

INTEGRATING IPD AND EXPLORING POTENTIALS

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At the beginning of the 21st century, a new process innovation surfaced in the construction industry in the form of a new delivery system called IPD - Integrated Project Delivery. IPD has the potential to solve the construction industry's biggest problem of delivering a product that not only satisfies the client and users, but also the value chain. However, the knowledge of IPD and its five defining elements, contract, culture, organisation, Lean Construction and Building Information Modelling, is fragmented so the aim of this research is to integrate this and explore potentials. The method used is a thorough literature review. The results of this research consist of a detailed description of the IPD system and each of its five elements. The discussion revealed that IPD has a potential for being further integrated by perceiving it as a Virtual Enterprise and hereby enabling the use of experience and knowledge from business research. Furthermore, the discussion showed that IPD can act as an innovation supporter. Finally, the research concludes that a large unexploited potential within integration and innovation is recognised in the IPD system which can be unleashed through further research and experience with adaption and implementation.

Keywords: IPD, Integrated Project Delivery, innovation, virtual enterprise

INTRODUCTION

The construction industry (CI) has a long and somewhat tiring history of falling behind other industries' performance in terms of delivering high quality products that fulfil client expectations on time, on budget and with high productivity. One of the main reasons for the CI's low productivity is its lack of innovation (Winch 2003) and the inability to fully satisfy client expectations due to buildings' evolvement from simple structures towards high-performance products (Fischer *et al.*, 2014). The OECD defines process innovation as: A new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software, and the CI has undertaken several of these to accommodate the challenges. Some of these innovations are known as Design-Built, Partnering and Concurrent Engineering. All improving the CI's ability to deliver the products demanded by today's construction clients.

The latest process innovation within the CI is Integrated Project Delivery (IPD). This delivery system has the potential to improve project performance through a collaborative approach aligning the incentives and goals of the project team through shared risk and reward, early involvement of all parties, and a multiparty agreement (Kent and Gerber 2010). Kim and Dossick (2011) found that five elements, contract, culture, organisation, Lean Construction and Building Information Modelling (BIM), contribute to the integration of IPD. Furthermore, the Simple Framework Diamond (SFD) (Fischer *et al.*,

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2017) is represented through the elements by having contract as the framing integration agreement and the other elements working as fundamental nexuses for the four quadrants of the SFD, i.e. Lean Construction as nexus for quadrant 1, culture for quadrant 2, organisation for quadrant 3 and BIM for quadrant 4. Kim and Dossick (2011) say about the elements: these enhance one another's effectiveness such that the whole is greater than the sum of the parts, and Fisher *et al.*, (2014) elaborate on the contract itself: By itself, the IPD contract accomplishes little. Just as a skeleton creates the potential for motion by providing a structure, an IPD agreement creates the potential for success by providing structures that allow other elements of IPD to function effectively. Fisher *et al.*, (2017) finish with saying: These elements are supported by the integrated agreement that removes barriers to collaboration and enables the project team to function as a virtual organisation.

The IPD system is basically founded on the idea of obtaining the benefits from being and acting like one single company (Fischer *et al.*, 2017). To understand the IPD system, one could perceive it as a Virtual Enterprise (VE). The VE is a customer solutions delivery system created by a temporary and reconfigurable Information and Communication Technology (ICT) enabled aggregation of core competencies, like IPD. The core competencies come from people in different enterprises with a set of specialist skills and the knowledge necessary for the creation of a high value customer solution. ICT is what the CI refers to as BIM, and is, in the CI, an important enabler for the creation of a VE and hereby the Virtual Organisation (VO). The VO organises and structures the highly skilled people in the VE. Furthermore, the VO holds the adaptability to secure the competencies needed to deliver high efficiency and effectiveness in product design and production while, at the same time, delivering value for money.

Because the IPD system can be perceived as a VE, it is possible to use other industries' knowledge and experience in innovative delivery systems. This development is important because until now, several organisations have supported the advancement of IPD and provided insights and understanding (Thomsen *et al.*, 2010; AIA 2012). Several studies have demonstrated its benefits (Suttie 2013; Mesa *et al.*, 2016; Cheng and Johnson 2016), but the number of projects using IPD remains relatively small, and the major breakthrough has still not occurred. The IPD system's development and breakthrough have a large potential due to the change in competition taking place in the CI. Currently the competition is company vs. company, but the future competition in the CI will move towards supply chain vs. supply chain like other industries recognised decades ago. This future state can be seen as a paradigm shift within the CI. These supply chains have the structure of a VE with a VO. If these organisations want to survive, they need a competitive advantage and this is achieved through innovations. The innovations could be both product and process innovations, and the relative importance of these changes as the industry evolves. To enable these innovations, a strong support framework is needed. The framework should support and encourage ideation through communication, collaboration and a no blame culture, much like IPD.

The purpose of this study is to identify how literature has described and used IPD. The research focuses on the five elements: contract, organisation, culture, Lean and BIM, and on how these key elements are defining for the IPD system's current state. With an outset in a literature review which presented the five elements defining the IPD system, this research had the following research questions: A) How can integration of the project organisation and communication be accomplished by deploying the VE paradigm? B) Can IPD support innovation?

METHOD

This research is based on a literature review. It explores and investigates how the literature in the CI treats and defines the five elements that make a project delivery system integrated. The five elements, found by Kim and Dossick (2011) and within the SFD Fischer *et al.*, (2017), are contract, culture, organisation, Lean Construction and BIM. The paper and book (*ibid.*) were used for initial research and ensured that the literature review was focused on the specified topic. The study was undertaken as analytical research, where facts and information from already available material are analysed and evaluated. The research was exploratory since the objective was to answer research questions and from these develop a hypothesis, rather than verifying it. This section presents the methodology for choosing, describing and classifying key elements and main concepts.

The literature study was structured into five phases to select and find relevant papers. The papers were, after each phase, divided into four piles A+ to D with A+ being papers used directly in this research. To form a base of evidence, Levy and Ellis (2006) were used as a guide to a secure a structured and valid approach.

In phase 1, primary keywords to be used in online search engines were defined. Keywords and search engines were selected based on the above-mentioned paper and book, prior experience and discussions with colleagues. Keywords chosen: IPD, Integrated Project Delivery, Integrated Project Delivery + name of element and construction and/or project + name of element. Online search engines chosen: Scopus.com, scholar.google.dk, IGLC.net and Business Source Complete. Phase 1 resulted in a total of 300 papers. Phase 2 focused on titles and keywords. Clear criteria for excluding papers for phase 2 were defined. Exclusion criteria: language other than Danish and English, IPD related content older than 2003. Phase 2 resulted in a total of 200 papers. Excluded papers went into pile D. Phase 3 consisted of reading abstracts. This phase did not have a clear criterion for exclusion. This phase was based on a subjective evaluation of the abstracts and thus the paper's relevance. Papers were included if they focused on IPD directly or addressed one of the elements in the context of IPD. Phase 3 included 40 papers. The excluded papers from phase 3 went into Pile C. Phase 4 involved reading the full papers. It had a subjective inclusion criterion and if doubt about relevance were found, the supervisor and academic peers would partake in the final decision. Phase 4 included 23 papers that went into pile A. Excluded papers went into pile B. Phase 5 consisted in reading references. This phase had identical inclusion criteria to phase 4. This phase found another three papers that were included in pile A.

To secure the quality of the 26 papers in pile A, metrics and indexes were chosen. The primary aim was to find peer-reviewed papers with a high impact factor level. Furthermore, the individual number of citations contributed to the full picture of quality. It was noticed that papers in the CI generally have low impact factors and other metrics and indexes.

The Thomas Reuters WOS and the Danish bibliometric indicator list were used as a supplement. Finally, the H-index of authors was used in combination with these metrics. The use of metrics reduced pile A from 26 papers to an A+ pile containing 21 papers, all used in this research.

RESULTS

This section presents a literature review on IPD and the five elements. The literature used addresses one or more of the elements in or outside an IPD context.

Contract

IPD is based on trust, collaboration, coordination, risk sharing and innovation (Fischer *et al.*, 2014). One of the key elements of delivering an IPD project is the contract between the participants. In general, two broad classes of contracts are used: transactional and relational contracts. Traditionally, Design-Bid-Build and Design-Build projects are based on transactional contracts, however, the need for relational contracts arises because the transaction costs increase due to the rising uncertainty and complexity in construction projects (Matthews *et al.*, 2003).

Traditional project delivery practise shows four consistent problems (ibid.): Good ideas are held back, limited cooperation and innovation, inability to coordinate and focus on sub-optimization by project participants. Relational contracts used for IPD projects can mitigate this by creating a contractual incentive for corporation through a shared profit pool. The shared profit pool is based on the contractual compensation structure in the relational contracts where profit is distributed according to all verifiable costs that each signing partner in the IPD project can present. Profit is calculated at project level at the end of the project and divided based on the contract controlled by the Core Group. This model creates an incentive for the whole project team to super optimize the project with respect to the project scope.

The Core Group consists of the representatives from the partners who signed the relational contract, and will include at least owner, constructor and design professional (AIA 2012). The purpose of the Core Group is to secure a successful project through integrated governance, management of information infrastructure and leadership of the organisational change towards functioning as an IPD project organisation (Knapp *et al.*, 2014). The number of signing partners often exceeds three because it enhances collaboration and brings important skills to the table (Cheng and Johnson 2016). The Core Group's size and skills should be closely examined because the Core Group's ability to work as a team is closely related to the IPD project's success (Seed 2014; Knapp *et al.*, 2014). The three main multiparty IPD contracts used today are the AIA Document C191-2009 created by the American Institute of Architects, Consensus-DOCS 300 created by the Association of General Contractors (AGC) in 2007 and, finally, the Sutter Health's Integrated Form of Agreement (IFOA). If other parties aside from the Core Group should be included in the agreement, modifications are needed. Procurement in traditional delivery methods uses appointment criteria such as low bid or best value total cost. The IPD contract uses qualification based selection where price is not a factor in the final selection criteria (Mesa *et al.*, 2016).

There are two risk allocation strategies according to Mesa *et al.*, (2016): shared risk and split risk. Traditional contracts use split risk among the project members. By using risk transfer, a culture of idealistic behaviour is reinforced and very little is done to proactively avoid risks by treating the causes of the risks (Fischer *et al.*, 2014). IPD contracts use the shared risk strategy where the client, the design team and the contractor collectively manage and appropriately share risks, frequently through a shared contingency (ibid.). Due to the risk allocation clauses in the IPD contracts, certain issues arise relating to project insurance among the project members. Traditional insurance

companies will not cover IPD projects due to the contract's no suit clauses (indemnification clause) (Fish and Keen 2012).

Disputes within traditional transactional contracts are often caused by the contract structure. The IPD system has a documented positive effect on conflict resolution (Mesa *et al.*, 2016). There is no formal conflict resolution method associated with IPD, but dispute resolution through discussion and agreement within the Core Group is beneficial (Matthews *et al.*, 2003).

Culture

Culture can be defined as a social domain emphasizing the practices, discourses and material expressions of an organisation. Cultural change refers to the change of the construction industries' ability to change its traditional methods, as many architects, engineers and contractors are accustomed to their own narrow leadership. Cultural change is crucial for the realisation of IPD (Thomsen *et al.*, 2010; Suttie 2013). Open communication and trust form the basis for achieving high performance (AIA 2007; Chinowsky *et al.*, 2008). This was demonstrated by conducting a Social Network Analysis of information flow between project participants on a large-scale traditional construction project. IPD practices promote an increased number of participants in design and, thus, IPD increases the need for coordination and better communication in the project team (*ibid.*).

Involving team members in early goal definition and performance evaluation enforces the cultural change needed in an IPD organisation (Thomsen *et al.*, 2010). Trust, cooperation and a no-blame culture among the project participants are revealed as some of the most influential drivers of project delivery performance (Mesa *et al.*, 2016; Ghassemi and Gerber 2011). Findings show that successful IPD projects are achieved through proper selection and involvement of all main players as well as ensuring that these main players achieve trust in each other (Ghassemi and Gerber 2011).

Organisation

An integrated organisation in IPD is a collection of people organised in an integrated structure that is aligned to the project. Essentially, it is a group of individual organisations - and their employees - that embrace a common set of values and goals and act as if they were one company - a virtual organisation we call the Project (Fischer *et al.*, 2017).

This integrated organisation is the key to efficient project delivery, which optimizes value for the client and minimizes expenses. In IPD, early integration of stakeholders and value creation are managed through integrated governance. IPD enables the client to use the whole project organisation (IPD's value chain) in the initial project phases (value co-creation) to discover needs, requirements and value within the project scope.

The IPD organisation needs to restructure the way in which sharing information is performed. Sharing information is the backbone of the IPD organisation. Information must remain consistent across all trades. One study found that architects and engineers spend 54% of their time managing information when they work in fragmented teams (Flager *et al.*, 2009). BIM, 3D visualization and Co-location are some of the tools to implement this infrastructure and advance information flow (Suttie 2013).

The IPD project organisation is much more efficient in handling changes than traditional project delivery methods due to the relational contract, organisational structure and its large flexibility enabled by common incentives (Matthews *et al.*, 2003). IPD's high

efficiency is proven in case studies where IPD systems and traditional systems are compared (Suttie 2013; Mesa *et al.*, 2016).

Lean Construction

Lean Construction is an array of tools and processes that enable people to utilize their knowledge to design and produce products according to customer needs without embedding any waste. Cheng and Johnson (2016) conclude that: IPD sets the terms and provide the motivation for collaboration; Lean Provides the means for teams to optimize their performance and achieve project goals and (ibid.) further found that: The powerful complementary strength of IPD and Lean supports success.

Lean tools such as the Last Planner System and Target Value Design are usually brought in to the IPD contracts as agreed upon management tools (Knapp *et al.*, 2014). The unifying and complementary effect is achieved because IPD organisations acknowledge that IPD behaviours and processes (collaboration and Lean) are a result of choosing the right people and continued education (Ghassemi and Gerber 2011; Fischer *et al.*, 2017). Seed (2014) adds that the success also depends on choosing a project manager with a skill set matching the requirements of IPD projects.

Cheng (2016) concludes that IPD and Lean are effective, but the identification of the precise mechanisms for collaboration is still ongoing. Tillmann *et al.*, (2012) discuss Lean's importance for collaboration in IPD, and many case studies document how the synergy between Lean and IPD improves collaboration and efficiency in IPD projects (Fischer *et al.*, 2017; Cheng and Johnson 2016; AIA 2012; Kim and Dossick 2011).

BIM

BIM is the digital tool that binds the information flow of an IPD system together and creates the platform for VDC, integrated information and collaboration. Fischer *et al.*, (2017) crystalize the connection between BIM and IPD: The importance of integrated information to IPD cannot be overstated; it is the backbone and the source of truth and insight ... There are several aspects of what we call integrated information which includes ... Extensive use of 3-D models, a robust information technology (IT) infrastructure...By using BIM, teams can make decisions after analysing many options, not just on the basis of a handful of options. BIM allows the team to explore many design options rapidly and consistently, discuss how different designs will add value (or not), and how they will affect performance targets. Simulation allows teams to understand the impact of a scenario later down the line, and begin either modifying plans, or prepare interventions to mitigate negative impacts and risks. Fischer *et al.*, (2014) also emphasise the importance of BIM's role in IPD projects with the argument that BIM binds human and technological collaboration together. Furthermore, case studies show BIM's decisive role in collaboration and communication within IPD projects (Fischer *et al.*, 2017; Cheng and Johnson 2016; Cheng 2015; AIA 2012; Kim and Dossick 2011).

DISCUSSION

The discussion takes its outset in the five elements observed in the literature study. Focus is on framing the future state of IPD through two research questions.

1 - How can integration of the project organisation and communication be accomplished by deploying the VE paradigm?

Whether an individual pursues own goals or common goals depends on the perception of how dependent each person is on others. If individuals experience the context in which they are included as interdependent, it is more likely that their goals will be positively

related to each other, and they will understand that fulfilling own goals is directly connected to the degree to which they help others achieve theirs.

In IPD projects, this positively related context is structured through the first element, the relational contract, which contains an incentive to pursue the described and wanted processes and behaviours. The challenge is to communicate this interdependent relational context to the whole IPD project organisation, insuring integration and coherence in the whole project team, and not just to the negotiating PMs from each IPD partner. Communicating this context means communicating the full content of the five elements in a simple and logical way. This can potentially be accomplished by deploying the VE paradigm, thus perceiving the IPD project as one company.

By perceiving IPD through the lenses of a VE, platforms used within the business world to communicate structure and goals become available. The platforms proposed are the Business Model Cube (BMC) (Lindgren and Rasmussen 2013) and the vision, mission and value statement.

The importance of a vision, mission and value statement to secure team coherence and results in IPD projects has been emphasised several times (Fischer *et al.*, 2017; Paolillo *et al.*, 2016), but the means to communicate the actual structure of the unique virtual organisation and enterprise (individual IPD projects) in a simple structure are missing. The BMC could potentially deliver the solution with its seven generic dimensions: 1) Value Proposition 2) Customer 3) The Value Chain 4) Competences 5) Network 6) Relations and 7) The value formula. Ashcraft (2014) furthermore states that understanding the business model of an IPD project is an important part of creating the right contract structure. The following section provides a short proposal on how IPD can be described through the seven dimensions of the BMC.

1) The value proposition in IPD is the value targets agreed upon by the IPD signing partners and the owner. 2) The customer dimension represents the customers' world and perception of construction, together with a clear view of the end user. 3) The internal value chain could be displayed through Porter's value chain. This model describes a range of support activities that enable primary activities. The drivers for the support activities could, in the context of IPD, be the five elements or even be partly found within these. The five elements of IPD would in Porter's model work as enablers for the primary activities which would be represented by each partner in the IPD's value chain. 4) The competence dimension highlights each IPD partner's core competencies, showing the whole VO how each of them bring unique enablers to project success. 5) The network dimension has a key message that is to explain that no business is an island, meaning that no company, whether they join an IPD project or not, is able to deliver high value to a customer alone. 6) This dimension shows that relations are used for creating, capturing, delivering and receiving value, meaning that every partner including the owner has a responsibility to deliver value to the project. The explanations of both network and relations should be done in the context of Lean and BIM explaining how the given project handles this. 7) The value formula dimension disseminates the whole incentive structure of the contract.

If the BMC were to be brought in as an integrated tool in the contract negotiations this would potentially lighten the task of integrating the project organisation and communication because using the BMC as an integrating tool for the VE and hereby the IPD could create continuity in the communication of the context described earlier.

2 - How can IPD support innovation?

For IPD to support Innovation, IPD must support actual innovation enablers in the CI. Some of these enablers have been identified in the following research.

Research done on User Driven Innovation (UDI) by Wandahl *et al.*, (2011) and innovation in the construction material industry by Wandahl *et al.*, (2014) show that both have a list of well-defined enablers. Furthermore, Employee Driven Innovation (EDI) has been investigated in large project organisations by Sørensen and Wandahl (2012) and Sørensen *et al.*, (2014). This work showed that EDI also has a list of innovation enablers. The four studies all have unique enablers for innovation, but comparison of the studies revealed a list of 10 overlapping enablers:

1) Management (focus, support, resources), 2) Common incentives (shared risk and reward), 3) Trust, 4) Communication, 5) Collaboration, 6) Culture (no blame), 7) Network (use of external partners), 8) Process (a formalised innovation process management by a facilitator), 9) Knowledge sharing, 10) Employees (the right skills)

Several of the innovation enablers have a clear possibility of being supported by the five elements of IPD, which suggests that IPD can work as an innovation supporter from a theoretical point of view. The only enabler that is not supported by the current state of IPD's five elements is a formalised process to facilitate the innovation process. A solution to this last enabler could be found in an agile and iterative process. This process, also known as Scrum, supports the innovation process and works as a facilitator (Wysocki 2012). Parts of the Scrum concept have already been discussed as a tool for integrating the project organisation (Fischer *et al.*, 2017) but not as a means to support innovation in the CI. Furthermore, IPD's ability to support building innovation is presented in case studies by Cheng (2015) presenting EDI in IPD projects. The respondents emphasise that the innovative solutions found for each given project were enabled by good collaboration and communication in the delivery team which was working towards a unified goal as a team.

Cheng (2015) also suggests that IPD can support innovation. And a way to ensure that IPD fully supports the innovation enablers in the future could be by informing future partners in IPD projects about the importance of innovation to reach their project goals as emphasised by Paolillo *et al.*, (2016). This information could motivate the signing IPD partners to ensure that the structure of the contract describes and incentivises the right processes and behaviours to support the innovation enablers identified here. Future research should look more into this.

CONCLUSION

The key elements of integrating an IPD project, i.e. contract, culture, organisation, Lean Construction and BIM, were identified through the work of Kim and Dossick (2011) and Fischer *et al.*, (2017). These elements have been shown to enhance the effectiveness of each delivery team member such that the whole is greater than the sum of its parts, all contributing to the success and integration of IPD projects.

It was found that by deploying the Virtual Enterprise Paradigm, IPD has a potential for further integrating the project organisation and communication, creating an interdependent context for the project team. This context could help IPD increase value output. Furthermore, IPD was found to potentially support nine innovation enablers in the CI. IPD's ability to support the individual innovation enablers has not been proven, only IPD's ability to create building innovations is documented.

The research concludes that there is a large unexploited potential within integration and innovation in the IPD system, which can be unleashed through further research and experience with adaptation and implementation.

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