields, preventing rework and conflicts. As a result, this will decrease the project duration and cost, as well as, decrease the demolition and the rework affecting the environment.

Table 2 IPD principles and the sustainability dimensions

IPD principle	Sustainability		
	Social dimension	Economic dimension	Environmental dimension
Mutual respect and trust	✓	✓	
Mutual benefit and reward	✓	✓	✓
Collaborative Innovation and decision making	✓	✓	✓
Early involvement of key participants	✓	✓	✓
Early goal definition	✓	✓	✓
Intensified planning	✓	✓	✓
Open communication	✓	✓	
Appropriate technology	✓		✓

The early involvement of key participants and the early goal definition are related because the parties are involved in early stages and define the project goals from early stages, resulting in a project that will be easier to direct easier and the decision making process will be simpler. This could result in the project being handed over sooner and ensures that the quality of the project is according to its specifications, thereby, decreasing the costs.

The intensified planning is an important principle that affects all the dimensions of the sustainability because a well-planned project has minor conflicts and its construction phase has fewer negative effects on the environment.

Open communication allows for the flow of ideas between parties and the sharing of experiences to prevent past mistakes which, in turn, will reflect on the duration needed to finalise the project and help in reducing the costs of construction.

The appropriate technology helps in studying the project better and having a better overview on the construction process. Besides, it helps in studying the environmental impacts of the project and its emissions. Moreover, it gives a visual on how each phase is going to be held and how it will be mobilised because this gives an overview of all the project details. As a result of this study, the project conflicts and the time of construction will be reduced which, in turn, affects the cost of the project, as well as, the environmental analysis.

6 Research and Method

This paper aimed to investigate the role of IPD in achieving sustainability in construction projects. In order to meet this aim, the research method involved a detailed literature review and the investigation of two case studies, that of the Cardinal Glennon

Children's Hospital Expansion and Sutter Medical Centre Castro Valley. The literature review was designed to build a comprehensive background on the research topic, where the sustainability dimensions, the procurement methods and the integrated project delivery was studied to gain better knowledge and understanding. The presentation and analysis of the two case studies show the role of IPD implementation in achieving sustainability.

7 Case Study

This section presents two case studies of health care projects that used the integrated project delivery in order to reduce the time consumed in construction. In these cases, all parties acted as partners. Both projects were renovation and extension of the hospitals. Therefore, in one of the case-studies the application of IPD was not implemented in the early stage of the project, which did not allow the parties to identify goals and apply IPD in early stages.

7.1 Case Study 1: Cardinal Glennon Children's Hospital Expansion

This is located in St. Louis, Missouri.

Project Description

The project was to build a children's hospital expansion on 138,000 square feet with a budget of \$45.5 million. The expansion consists of 10 surgical suites, an intensive care unit to hold 60 beds, a central sterile unit, 10 recovery rooms and a shell space for future radiology and laboratories.

This project was the first time that all the parties experienced using IPD. The decision to use IPD was made in the design phase. The architect, the builder and the MEP engineer had worked together previously in phase 1 of this project (Fig. 2).

Shared Risk/Reward

The parties were at the design phase when the decision was made to work under the IPD. The architect had its contract and the builder had the CM at risk arrangement.

The owner held a lean seminar from the lean construction institute and some partners from the design and construction community. The project parties challenged each other to try to work under the IPD in this project and all agreed.

The owner's attorney negotiated an integrated form of agreement based on the project with a plan to make it a model for the future work. As the project had already started, it was too late to involve early application of IPD.

Fig. 2 Cardinal Glennon Children's Hospital Expansion—St. Louis, Missouri



Financially, about \$400,000 were saved with approximately \$1 million contingency. The incentives were distributed among parties as follows: 40% owner, 20% design team, 40% builder and lean partners.

The Contract

The integrated form of agreement was a four-way contract including the owner the MEP engineer, the architect and the builder. All parties were accountable to each other as equal partners. The builder, along with the architect, had combined contingencies and were jointly responsible for the construction errors and design.

Decision Making

The integrated form of agreement designed two teams, the field team and core team. The field team consisted of mid-level partners and was responsible for resolving routine issues. While the core team consisted of the owner, architect, engineer and builder as well as the lean partners, who set a weekly meeting to resolves issues and make decisions.

The core team was highly cooperative and refused the idea of “*one party win and the other lose*”. As an example of the cooperation between the parties, the builder suggested that they use the concrete maturity test (CMT) to measure the strength of concrete which was not used in the traditional method. That resulted in reducing the time needed for the concrete to cure.

Challenges

An example of a challenge experienced was a conflict between rebar in the flat slab and the plumbing sleeves that needed to penetrate the slab. After carefully studying, this could be solved by shifting the entire plan 3.5" with respect to the column grid. As a result of the full dedication of the design team, they made it work which resulted in early delivery of the project with 6 weeks earlier than planned [25].

7.2 Case Study 2: Sutter Medical Centre Castro Valley

The vision of this was to be a landmark medical centre that includes advanced technology and integrates it with the quality of service required. The owner is considered one of the leading non-profit funders and set a budget of \$320 million for the project. The project did not only include hospital rooms and a building but also included the demolition of the old hospital, construction of a new parking area and improvement to the campus (Fig. 3).

There were new laws passed that compressed the time frame for construction, which encouraged Sutter to reduce time and budget overrun by using the IPD. The schedule was required to be accelerated by 30% without exceeding the cost target. Early in the planning phase the core team of the contract was gathered signing the Integrated Form of Agreement (IFOA). There were 10 parties in that team, namely, owner, architect, general contractor, mechanical and plumbing designer, electrical designer, structural designer, mechanical designer, electrical designer, fire protection and lean/BIM project integration team.

The IPD approach encouraged the participating firms to change their normal work process and devote people full-time to this project, as opposed to the traditional process where they typically have people working on 3–4 projects at the same time. In addition to the core IPD team, there were over 25 additional firms in the expanded project team, who are also supporting the IPD approach and adjusting their traditional processes to work with it.

Given the challenges of the site, the complicated shape of the design, and the schedule and budget constraints, the use of BIM on this project was indispensable. That helped in generating the 3D model before starting the project in addition to discovering conflicts before facing them in reality. Remarkably, the time for construction was reduced from an expected 15 months to 8 months, and was informed by far more information from other disciplines than what is usually available which led to better design quality.

Fig. 3 Sutter medical centre
castro valley



Result

This project can be considered as a landmark project in the US architectural, engineering and construction industry as it was the first one to show that IPD is not just a utopian vision but a practical reality that can actually be implemented on large, as well as, small projects. First and foremost, though, it takes the initiative and leadership of an owner such as Sutter Health, which had the confidence to embark upon unchartered territory and put together a team that could actually deliver on this project as envisaged by the IPD concept.

- The delivery of the project was 6 weeks earlier than the original intention of compressing it by 30%.
- The project cost \$2 M less than the budget.
- The steel delivery was 6 months earlier which saved \$1 M.
- 97% of the inspections passed on the first time [26].

7.3 Summary for Case Studies

The IPD helped in reducing the time of construction which affected the environmental aspect of sustainability as well as the economic aspect. Besides, it reduced the cost of the project affecting the economic aspect of the sustainability dimension. Since the project helps the community it in turn, affects and benefits the social aspect of the sustainability dimension, which makes the application of IPD in these projects an achievement in meeting the sustainability goals. Table 3 summarizes the case studies against the sustainability dimensions. In the first case there was no early involvement of the parties as a result of implementing the IPD later in the project. While in the second case study they implemented the IPD in early stages and all the parties were involved in early stage which was reflected on the sustainability dimensions as shown in the table.

8 Conclusion and Recommendations

The construction industry has proven to have a negative effect on sustainability. This paper focused on the role of the construction procurement method in impacting sustainability. Literature shows that the usage of the traditional procurement methods negatively affects sustainability as it consumes more resources; either human, natural or economic. The non-traditional methods for procurement provides a potential solution for these resource wastage problems. One of the non-traditional procurement methods is the integrated project delivery (IPD), which requires the early involvement of all parties and defines their relation as partners. The usage of the IPD results in meeting the goals of sustainability. This was verified using two case studies that of “Cardinal Glennon Children’s Hospital Expansion” and “Sutter Medical

Table 3 Case studies implementing IPD principles and their effect on sustainability

IPD principle	Sustainability dimensions					
	Case 1			Case 2		
	Social	Economic	Environmental	Social	Economic	Environmental
Mutual respect and trust	✓	✓		✓	✓	
Mutual benefit and reward	✓	✓	✓	✓	✓	✓
Collaborative innovation and decision making	✓	✓	✓	✓	✓	✓
Early involvement of key participants				✓	✓	✓
Early goal definition				✓	✓	✓
Intensified planning	✓	✓	✓	✓	✓	✓
Open communication	✓	✓		✓	✓	
Appropriate technology	✓		✓	✓		✓

Centre Castro Valley”. The usage of IPD in these two cases contributed positively to economic, environmental and social aspects of sustainability, as it reduced the cost and time of the construction of the project, as well as had a positive effect on the community. It is recommended that future projects consider the IPD to reduce disputes, time consumed in construction and project cost, as the IPD application enhances the feeling of ownership and encourages trust between all parties of the project resulting in increasing the value of project.

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