Integrating Multi-Party Contracting Risk Management (MPCRM) Model with Building Information Modeling (BIM)

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ABSTRACT

This paper presents the result of a comparative analysis of conventional project delivery contracting strategies with an evolving Integrated Project Delivery (IPD) contracting approach, and outlines the changes in the process, and their risk management approaches. The paper also highlights the important role of advances in Information Technology (IT) and IT-based collaborative tools like Building Information Modeling (BIM) in facilitating such transformation. Considering the future direction of project delivery contracting strategies (PDCS) and their risk management approaches, the research then identifies and discusses the existing gap in current BIM process/tools and suggests the development of a Multi-Party Contracting Risk Management (MPCRM) Model integrated with BIM. The paper develops and describes a conceptual MPCRM model. The proposed MPCRM model integrated with BIM extends the current capacity of BIM in serving the collaborative teams earlier in the process into the contracting phase. The model provides a decision support framework and a common platform for processing shared database on risk management strategy during the entire project life cycle – contracting, planning, design, construction, operation, and salvage.

Keywords: risk management, BIM, project delivery, contracting, collaboration

1. INTRODUCTION

Project Delivery and Contracting Strategies (PDCS) have been constantly evolving to satisfy project needs. New Project Delivery methods usually begin to form when existing methods are found insufficient in delivering projects in an efficient manner. According to Pishdad & Beliveau (2010), the history of project delivery evolution indicates the fast-paced nature of PDCS changes especially in the last few decades. They argue that the rapid development of information technology and the shift in the cultures and procedures to effectively and efficiently utilize these advancing technologies are the underlying reasons for these evolutions.

In a transformation process, when changes occur and a new paradigm forms, the old problems and challenges -- which were the underlying reasons for changes-- would most likely go away and be replaced with new ones. The new challenges at first might not be recognized until the process is examined. Once recognized, another action is taken to correct the existing inefficiency, and this is a continuous loop which causes evolves the process towards progression.

Integrated Project Delivery (IPD) is a current evolving approach. According to Duke, Higgs, and McMahon (2010) "some of the most significant drivers of change [from the conventional approach to integrated approach] are: 1. Perceived inefficiencies in the current delivery model, 2. Renewed scrutiny on costs and budgets, 3. Desire for transparency, 4. Lack of trust, 5. Too much conflict, 6. Frustrations with defensive behavior and finger pointing, 7. Desire to improve communication and collaboration, 8. Increased publicity on an alternative / better solution, and 9. Need for a better quality product"(p. 4).

For the above reasons, a transition is made from conventional delivery approach to an Integrated Project Delivery (IPD). IPD is a project delivery method distinguished by a contractual agreement between owner, design professional, and builder (at a minimum) to increase collaboration. In IPD, risk and rewards are shared and stakeholder success is dependent on participant behavior and project success. The goal of an IPD approach is to optimize **the project** outcome rather than focusing on **the individual** business outcome.

Multi-Party Contracting and risk sharing are relatively unique to this currently evolving paradigm. Comparison of conventional approach towards contracting and risk management with the IPD approach would allow us to understand the nature of transition, its direction, and its reasons. Furthermore, it would assist in better understanding the new paradigm and the potential areas for improvements as compared to the more settled approach of conventional methods and with considerations of new tools and technologies.

This paper therefore presents the comparative analysis of conventional methods and IPD methods, and their approach towards contracting, and risk management. The paper also discusses the currently emerging tools and technologies to assist the delivery of projects.

2. METHODOLOGY

This research employs literature to identify current changes occurring in the world of project delivery and contracting strategies (PDCS), their applied risk management approaches, and their supporting tools and technologies. Following information gathering, the research sets the collective pieces of information in order of time to identify the trend and the direction of transition. Consequently a gap analysis is conducted. The research identifies the potential area of improvement in the evolving PDCS process and tools by envisioning the future direction based on the current transitions. The research finally proposes a conceptual model to fulfill the identified gap. This paper is part of an ongoing research. The methodology is going to further continue to critically evaluate several case study projects. Through case base analysis, the model will be examined and further developed into finer details.

3. BACKGROUND AND LITERATURE

3.1. Conventional Project Delivery Strategies vs. Integrated Project Delivery (IPD)

A look at the history of Project Delivery Methods indicates the gradual shift of the industry's desire from segmentation and fragmentation towards collaboration and integration (Miller et al. 2009). A reflection of this argument is better recognized when comparing the Conventional Delivery Methods like Design-Bid-Build with the Emerging Delivery Methods like Integrated Project Delivery (IPD) approach. The difference is more evident when comparing PDCS approaches towards organizational structure and the layout of project phases. DBB has a fragmented characteristic with much less integration among the parties and the phases. The IPD's approach presents a more collaborative and integrated approach.

"The traditional construction project is organized into three "camps" with diverse interests that sometimes converge and other times are opposed: owner, designer and contractor. Project participants come into their camps at various times during the project, with designers coming on early, construction managers (if any) coming on in mid-design, and general and trade contractors coming on after design is substantially complete. Project communications typically reflect contractual lines, so that a trade contractor's issues flow up to the GC, over to the architect or owner, and if needed, down to the design consultant having the answer. As a result, traditional projects have organizations that resemble silos or chimneys, with each camp organized vertically and separated from each other by contractual walls" (Thomsen et al. 2010).

Unlike the conventional delivery methods, the essence of the IPD is trust, integrity, and collaborative teams. Multi-Party contracting and Risk Sharing are two key contractual characteristics of the IPD approach which provides the opportunity for collaboration and reinforce integration among project teams.

Building Information Modeling (BIM), as a technological tool facilitates integration of data and project coordination efforts (Cohen 2010, Cooper 2009, AIA 2009).

The following sections further elaborate the differences between IPD and Conventional approach with respect to their contracting strategies, risk management approaches and their applied tools and technologies.

3.1.1. Two-Party Contracting vs. Multi-Party Contracting

Contracting for more conventional project delivery methods often involves multiple two-party agreements between project participants. Due to this nature of contracting, there might not be direct relationships between various key participants (e.g. designers and constructors) in the project; and therefore, it is more difficult to align goals and incentives of the parties towards project success.

Unlike the conventional project delivery methods with two-party contracting agreements, 'true' Integrated Project Delivery (IPD) approach is based on single Multi-Party Contracting agreement among the key IPD players. A well-designed Multi-Party Agreement (MPA) for integrated project should promote collaboration and align the interests of Owner, Architect, Contractor and other stakeholders in terms of sharing risks and rewards.

Sutter Health is one of the early adaptors of Integrated Form of Agreement (IFOA) (Duke, et al., 2010). Essentially, there are four principal industry form IPD contract documents available for use: 1. Consensus DOCS 300, 2. AIA A195, B195 and A295 (Transitional IPD), 3. AIA C195 (Single Purpose Entity), 4. Hanson Bridgett. While several industry form contract documents exist in the marketplace, experts agree that an "ideal" contractual document does not" (Duke, et al., 2010, p. 30) & (Ashcraft, N/A, p. 9).

Multi-party agreements require thorough planning, team building, alignment of interests and goals, and careful negotiation of contract terms and risk management strategies. The process should include as many IPD players as possible who are willing to be part of risks/rewards sharing pool. Due to the critical role of risk management strategies in contract development, the following section further elaborates on this subject and present a comparative analysis of a conventional and IPD approaches' towards risk management.

3.2. Evolution of Risk Management Strategies

Risk Management process involves seven steps: 1) risk identification, 2) risk assignment 3) risk measurement, 4) risk control, 5) risk financing, 6) implementation, and 7) monitoring and evaluation. The goal of risk management is to ultimately reduce the total cost of risks in the project. As defined by CII (1993), the total cost of risk management includes: 1) cost of insurance, 2) losses, 3) cost for loss control and safety program, 4) claims handling expenses, and 5) administrative costs of risk management; this research also adds to the list, 6) cost of contingency. The potential economic loss of risk is evaluated through determining the probability of occurring loss and the magnitude of that loss. Effective risk management based on cooperation and trust would significantly reduce the total cost in a construction project.

The AIA National and AIA California Council (2007) compared the Traditional Delivery Methods with the Integrated Project Delivery approach from the risk management standpoint and highlight that in traditional delivery methods, risks are individually managed, and transferred to the greatest extent possible. Comparatively, in IPD, risks are collectively managed, and appropriately shared.

3.2.1. Risk Allocation Featuring Two-Party Contracting

Conventional project delivery contracting methods are often based on risk allocation. This risk allocation normally assigns risk to one party. Equitable risk allocation principle implies that each identified risk should be taken by a party who is best-positioned both technically to control/manage risk and financially to absorb risk should it occurs. Consequently, risk is most effectively and efficiently controlled, its possibility of occurrence and its severity is minimized, and ultimately the cost of risk is significantly reduced.

The review of literature and the interviews with experts indicate that the traditional projects are mostly based on the concept of risk allocation rather than risk sharing. "Traditional commercial terms result in riskier projects. As traditional construction contracts shift risk among the various participants, and sometimes, despite the common wisdom [equitable risk allocation principle], the party who bears the risk is the one with the least bargaining power rather than the one best able to manage the risk. Even more problematic, this risk-shifting principle assumes that there is one, and only one, party that can effectively manage the risk. Not only is it unfair to make a party solely bear a risk it cannot effectively control, it is also inefficient. If a party is responsible for a risk it cannot effectively control, that unmanaged risk may hurt not only the responsible party but also the other participants and the project as a whole." (Thomsen et al. 2010).

Inappropriate allocation of risks in a project can lead to considerable financial consequences. According to CII (2006) the cumulative financial impact of inappropriate risk allocation measured in 17 case studies totaled 14 percent of the cumulative construction budget. Figure 1 represents the overall percentage breakdown of the financial impact of the 17 case studies conducted by CII.

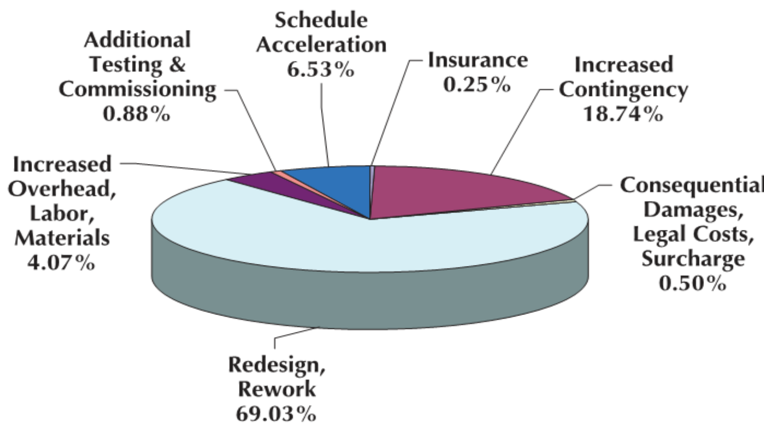

Figure 1: "Percentage Breakdown of the Financial Impact of the 17 Case Studies" (CII, 2006, p. 6)

As seen in Figure 1, the largest financial impact of inappropriate risk allocation belongs to redesign and rework mainly resulting from ambiguous acceptance criteria in these case studies. The second largest component of financial impact nearly 20 percent came in the form of increased contingencies by contractors in response to inappropriate risk shifting by the owner. This supports the importance of implementing equitable and appropriate risk allocation/sharing technique as a risk management strategy in the contract negotiation phase.

In an effort to allocate risk equitably in a conventional project delivery approach, CII suggested utilization of the "Two-Party Risk Assessment and Allocation Model as a framework for contracting parties to assess and allocate risk through a cooperative, non-controversial contracting relationship. The primary means by which the model encourages two-party cooperation is through the utilization of a set of risk assessment worksheets. The worksheets are a means by which to bring two contracting parties to a place where both common and individual contracting concerns can be identified, discussed, and negotiated" (CII 2007).

3.2.2. Risk Sharing Featuring Multi-Party Contracting

Equitable risk allocation principle might suggest that a risk best managed if it's assigned to more than one party and is shared. Besides effective risk management, risk sharing strategies facilitate alignment of goals and interest among the participants, promote team behavior, and incentivize the team to achieve project success. According to Duke et al (2010), risk sharing is one of the core principles of IPD method and in fact is one major reason why the Architecture, Engineering, Construction (AEC) industry is now moving towards implementing the IPD method.

"Rather than simply shifting risk among each other, members of an IPD team typically agree in various ways to share risk and collectively manage it. By sharing risk, all project participants have a financial stake in effectively identifying and mitigating risks that in traditional projects would be 'someone else's problem', leading to a less risky project overall as well as a more equitable approach to risk management. When another's problem will have a direct impact on your bottom line, you are more likely to offer help in solving the problem – promoting an "all for one, one for all" culture with everyone trying to reduce risk in their own way. Collective risk management means less risk for the whole project.

IPD projects use many creative ways of sharing risks and fostering collective risk management. Three common approaches involve sharing the cost-savings or cost overruns against an estimated cost of the work, pooling some portion of the team member's profit and placing it at risk, and/or pooling contingency funds and sharing any amount remaining after project completion" (Thomsen et al. 2010).

Compared to traditional delivery method, 'true' IPD offers a better opportunity of achieving equitable risk sharing and reducing the cost of risks. AIA (2007) argues that, "the increased interdependence of collaborative projects increases the number of parties relying on another party's contributions and who could potentially initiate a lawsuit. But the same interdependent web can reduce the likelihood and severity of loss. Exposure may increase, although true risk decreases". However, it is important to note that risk sharing is best suited for teams who have trust in each other and are collaboration.

3.3. Emerging Information Technology Tools for Collaboration and Integration

This paper focuses on two emerging technologies, BIM and PMIS as two emerging collaboration tools most appropriate for Integrated Project Delivery approach.

3.3.1. Building Information Modeling

BIM, the current buzzword in the Architecture, Engineering and Construction (A/E/C) industry, is known as a revolutionary paradigm. As with any new technology, BIM is evolving very rapidly and gaining momentum in our industry. Various definitions have been proposed for BIM, describing different aspects of it. Some describe BIM as a parametric object-oriented digital model. The model includes different types of information such as geometry, performance, attributes of building components, construction process, schedule, cost, and information on operation and maintenance. BIM helps users to learn about the whole building. "The idea behind a building information model is that of a single repository. Every item is described only once. Both graphical documents—drawings—and non-graphical documents—specifications, schedules, and other data—are included. Changes are made to each item in only one place" (Cyon Research Corporation 2003). BIM is highly complementary to Lean and IPD. While IPD without BIM could exist, BIM without collaboration is simply a representation tool such as Computer-Aided Drawing (CAD) tool.

Through capturing information in a single database and storing it in a central platform, BIM enhances the consistency of information and greatly reduces the communication errors associated with multiple models and different databases. BIM provides excellent benefits to an integrated team, key among them are: 1. A common platform and a shared knowledge source for information, 2. A documentation tool, 3. A collaboration tool, 4. Parametric, and 5. A tool for clash detection and constructability analysis.

1- A shared knowledge source for information: BIM serves as a common platform where project participants across disciplines converge around it to collaboratively build the digital models and figure out how difference pieces of the project come together. The shared knowledge source allows the team to see all different information about the facility in one place and ultimately to better recognize and address the conflicts and clashes of different pieces.

2- A documentation tool: "BIM is a documentation tool, replacing legacy-drafting procedures. It may include information such as the physical configuration, programmatic requirements, functional characteristics, specifications, systems performance, supply chain threads, construction sequence, cost or any other information that might be useful" (Thomsen et al. 2010). Multiple customized reports extracted from BIM serve as contractual tool.

3- A technology for collaboration: BIM facilitates collaboration among teams, and serves as an integration tools for our fragmented and specialized building industry. "A basic premise of BIM is collaboration by different stakeholders at different phases of the life cycle of a facility to insert, extract, update or modify information in the BIM to support and reflect the roles of that stakeholder" (AIA National and AIA California Council 2007).

4- ***Parametric:*** BIM has parametric characteristics. If properly structured and implemented, BIM can ensure that changes in a plan carry through to all of the related items in other plans and budgets. This enables the project team to avoid rework and engage in real-time estimating, as changes to the plans and design occur.

5- A tool for clash detection and constructability analysis: BIM provides the team with the opportunity to build virtually, to automatically identify the clashes, and to uncover problem before building physically.

It is important to emphasize that while BIM provides a great opportunity to promote design, construction, collaboration, and integration throughout a project life cycle, its full capacity can only be recognized in a collaborative environment.

3.3.2. Project Management Information System (PMIS)

Another emerging IT-based collaboration tools is known as Project Management Information System (PMIS). According to Thomsen et Al. (2010), PMIS is a web-based shared database created and used by the project team. While BIM is known as a shared digital model representing physical and functional characteristics of the facility; PMIS is centralized databases representing project-specific information and non-geometric documentations.

PMIS proves to be beneficial in communication of information such as goal, scope, quality, organizational structure, roles, contract terms, general condition, time and cost. PMIS is a documentation tool. It manages documents such as: contracts, permits, approvals and commitments, and makes the data easily accessible to participants. PMIS records project status of a facility from concept to implementation. Such project data would be useful for portfolio management and for planning future projects.

4. DISCUSSION

The multi-disciplinary industry of Architecture/ Engineering/ Construction/ Facility Management (AECFM) has experienced enough inefficiency resulting from fragmentation in the past few decades. The industry is now starting to realize the importance of tackling the problems associated with the traditional segmented way of business and is transforming towards a more collaborative approach. Formation of new project delivery approach such as Integrated Project Delivery (IPD) is an indicator of the industry's desire in shifting the culture and transforming towards integrity. Another indicator of such transformation is the fast-paced evolution of information technology as the era we live in is called 'Information Technology' age. Emerging IT tools are continuously enhancing and promoting communication and collaboration among teams essential to integrated environment.

Review of the existing collaboration tools such as BIM and PMIS suggests that while these tools provide great opportunities throughout project life cycle from inception onward; they do not provide support during contract negotiation phase. The capacity of current IT-based collaborative tools can be expanded to facilitate collaboration, communication, and negotiation during the contracting phase. Such tool will be particularly beneficial in a single multi-party agreement where there are more than two parties involved and integrity in the process plays a major role in project success.

A "true' form of Integrated Project Delivery (IPD) approach utilizes a single Multi-Party Agreement (MPA). As discussed, risk management plays a significant role in determining the overall characteristics of contract elements. Considering the existing gap in the current IT-based collaborative tools in serving throughout contracting phase, and the importance of risk management, this research proposes the development of a Multi-Party Contracting Risk Management Model integrated with BIM. MPCRM would assist the contracting parties to gain alignment with respect to their individual interests, goals, and ultimately approaches towards risks management while negotiating an agreement.

5. RESULT

5.1. Conceptual design of Multi-Party Contracting Risk Management integrated with BIM

This research suggests that the next generation of Building Information Modeling (BIM) includes a Multi-Party Contracting Risk Management (MPCRM) model. MPCRM model is an IT-based tool for collaborative risk management during project life cycle form contracting phase onward. Development of MPCRM model will allow the potential contracting parties to share their insights about the existing risk, collaboratively develop the most effective risk management strategies, and to negotiate contract terms accordingly. MPCRM model integrated with BIM promotes current BIM capacity through adding the contracting phase under the spectrum of its services. As opposed to current BIM which supports the collaborative efforts during project inception onward, the future MPCRM integrated with BIM provides wider supports through including the contracting phase as well. See Figure 2.

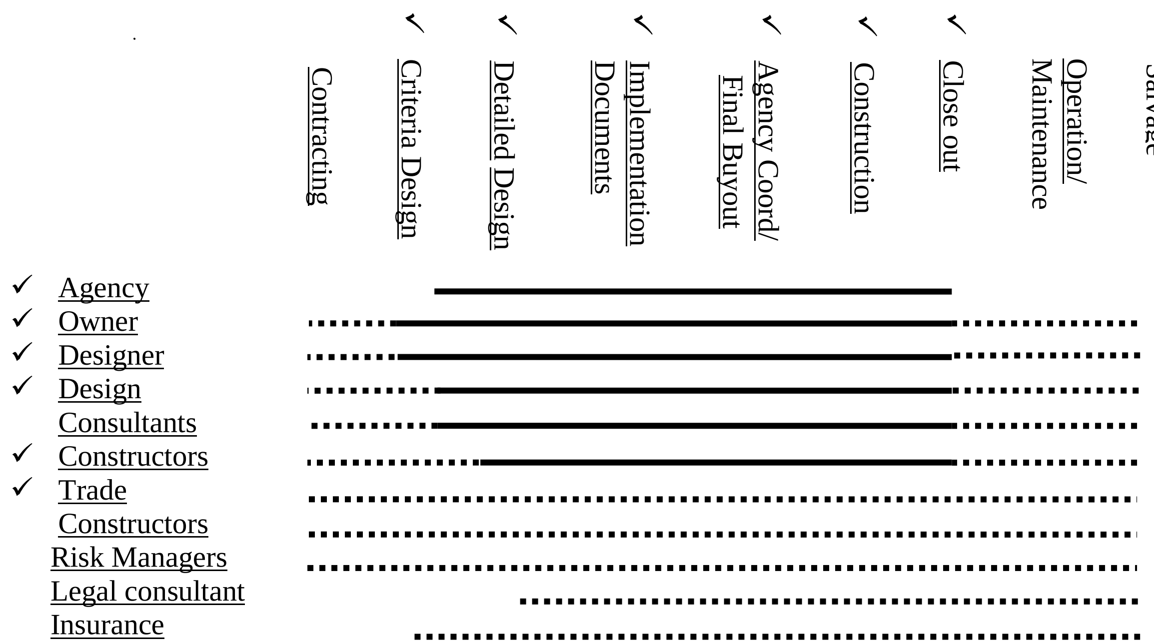

Figure 2: A comparison of current BIM capacity versus the proposed MPCRM integrated with BIM

Figure 2 indicates current industry's image of integrated process, its phases, and the parties involved as originally defined by AIA California Council "Integrated Project Delivery: Working definition". The solid lines indicate the involvement of the parties in the integrated process as introduced by AIA National and AIA California Council (2007). The proposed MPCRM integrated with BIM in this research, suggests promoting BIM capacity throughout wider spectrum and involving more participants for the purpose of risk management in multi-party contracting projects like IPD. The dash lines represent the expansion of the parties' involvement through the project life cycle.

MPCRM will transform the current way of risk management practice from paper-based risk assessment worksheet to a collaborative digital environment. MPCRM model provides a common platform and a decision support framework for the integrated team to share information about risk and risk management strategies.

MPCRM decision support framework contains a library with a checklist of potential risks, and possible risk management options from which the contracting parties can choose from. Each contracting party has access to the database and could activate the risks applicable to the project. Furthermore, they have the authority to add to the system, risks that are not included in the library checklist. Any time a new risk or risk management strategy is added; the system will automatically store it into the library and include it in the risk checklist for future use.

The automated MPCRM model, featuring the library checklist for potential risks, decreases the possibility of passive risks on projects. Passive risks as defined in the literature are risks which have the potential for occurrence but have not been proactively managed due to the parties' lack of knowledge about their existence. The MPCRM model incorporates automated feature through which the model will warn the integrated teams on passive risks which were left out of risk management consideration. See Figure 3.

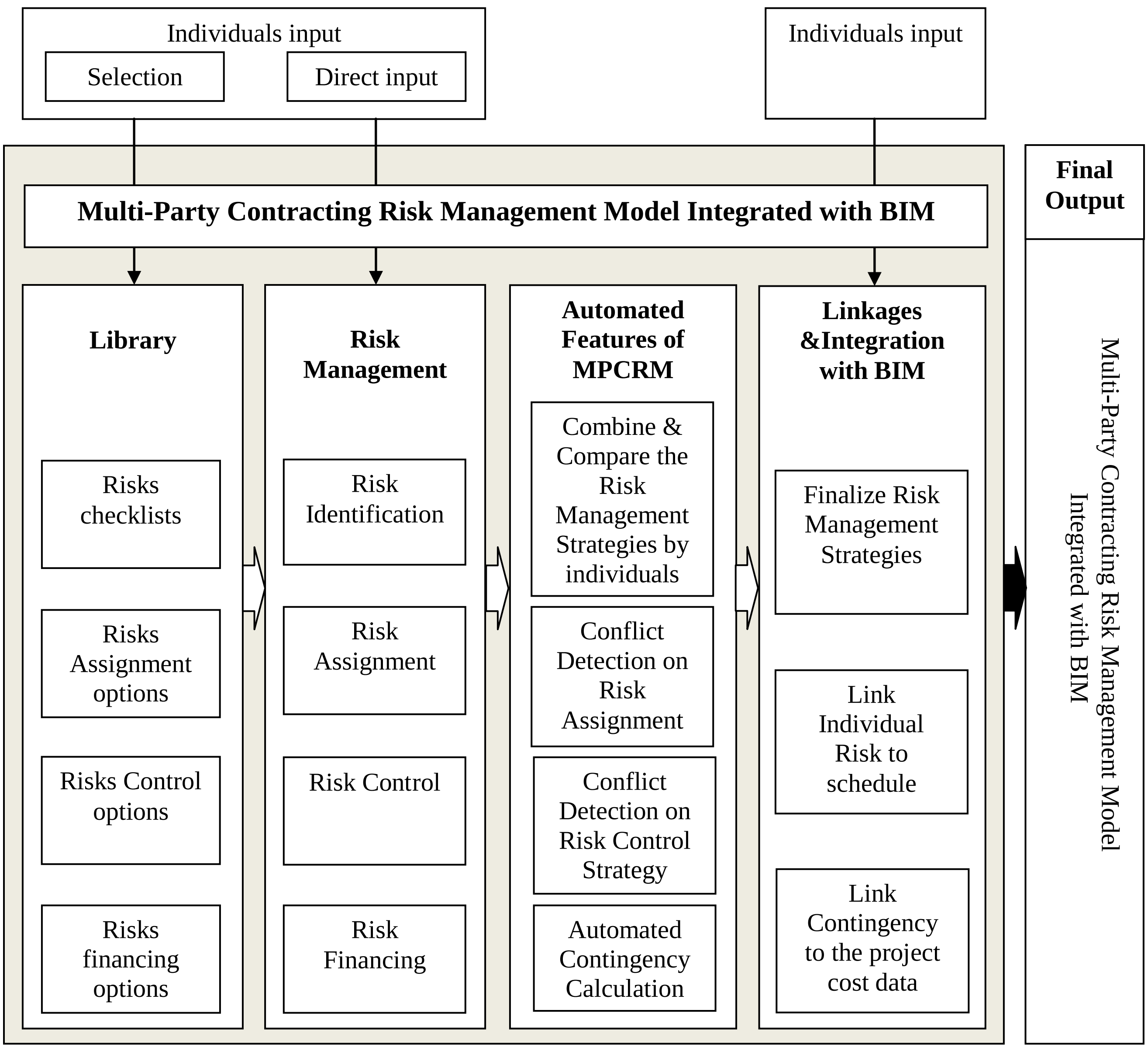

Figure 3: Conceptual Schematic Design of Multi-Party Contracting Risk Management Model Integrated with BIM

Furthermore, the automated feature of MPCRM model would also warn the parties on those risks that parties do not have consensus on the risk assignment, management, and financing strategies. In other words, the MPCRM model has automated clash detection feature for conflicting risk assignment / management strategies as proposed by the contracting parties. The MPCRM model also asks parties for their input on the proposed risk financing strategies and their associated cost. Risk financing includes the cost of self insured-risk in the form of contingency as well as the cost of transferred risk in the form of insurance.

Once the teams reach a general consensus, the system records the final risk assignment and management strategy. MPCRM model also contains a legal chart in its library which has the equivalent contract language for the selected risk management strategy. Upon selection of a risk assignment, the contract language or the contract provision would automatically be proposed by MPCRM model for the review of the contracting parties. Once the contracting parties develop the final version of the contract the model store it in the system. During the project at each phase, the MPCRM will remind the contracting parties of their risk liability issues, and the teams could view their risk management strategy and the amount of risk financing available for them.

MPCRM suggests a default time schedule for each risk. The risk time schedule represents the time frame during which the risk would occur. The operator has the opportunity to either chose from the default options or proposes a new time frame. Thus in the MPCRM model, each risk is linked to the schedule and presents the time frame of its potential occurrence. As the schedule is updated during the project, the MPCRM model automatically identifies the risks which are no longer threatening the project. Consequently, the risk manager or the operator enters the as-build information on those risks into the system. The actual as-built information includes the status of actual data about risks occurrence, cost of risk, and risk management approach is updated by an operator in the system as the as-built risk data. In the end, the model contains both information about as-planned risk data and their results.

Based on the actual risk inputs, the MPCRM automatically update the information on contingency cost required for the project. Following each update, the system would automatically perform a comparative analysis between the original estimated risks and actual risks, re-calculate the contingency for the project, and identify if the contingency is exhausted or if a part of contingency can be released. This feature to some extent is similar to the parametric characteristics of our current BIM model in which the information are linked and the update and changes in one database would automatically lead to consequent changes in the relative linked databases.

According to Thomsen et al. (2010), for true IPD project it is more cost effective to consider a shared contingency pool for the whole project as opposed to have contingency set aside by each party. Shared contingency pool reduces the problem of contingency stacking. In these types of contingency arrangements, with the help of MPCRM model, the project manager could easily determine whether the contingency will be sufficient for the rest of the project or even if part of contingency can be released and invested in other opportunities. Thus the use of automated MPCRM model could offer a significant value to the owner.

The MPCRM model includes a series of interconnected databases such as risks, contingency cost, schedule, and project cost. Thus any change on the risks information will automatically be reflected in the contingency cost and consequently will be reflected on the project cost. This automated and parametric characteristic of the MPCRM provides the owner with the opportunity to better manage contingency cost on the project. Following each update, MPCRM automatically calculates risk variances through comparing the resultant risk information with as-planned data. Positive risk variance represents that resultant risk quantity exceeds as-planned risk quantity. The system highlights the positive risk variances; the risk managers would identify the underlying reason, and record the information as lessons-learned for future similar projects.

In some way, the MPCRM serves as an automated case-study conductor. Throughout the project life cycle starting from early contracting phase, the MPCRM model continuously records the information on the history of negotiation, the debates and individuals inputs, the risks assignments and sharing, and the expected cost of risk, in a parametric model. As the project progresses and the risks are unfolded, the

MPCRM model records the new information as actual risks data. At the end, the model includes a forensic analysis of how the risk management plan was initially developed, and if and how the resultant risk data is different. From this a company can better understand the impact of their selected contracting delivery method and risk management strategy on their bottom line.

The idea of MPCRM integrated with BIM, proposed in this paper, will promote the current capacity of BIM in facilitating integration throughout different phases. The MPCRM integrated with BIM will tie contracting, pre-design, design, construction, operation / maintenance, and salvage together in a seamless loop of information. Current BIM tools facilitate integration by virtually collocating teams on a common IT platform early in the design phase. Comparatively, the MPCRM integrated with BIM, allows this integration to happen even earlier during the contracting phase while developing the risk management strategy and negotiating the single multi-party contract.

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