

Leveraging on Integrated Project Delivery (IPD) Methodology to Successfully Deliver a Canadian Net-Zero Commercial Building: A Case Study from the Alberta Construction Industry

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Introduction

Traditional project delivery entices stakeholders to maximize their individual outcomes, regardless of the effect on the overall project outcomes. Because interests are not aligned, if conflicts arise, individual self-interest tends to place the project at risk of failure. Integrated Project Delivery (IPD) aims to create alignment among all stakeholders regarding why and how a project will be accomplished. An IPD method integrates people, systems, and practices into a process that collaboratively harnesses the talents of all participants to optimize efficiency through all phases of design and construction. These dynamics are difficult to simulate in academic environment. This paper will focus on the pedagogy of project delivery methods in academia. A case study will illustrate the merits IPD offers in building a net-zero commercial building in Alberta, Canada that is validated by student simulation role playing. This paper highlights the lessons learned of simulation in terms of student outcomes and educator expectations.

Project delivery methods in construction

To appreciate the inherent dynamics of IPD, a description between the IPD and Traditional Project Delivery (TPD) method is presented. The traditional project delivery method includes design-bid-build, design-build and construction management at-risk methods [1]. The TPD method has clear separation of relationships among owner, contractors and designers. There is no direct contractual relationship between the designer and the contractor, but an indirect relationship exists because the designer is acting as the agent of the owner for the project [1]. The TPD model differentiates one party from another and therefore, causes polar interests. For the owner, separation of interests encumbers the project's goals and causes unnecessary rivalry among stakeholders when disputes arises.

The TPD method promotes individual stakeholder's financial success which is not necessarily tied to the project's success [2]. Collaboration of subcontractors, contractors, designers, and owners is limited since there are little to no financial incentive for teamwork and early engagement in project design. The contractor is rarely involved with the design phase. Lack of contractor input from the start can translate into problems later on in the construction process and cost more to mitigate due to change orders [3]

IPD can be defined as "a project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harness the talents and insights of all project participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication and construction" [2].

The following are common features of IPD: (1) multi-party agreement, (2) early involvement of all parties, (3) shared risk and reward and (4) Enabling Technology (e.g. BIM). These are not the only features, however, they have been recognized as ones that have measured results to successful project outcomes.

Most existing IPD contracts include elements that are designed to encourage teamwork and promote the success of the project rather than any specific team member. Unlike traditional projects, IPD contracts combine the risks and rewards of all team members and incentivize collaboration in order to reach common project goals. Since liabilities are shared, the IPD method encourages involved parties to pursue a construction project in a way that benefits all parties and in turn, the owner [4].

One of the most fundamental advantages that IPD affords is the ability for all parties to be present and involved with a project from the earliest design phase. While it is important to recognize that this early collaboration does not require the use of technological tools, it is also important to note that information technology, such as Building Information Modeling (BIM), can greatly increase the efficiency of collaboration throughout all phases of a project. [4]

IPD method fosters an environment where all participants are regarded as team members rather than as separate entities. Professionals functioning in a single team ensure all members work towards a united vision of the final product.

Integrated Project Delivery (IPD) seeks to improve project outcomes through a collaborative approach of aligning the incentives and goals of the project team through shared risk and reward, early involvement of all parties, and a multi-party agreement [5]. The coupling of Building

Information Modeling (BIM) with IPD enables a level of collaboration that not only improves efficiency and reduces errors but also enables exploration of alternative approaches and expansions of market opportunities [4]. BIM is not only a tool but also a process that allows project team members an unprecedented ability to collaborate over the course of a project, from early design to occupancy [6].

The pedagogy of project delivery methods in construction education

To highlight the complex dynamics in various project delivery methods, these methods were represented in role playing activity for students in a learning environment. Traditional delivery methods such as design bid build (DB), design build (DBB), construction management at risk (CMR) were contrasted with integrated project delivery. Student groups were assigned a particular delivery method and had to individually represent his/her stakeholder position such as owner, designer or builder. Simulations were conducted based on resolution of change orders, schedule delays and cost overruns during the pre-construction and construction phases. Simulations of different project delivery methods were role played by students taking on changing stakeholder positions.

An aim of the exercise was to allow students to see the competing interests of each stakeholder group in conflicts. Following the simulations with traditional delivery methods which identified issues of win-lose resolutions, the students were introduced to the integrated project delivery method. IPD was explained to them with the focus of a collaborative and cooperative approach to resolving issues.

An actual IPD project was used as a case study for students to examine. Students met with key stakeholders such as the owner and builder to discuss and confirm the benefits of this delivery method over the traditional delivery methods. The focus of the case study was to bring real life construction issues into the learning environment where student recognized the value of collaborative and cooperative approach to resolving issues. Students comment on the importance of a team philosophy in the construction process. In the case study, the criteria of a sustainability requirements (net zero commercial building) played a significant challenge for the owner as it was project of its kind in Alberta.

Embedding IPD philosophy into the curriculum via case studies and role playing significantly adds value to students learning when they enter the work force whereby they need to embrace the growing trend of IPD in construction. For educators, recognition of trends in construction delivery systems and inclusion into curriculum is vital to keep students current of construction industry state-of-practice.

Case study

A case study is presented which discusses the lessons learned that can support the use of IPD for project success in an educational setting. The challenges in this case study involved designing and delivering a commercial building using net-zero performance criteria. As this project criteria are unique, the owner was keen in exploring the use of IPD for enabling project success. This case study will provide insight into how IPD mitigated issues during its design and construction phases. The success of the project came about with the IPD approach incorporating the four features discuss above: multi-party agreement; shared risk and reward; early involvement of all party; and enabling technology. These features were validated by students in a simulation activity in the school.

The owner's goal in this case study was to obtain net-zero energy use. The general contractor is experienced in IPD and a promoter of it. The general contractor is also recognized as a traditional project delivery company. Some of the design criteria to fulfill the net-zero requirements were use of solar panels, geo-thermal heating, materials, windows, mechanical and lighting systems.

The Mosaic Centre will be applying for Living Building Challenge Petal Certification (LBC) AND LEED-NC certification. Part of the reason behind attempting two certifications on this project is to show the similarities and differences between the two programs. Leadership in Energy and Environmental Design (LEED) is a rating system that is recognized as the international mark of excellence for green building [7]. The design aims in the Living Building Challenge is to attempt at least three petals: energy, equity and beauty [8].

The case study highlights to students the success of IDP in resolving construction issues, and sustainability criteria. Owing to IPD, this commercial building project (Mosaic Centre) in Alberta was delivered 12% below market cost and 29% ahead of schedule. At the same time, the

general contractor was the successful bidder on a public tender project that is very similar to the Mosaic Centre. Both buildings are roughly 30,000 square feet; the structure is the same; fees are comparable; they are both mixed-use office buildings and were both procured at the exact same time [9]. Since the general contractor was constructing both projects, there was the opportunity to conduct a detailed apples-to-apples comparison of costs as shown on Table 1. Project X is named accordingly at the request of the design firm for confidentiality.

Table 1: Comparison of IPD vs TPD Projects on Costs and Schedule

ITEM	MOSAIC CENTRE	PROJECT X
	IPD	TPD
Contract	\$11,341,879	\$15,614,000
Sitework	(\$705,507)	(\$1,514,890)
Consultant Fees	(\$627,045)	N/A
New Zero	(\$237,770)	N/A
Profit Erosion	\$256,893	N/A
Artificial Turf	N/A	(\$118,840)
Movable Partitions	N/A	(\$100,488)
Lockers	N/A	(\$19,375)
Food Equipment	N/A	(\$129,097)
Multiple Seating	N/A	(\$159,945)
Roof Access	N/A	(\$398,692)
Out of Town	N/A	(\$1,761,477)
Cost Totals	\$10,028,450	\$11,411,196
	\$334/SF	\$380/SF
Schedule	12 Months	17 Months

The design challenge was to provide a high sustainable building with net-zero energy consumption, meaning that the total amount of energy used by the building is approximately equivalent to the amount of renewable energy created by the building.

Since the IPD method fosters collaboration, it is expected that fewer change orders are generated compared to projects completed under the traditional delivery method. During the construction of the Mosaic Centre, involved team members reported minimal change orders. As a result,

project modifications efficiently and did not disrupt the flow of work which in turn helped the project stay on schedule. From the Mosaic Centre construction project, it is apparent that the IPD method does limit the number of formal change orders since all involved parties are acting as one team [9].

The owners mentioned that since the Mosaic Centre is an innovative building different from traditional buildings, they were prepared for some unexpected outcomes. As a testament to the effectiveness of the IPD method in mitigating costly errors, the project team avoided a \$280,000 potential cost mistake during the construction and was able to limit the mistake to \$80,000 due to the collaborative effort of all parties involved in the project.

In the planning stages, the Mosaic Centre was expected to be finished construction in 18 months; however, the construction was shorter. Due to the IPD model, the project team was able to finish ahead of schedule despite having complications during the construction. The owner discussed how the concrete portion of the project delayed other activities since it was part of the critical path. However, a design firm member confirmed how complications were resolved effectively due to the project team addressing issues in a collaborative approach. Both the owner and contractor acknowledge the benefits IPD brings to a construction project and both agree that the project was a success. Comparing the Mosaic Centre with a comparable project, the Mosaic Centre was complete in twelve months compared to seventeen months for the other project. The savings of five months lowered the carrying cost of the project significantly [9].

The state-of-practice in project delivery methods for achieving sustainable, high performance building projects such as the case study case net zero building was examined under the lens of IPD. The case study also contrasted a building similar in size to the Mosaic building without the sustainability criteria. The use of IDP clearly improved project outcome than with the TDP methods as noted with cost and time savings. Collectively the team generated solutions that would not have occurred under design build that would be acceptable to the owner. Although alternative design alternatives could have been developed under other delivery methods, the collaborative approach was key in a quicker and lower cost fix to issues that arose.

Lessons learned

Through the simulations and role playing coupled with an analysis of the case study, students and educators can truly appreciate the value of real life construction issues resolution and identifying trends in the construction industry.

The take away for an educator with IPD methodology to ensure student groups are exposed to and can apply a collaborative and cooperation approach to conflict resolution and construction issues. Students must be required to work in teams as opposed to in isolation. Students possess different backgrounds, skillsets and perspectives that should be brought together in problem solving. Lessons learned regarding the use of IPD in an educational setting has shaped additional curriculum development with building information modelling and related software [10].

Motivation may also play a factor in the success of developing integrated curricula. The main motivation for industry to move towards collaborative working and the use of BIM has been pressure from major Clients and various governments, and the opportunity for improved profits and competitiveness. Educators are not generally subject to these same pressures. However, the construction industry has expressed a need for graduates skilled in collaborative building design [11].

The goal of introducing IPD into a course is to teach IPD in a way that transfers knowledge and skills in construction to solve real problems in a constrained project delivery environment.

Factors essential for successful adoption of IPD include: understanding of basic project delivery method concepts; determining roles in various project delivery methods; and a connection among academia and industry, coupled with the connection among technology, knowledge and practices.

The simulation technique used in IPD differed from TPD in a sense that all stakeholders were brought together to the table to discuss and brainstorm solutions as opposed to the TPD system where individual meetings had to be held among competing stakeholders on resolving issues.

The TPD approach results in an adversary positions where each stakeholder is seeking strengthening his or her interests.

Lessons learned with the simulations was to illustrate the merits of IPD approach. Different results with respect to time and cost resulted. It took less time in the IPD approach to come up with a solution. The costs to resolve the construction also was reduced with the IPD approach.

In the IPD simulations, integrated teams are established, whereby all project stakeholders (owner, designer, contractor and subcontractor) involved in the construction process all have an equal say in project decision-making. The project teams must use IPD principles to address the issues/problems described in each of various scenarios in a manner that saves time, improves productivity, and creates a win-win outcome for all the involved parties. Example issues scenarios can include: schedule issues such as shop drawing submission weeks late; change orders such as foundation piles diameter changes; quality control such as pile driving mistakes happen during construction; weather issues; payment issues; scope changes and clash detection issues. The inclusion of other disciplines within construction schools should be explored. For example, architectural program students should be embedded with construction program students into teams.

Any major change process is likely to encounter resistance. Some of the difficulties for academia in introducing IPD may include: questions about how to fit new topics into a crowded curriculum; reluctance to change teaching habits established over many years; for those who may have developed their expertise, there may be resistance to take on a new subject or to retrain in an area they are not familiar with; academics who have been out of industry for some time may feel overwhelmed trying to keep abreast of trends; and the traditional silos of architecture, engineering and construction schools can be difficult to bridge. Time required to convert large cohort standard lecture-based courses into smaller multidisciplinary teamwork-based courses may seem an insurmountable challenge.

Conclusion

The Integrated Project Delivery (IPD) method is described as an alternative method of construction that shows characteristics not present in the traditional project delivery method of construction. Characteristics such as lean construction, building information modelling, and the benefits that follow make IPD effective and worth considering. When comparing with the Traditional Project Delivery method, IPD shows advantages during construction phases, contractual relationships, and compensation of contractors. The construction of the Mosaic Centre provides a practical example of how IPD encouraged collaboration and better profits

through minimal change order requests, cost-savings, and early completion date achieved by the team.

The use of simulation and role playing of different stakeholders in project delivery methods in a construction education context has proven to be valuable. Students were given the opportunity to contrast the responsive to construction issues arising and through the case study, were able to validate the merits of IPD as a method to delivery projects particularly a high sustainability project with unique constraints.

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