THE RESHUFFLE OF RISKS FROM IMPLEMENTING BIM BASED INTEGRATED PROJECT DELIVERY IN SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

The shift from traditional procurement systems, towards more collaborative procurement systems which are backed-up with information and communication technology (ICT), is becoming the new trend in the present day construction industry around the world. Integrated Project Delivery (IPD) and Building Information Modelling (BIM) are the two most emerging and widely used systems to achieve this shift. These concepts are likely to be the new industry standard in the near future due to their collaborative nature, ability to implement sustainable procurement strategies, risk and reward sharing basis and high efficiency of construction by promoting dry construction. Yet, the Sri Lankan construction industry is still following the traditional rigid and highly separated procurement systems with traditional 2D computer aided drafting (CAD). Therefore adopting and continuing BIM and IPD will generate many issues and risks since the industry is used to the absolute opposite of the underlying principles of both BIM and IPD. Under this context, a research is conducted with a broader aim of identifying the potential reshuffle of risks, which a construction project in Sri Lanka would be subjected, if it is delivered through BIM based IPD. This paper contains the preliminary findings of a literature review conducted on the current risks the industry faces and on identifying the requisites of BIM and IPD.

Keywords: *Building Information Modelling (BIM); Integrated Project Delivery (IPD); Risks; Sri Lanka; Sustainability.*

1. INTRODUCTION

Integrated Project Delivery (IPD) and Building Information Modelling (BIM) are modern day concepts that have revolutionized the way construction industry behaves. These two concepts are interrelated and need each other to produce a successful construction project (American Institute of Architects, National [AIA National] and McGrow-Hill, 2007; American Institute of Architects California Council [AIACC], 2007). Sri Lankan construction industry's procurement system is rooted on conventional procurement methods, while both designing and construction is still largely based upon 2D CAD drawings. Therefore adopting a highly technical ICT tool such as BIM and a highly collaborative procurement method such as IPD will be, challenging. This research is aimed at identifying the potential reshuffle of risks which a construction project in Sri Lanka would be subjected, if it is delivered through BIM based IPD.

2. INTEGRATED PROJECT DELIVERY

IPD is a collaborative project delivery method that has been developed for the construction industry. IPD is based on cross-functional project teams who are collaborating on a building's design and construction and, lifecycle management for optimized owner outcomes using model-based technology as a platform (Autodesk, 2008).

McKeon, (as cited in Jayasena and Senevirathna, 2012) states that the concept of IPD was created by a group of businessmen from Orland and Florida in 1990's. They had found that the new concept is very effective in serving the owner in a better manner and further reported cost savings and less stress

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during working. This had motivated them to work together for about five years and trademark the system in 2005.

AIA National and AIACC are two joint professional bodies which practice IPD. AIA National and AIACC (2007) define;

> IPD is a project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction.

Basically, IPD is a value based project delivery method. This value base is built on collaboration which in turn is built on trust, where all the key participants and their teams work together as they are part of one organization. They are bound by a well structured and trust based collaborative contract agreement and work with the intention of delivering a successful project rather than focusing on individual goals (AIA National and AIACC, 2007; Ashcraft, 2010).

2.1. PRINCIPLES OF IPD

IPD system is driven by a set of unique principles which allows the project stakeholders to acquire better outcomes. IPD expect the people who are delivering the project to adhere to these principles. Thus, by adhering to these principles only, a better outcome can be expected. Table 1 excerpted from the IPD Guide published by the AIA National and AIACC (2007) explains these key principles.

Table 1: Principles of IPD

Principle	Explanation
Mutual Respect and Trust	Owner, designer, consultants, constructor, subcontractors and suppliers understand the value of collaboration and are committed to working as a team in the best interests of the project.
Mutual Benefit and Reward	All participants or team members benefit from IPD. Since the integrated process requires early involvement by more parties, IPD compensation structures recognize and reward early involvement. Compensation is based on the value added by an organization and it rewards "what's best for project" behaviour, such as by providing incentives tied to achieving project goals. Integrated projects use innovative business models to support collaboration and efficiency.
Collaborative Innovation and Decision Making	Innovation is stimulated when ideas are freely exchanged among all participants. In an integrated project, ideas are judged on their merits, not on the author's role or status. Key decisions are evaluated by the project team and, to the greatest practical extent, made unanimously.
Early Involvement of Key Participants	Key participants are involved from the earliest practical moment. Decision making is improved by the influx of knowledge and expertise of all key participants. Their combined knowledge and expertise is most powerful during the project's early stages where informed decisions have the greatest effect.
Early Goal Definition	Project goals are developed early, agreed upon and respected by all participants. Insight from each participant is valued in a culture that promotes and drives innovation and outstanding performance, holding project outcomes at the centre within a framework of individual participant objectives and values.
Intensified Planning	The IPD approach recognizes that, increased effort in planning results in increased efficiency and savings during execution. Thus the thrust of the integrated approach is not to reduce design effort, but rather to greatly improve the design results, streamlining and shortening the much more expensive construction effort.
Open Communication	IPD's focus on team performance is based on open, direct, and honest communication among all participants. Responsibilities are clearly defined in a no-blame culture leading to identification and resolution of problems, not determination of liability. Disputes are recognized as they occur and promptly resolved.

Principle	Explanation
Appropriate Technology	Integrated projects often rely on cutting edge technologies. Technologies are specified at project initiation to maximize functionality, generality and interoperability. Open and interoperable data exchanges based on disciplined and transparent data structures are essential to support IPD. Because open standards best enable communications among all participants, technology that is compliant with open standards is used whenever available.
Organization and Leadership	The project team is an organization in its own right and all team members are committed to the project team's goals and values. Leadership is taken by the team member most capable with regard to specific work and services. Often, design professionals and contractors lead in areas of their traditional competence with support from the entire team. However specific roles are necessarily determined on a project-by-project basis. Roles are clearly defined, without creating artificial barriers that chill open communication and risk taking.

Source: Integrated Project Delivery (A Guide by AIA National and AIACC, 2007)

2.2. COMPARISON OF IPD WITH TRADITIONAL PROJECT DELIVERY

Traditional project delivery methods have many shortcomings since stakeholders focus on fragmented work scenarios and individual achievement rather than project goals. Hence the IPD system is created to remove all those shortcomings to make a win-win situation for all the participants. Table 2 excerpted from the IPD Guide published by AIA National and AIACC (2007) contains the key differences between the traditional project delivery methods and IPD.

Table 2: Key Differences between Traditional Project Delivery and IPD

Traditional		IPD
Fragmented, assembled on "just-as-needed" or "minimum-necessary" basis, strongly hierarchical, controlled	Teams	An integrated team entity composed key project stakeholders, assembled early in the process, open, collaborative
Linear, distinct, segregated; knowledge gathered "just-as-needed"; information hoarded; silos of knowledge and expertise	Process	Concurrent and multi-level; early contributions of knowledge and expertise; information openly shared; stakeholder trust and respect
Individually managed, transferred to the greatest extent possible	Risk	Collectively managed, appropriately shared
Individually pursued; minimum effort for maximum return; (usually) first-cost based	Compensation/ Reward	Team success tied to project success; value-based
Paper-based, 2 dimensional; analogue	Communication/ Technology	Digitally based, virtual; Building Information Modelling (3, 4 and 5 dimensional)
Encourage unilateral effort; allocate and transfer risk; no sharing	Agreements	Encourage, foster, promote and support multi-lateral open sharing and collaboration; risk sharing

Source: Integrated Project Delivery (A Guide by AIA National and AIACC, 2007)

3. BUILDING INFORMATION MODELLING

Building Information Modelling (BIM) is the process of creating a digital parametric model which represents the physical and functional characteristic of a building in full detail. BIM creates a shared knowledge pool which can be used to form reliable decisions during the design, construction phases and throughout the life cycle of the facility (Eastman *et al.*, 2011; BuildingSMART, 2012; Jayasena and Weddikkara, 2012). Furthermore this integration of information allows the various participants to the contract, to exchange information easily (Eastman *et al.*, 2011).

BIM is not a specific software itself. Yet, is an IT solution for integrating software applications. To achieve integration, the software are created with a standard data terminology called International Framework for Dictionaries (IFD) which defines the framework for development of data for BIM technology and Industry Foundation Classes (IFC) which defines the data exchange format. Therefore different software need to be interoperable with each other for them to be used in a BIM framework (Jayasena and Weddikkara, 2012; Wong and Fan, 2013).

One important object of implementing BIM is to promote sustainable construction. This is achieved by promoting dry construction rather than wet construction allowing the project to reduce construction waste including energy waste and reducing environmental damage (Wong and Fan, 2013). This is achieved by defining properties and behavioural relationships between each object within the BIM model which makes these objects "intelligent" (Jayasena and Weddikkara, 2012). Therefore each object knows its function and how it should relate with the other objects. This makes a complete computer generated model which contains precise geometry and data which are needed to support the construction, fabrication, and procurement activities (Eastman *et al.*, 2011).

While implementing a platform for software interoperability, BIM encourages high level of information sharing as well. Industry is used to work with different software applications which are usually incompatible with each other. However, BIM requires a major shift from working separately to working in a common platform (one common model), within a highly collaborative environment where people will have to interact more and exchange data for the benefit of the project (Pittard, 2013).

4. OVERVIEW ON CONSTRUCTION RISKS

Although risk is an inherent component in every endeavour humans undertake, the success or failure of any venture depend on the method that is used to deal with the risk. Yet, the construction industry and its stakeholders, mainly clients, contractors and the public, has suffered throughout the history due to the industry's failure to manage risk and meet time and cost targets (Thompson and Perry, 1998).

There are many different definitions by different authors on Risk in literature. According to Kartam and Kartam (2001), risk has been defined as the probability of occurrence of some uncertain, unpredictable and even undesirable event(s) that would change the prospects for the profitability on a given investment. Amaraekara (2009) emphasized risk as the uncertainty of loss, in a seminar on Construction Risks and Insurance at the Institute for Construction Training and Development (ICTAD) of Sri Lanka. The author further elaborates it as follows.

Risk = Hazard x Probability of Occurrence

According to the author this formula is to be used when the hazard is measured in terms of severity. Thus the probability of occurrence of a catastrophic hazard is extremely low; the risk may still be acceptable, whereas if the probability of a marginal hazard is extremely high, the risk may not be acceptable.

For a certain risk to exist there is a need of a cause or a source. The source of risks in the construction industry is the very nature of the industry itself, types of business and the environment (Kartam and Kartam, 2001). According to Thompson and Perry (1998), the inherent nature of the industry, which is, the size of the product, complexity of the process, speed of construction, location (geographical location), familiarity with the type of work, political planning and commercial planning creates these risks.

5. NEED FOR BIM BASED INTEGRATED PROJECT DELIVERY FOR CONSTRUCTION INDUSTRY

Current Sri Lankan construction industry faces many difficulties since it is driven by the traditional procurement system. Lack of trust between the key participants, the dominant figure held by the consultants (Gunathilaka and Jayasena, 2008; Osipova and Eriksson, 2012), and design variations

during construction period are some key difficulties while miscommunication between key parties adds fuel to these major problems. It is inevitable in the traditional procurement structure to reduce miscommunication since each stakeholder makes adjustments to his part of the project since they work largely in isolation (Wong and Fan, 2013). This leads towards the antagonistic relationship which is the root cause of disputes, cost and time overruns that plague the present day industry (AIA National and AIACC, 2007). Hence, there is a need of a well structured collaborative project delivery method for the industry.

The importance of the integrated construction project delivery, backed up with IT solutions for information exchange, had been identified by many authors throughout the literature as well as through industry surveys in recent times. Autodesk (2008) comment that, "Within the building industry there is a growing interest in IPD and the role of BIM in promoting integration among building professionals and improving design outcomes". They have derived this conclusion in the whitepaper published in 2008 as a result of doing a series of roundtable discussions throughout North America on the subject of IPD.

AIA National and AIACC have commented on the importance of IT based collaborative project delivery as well. The IPD guide by AIA National and AIACC (2007) states that, as a result of early collaboration and the use of BIM technology, more integrated, interactive, virtual approach to building design and operation is emerging. Furthermore a study conducted by the National Institute of Standards and Technology (NIST) of the USA from 2004, revealed that lack of AEC software interoperability is costing the industry $15.8 Billion annually (AIA National and AIACC, 2007).

Integrating IPD and BIM is a strong tool in implementing lean construction and achieving sustainability. The United Kingdom's Office of Government Commerce (UKOGC) has estimated that, savings of up to 30% in the construction cost can be achieved where integrated teams promote continuous improvement over a series of construction projects. UKOGC had further estimated that a single project employing integrated supply teams can achieve savings from 2% to 10% (AIA National and AIACC, 2007). Furthermore the importance of integrated processes has been acknowledged by sustainable rating systems such as LEED and ASHRAE in their new energy codes (AIA National and AIACC, 2007).

Proper project integration is vital to achieve the best outcome in the construction industry. Baiden and Price (2011) defines integration of project teams as "where different disciplines or organizations with different goals, needs and cultures merge into a single cohesive and mutually supporting unit with collaborative alignment of processes and cultures". They further emphasize that, when it comes to construction, this integration often refers to the collaborative working practices, methods and behaviours that promote an environment where information is freely exchanged among the various parties.

6. UNDERSTANDING PREVAILING RISKS IN THE CONSTRUCTION INDUSTRY

A construction project faces risks throughout the life of the project. Yet the greatest uncertainty of the project is in the earliest stages. Earliest stages of the project are when decisions with the greatest impact are made (Thompson and Perry, 1998). However, the client should bear all the risks, unless transferred to another party for fair compensation (Kartam and Kartam, 2001).

There are many categorizations of risks relating to the construction industry in the literature. One such is emphasised by Kartam and Kartam (2001) in their study on the Kuwaiti construction industry as physical, environmental, design, logistics, financial, legal, political, construction and operation risks.

Bunni (2009) has divided construction risks into major categories, considering the time of occurrence (chronology) and the nature of the risks. The author had further explained a whole variety of risks that can happen during each category.

Table 3 summarises the major risks in the construction industry that are explained by Bunni (2009) and by other authors in the existing literature.

Table 3: Existing Construction Risks Excerpted from Existing Literature

Classification	Risks
Feasibility stage	Procurement risks Identifying of client requirements Choice of site Inadequacy of soil investigation, surveys and site investigation Inadequacy of finance Inaccurate cost estimation (Osipova and Eriksson, 2012) Permits and regulations (Kartam and Kartam, 2001)
Design stage	Negligence, lack of care and failure to take account of foreseeable problems and work done in haste Inappropriate choice of design Lack of knowledge on basics and of state of the art technology Poor communication Adversarial relationship between consultants (Gunathilaka and Jayasena, 2008) Price-based selection of builders (Gunathilaka and Jayasena, 2008)
During construction, associated with the project and the location	Acts of god Resource availability (Kartam and Kartam, 2001) Inflation and unanticipated price changes (Kartam and Kartam, 2001; Kuganesan, 2007) War threats (Kartam and Kartam, 2001) Poor coordination with sub contractors (Kartam and Kartam, 2001) Financial instability Stability of the government Legislative changes Delays in site availability and issues with access to site (Amarasekara, 2009)
During construction, associated with the nature of the site	Acts of god Topographical and geological issues Underground obstructions Unforeseen physical obstructions
During construction, associated with the technical aspects of the project	Construction time overrun Technical complexity and innovation of new techniques Defective construction (Kartam and Kartam, 2001) Defective material and dangerous substances Defective or early removal of temporary work or supports Corrosion, collapse, vibration, oscillation and subsidence Inadequate site management Defective design Late material deliveries (Amarasekara, 2009) Sub contractors failure to perform (Amarasekara, 2009)
During construction associated with acts of man	Negligence, lack of care and inadequate supervision Conflicts leading to disputes Variations and extra work Lack of communication and poor programming of work Health and safety issues Fraud, theft, burglary, arson, riots, civil commotion and strikes Dominant figure of the consultant (Gunathilaka and Jayasena, 2008)
Post-construction stage	Damages (Amarasekara, 2009) Durability, serviceability and fitness for purpose issues Operational issues of elements Poor resistance to fire and other hazards

7. RISK ALLOCATION APPROACHES IN THE PRESENT SRI LANKAN CONSTRUCTION INDUSTRY

Traditional procurement approach still plays the major role of procurement within the Sri Lankan construction industry. This approach has created a highly fragmented nature in the industry environment where parties to the contract act as rivals (Gunathilaka and Jayasena, 2008). This has caused the functions done by each party to become fragmented as well, although each function is critical to be connected to each other in order to finish a construction project successfully. This has caused the construction professionals to highly depend on the conditions of contract, in order to solve every construction related issue.

Although construction risks are a responsibility of the client in general (Kartam and Kartam, 2001), the Sri Lankan procurement system is fixed in a manner which passes a majority of the risks to the shoulder of the builder. The builder is responsible to obtain a separate Insurance policy for each project such as Contractor's All Risk policy. Although the costs incurred during obtaining insurance policies and costs related to having an insurance policy (premium) are covered through the contract sum, the contractor is responsible to mitigate all kinds of risks that may happen inside the site.

Therefore the contractors have to decide risk management strategies including aspects such as risk responsibility, risk patterns and risk management capabilities. In managing these risk strategies main contractors even tend to pass the responsibility of certain risks such as quality of material and workmanship to subcontractors as well (Perera *et al.*, 2008). Due to this factor contractors and sub contractors sometimes tend to input high contingency values to the contract sum which makes the contract sum rather high. However there is some sharing of risks by the client and the contractor when it comes to uninsurable risks and bureaucratic delays (Amarasekara, 2009).

8. RISK ALLOCATION APPROACHES IN BIM BASED IPD SYSTEM

Since BIM is a tool which is used in designing, majority of the risk allocation structure lies with the IPD framework itself. One of the principles of IPD is "Mutual Benefit and Reward" which is about "Sharing Risks and Sharing Benefits" (AIA National and AIACC, 2007). IPD agreements include participants agreeing to place all or a part of the participants' profit to a risk pool that is augmented if the project performance is met or exceeded. This will be used to cover the cost overruns if the project goals are not met. This makes the key participants to the project to share any risk that will happen during the different stages of the project. Furthermore the individual profit under IPD agreement is not about fulfilling one's own work scope, amount of work performed or about individual performance. Hence the individual profit is a proportionate amount to the overall project success (Ashcraft, 2010; Cleves, 2011).

An agreement to share the risks and rewards helps to discourage selfish actions by individuals as well. Therefore every participant to the contract will be fully committed to do the project as it is expected to be (HansonBridgett, 2010).

Liability waiver concept is another strong point of IPD as IPD discourages going forward with any dispute resolution mechanism. Selecting a dispute resolution method as a mean of escape is always an indication of lack of trust. Therefore parties agree to waive any claim against each other except for wilful defaults (AIA National and AIACC, 2007). In order to compensate this, an assessment to quantify the potential risks can be done prior signing the IPD agreement and including an allowance in the project cost. Each party can do this assessment and allocation of a sum to the project cost (Ashcraft, 2010). Though a contingency is applied an actual saving of monetary terms will be there, since liability waiving reduces the costs related to dispute resolution (Ashcraft, 2010).

It should be noted that the IPD system is made in a manner that every key participant (owner, architect, engineers, contractor, cost consultants and other professionals) to the contract get involved in the project at the project initiating stage. This makes every participant to be a part of the decision

making process where every decision is taken by collaborating with each other. This makes every participant liable for project risks as well.

9. GOVERNMENT AND INDUSTRY'S ROLE IN PROMOTING COLLABORATIVE WORK PRACTICES

Sri Lankan government's usage of the traditional procurement system as its prime method for a long time has acted as a major contributing factor for the industry to hold on to the traditional system and to believe it as the only possible way of working in the industry. Therefore, the industry has somewhat become saturated, though it has a great potential to achieve better development (Gunathilaka and Jayasena, 2008; Rameezdeen and Silva, 2002).

Collaborative work practices are not something that is technical and need special scientific methods. Hence it is something psychological and can be achieved through respect, understanding, good communication and giving priority to project goals rather than individual goals (Rameezdeen and Silva, 2002; AIA National and AIACC, 2007). These are the very aspects that is lacking in the industry.

Promoting collaborative work practices can be initiated by any level in the industry; either by government sector, private sector or even the academic sector. Only catalyst that is needed to initiate this is, a new way of thinking, which will lead the way for the professionals to wanting to get out of the hardships and conflicts that they face due to the traditional system.

However once initiated, the government officials and statutory bodies have the responsibility of developing new strategies and help promote it throughout the industry. This can be achieved specially by developing new standards (standard documentation) and help the academics invent new ways of further developing the system. However the promotion and adoption of the system purely depend on the professionals' attitude of welcoming it. This factor equally affects the creation of new standards and regulations as well. However, the present era is the perfect time to adopt collaborative practices, since the Sri Lanka government is promoting development throughout the island.

10. CONCLUSIONS

Construction industry in any country is a complex and high-risk sector which is dominated by traditional contracts. Construction industry has a direct impact on the national economy and is generally used as an indicator for economic well being of the country. Yet the industry is criticised for failing to meet the demands of the modern business environment, low profitability levels, low productivity levels, using outdated technology and failing in the competitive international market. The main reason behind these has been identified as the traditional procurement systems and their limitations which the local industry is still using as its primary system (Gunathilaka and Jayasena, 2008).

There are many instances in the literature where the importance of a different but more collaborative procurement system has been identified. Yet the Sri Lankan industry doesn't practice collaborative procurement strategies such as partnering (Jayasena and Senevirathne, 2012) and hardly use state of the art technology for designing and constructing (Jayasena and Weddikkara, 2012). Jayasena and Weddikkara, (2012) further explained that, it would not be a challenge to adopt BIM technology since the country has comparatively high IT literacy and Architecture, Engineering and Construction (AEC) professionals with fair computer knowledge. Yet, they suggested that the challenge of introducing BIM would rather arise a resistance to change due to overlapping of professional boundaries. Researchers have further identified that contractors in general, are more supportive towards the adaption of collaborative practices and technological practices, and to shift from the traditional procurement system towards relational contracting (Gunathilaka and Jayasena, 2008).

As described above in the previous sections, the Sri Lankan construction industry is exactly the opposite to the fundamental principles of BIM and IPD concepts. Most importantly the IPD's principle

of risk sharing is a totally new concept to the local industry since the industry is used to passing the risk towards the contractor. Even the local insurance schemas have been developed under the basis that contractor bears all the risks.

Therefore any transition from traditional procurement system to a highly collaborative and highly technical procurement approach such as BIM based IPD will certainly be a risk shifting factor in the local industry which would lead to a change in the very way people look at construction risks and to define and create new risk transferring and risk mitigation methods.

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