GREEN BUILDING PROJECTS: PROCESS INNOVATION LEADING TO PROJECT INNOVATION

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Green Building (GB) project delivery is complex since these projects have many different requirements compared to conventional construction. There is not yet an agreement on which delivery approach is more effective in delivering more innovative and environmentally conscious GB projects. This paper investigates the GB project delivery approaches from an innovation perspective by reviewing the various empirical findings from previous research. Using 13 relevant studies identified through a systematic search, the relationship between innovation in delivery process and project innovation is identified. Depending on the extent of innovative features incorporated, each Project Delivery Method (PDM) is found to have the capacity to produce successful results. Incremental process innovation through the use of traditional PDMs is typically associated with a low level of project innovation and environmental performance while radical process innovation using integrated delivery method is found to be associated with a high level of project innovation and environmental performance in GB projects. Delivery process that encourages team work can be valuable as this promotes team integration and collaboration thereby leading to innovative solutions.

Keywords: green building, green performance, innovation, project delivery method

INTRODUCTION

Green Buildings (GBs) require the use of innovative construction techniques and delivery processes. Slaughter (1998) defines innovation as the actual use of a nontrivial change and improvement in a process, product, or system that is novel to the institution developing the change. GB projects are innovative projects and their level of green performance can be considered an indication of their level of innovation, which significantly depends on the project delivery approach. Unlike conventional building development where the environmental effects of construction activities are often disregarded, GBs focus on improved environmental performance.

For successful GB projects, delivery process can be as important as the technical aspects. Various Project Delivery Attributes (PDAs) are involved which are basically a set of circumstances, facts, influences or forces that either facilitate or impede project outcomes. Project Delivery Method (PDM) is one of the key PDAs for project success as it defines how project teams form, their working relationships, and levels of involvement during project timelines, and incentives to encourage contribution to the project. Two elements

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define a PDM: (1) relationships of project stakeholders; and (2) their timing of engagement in the project (El Asmar *et al*., 2013).

In GB projects, coordination between the work of various design disciplines and contractors can enhance the constructability and innovation aspects in design to improve green building projects' success (Li *et al*., 2011). Thus, innovative delivery approaches can result in higher levels of project innovation. Although a general understanding of the effect of PDMs on project innovation exists, there is relatively little research on the link between the level of innovation in GB projects and the level of innovation in their delivery processes. Accordingly, the purpose of this qualitative systematic review is to identify the role of project delivery approach on GB project outcomes, from an innovation perspective.

CONCEPTUAL FRAMEWORK

Green Buildings as Innovative Projects

The significance of innovation in GB projects is demonstrated by the rewarding of innovation. The Singapore Green Mark GB certification system gives a 15% weight to innovation. These innovative features include technological approaches as well as financing methods and management approaches, such as environmental management systems etc. (Li *et al*., 2011). The USGBC LEED ver. 4 (Building Design & Construction) gives only 5.5% weight to design innovation, the other 94.5% points shared by other categories (e.g. water efficiency, indoor environmental quality, etc.) are directly and indirectly affected by innovation in terms of advanced machinery, equipment and effective software applications which are required for optimizing environmental performance in GB projects.

Innovation, Project Delivery Methods and GB Project Outcomes

In construction, innovation can be characterised as incremental or radical innovations. Incremental means 'small, and based on existing experience and knowledge', whereas radical is 'a breakthrough in science or technology' (Slaughter, 1998). The delivery process of different GB case studies can be partially explained in terms of incremental and radical innovation. However, in order to gain a deeper insight into the factors for influencing delivery process innovation, 'architectural', 'modular' and 'system' innovations also need to be considered on GB innovation scale. 'Modular' is a change in concept within a component only, while 'system' means innovation within multiple components. Other than modular and system innovation to explain innovation within components, 'a change in links to other components or systems' is explained by architectural innovation (Figure 1) (Slaughter, 1998, Tidd, 1995).

Although the concept of incremental and radical innovation is easily applicable to processes as well as products, the concept of architectural and system innovation majorly evolved for products. One way of applying the idea of architectural innovation on processes is by considering different team members in project delivery process as the components of a delivery system. In these terms, architectural innovation will result from a difference in interrelationships among the components (team members) involved. This difference in interrelationships will arise from the variation in contractual terms, roles and responsibilities, etc. which are the specific characteristics of a PDM. Therefore, a PDM is subjected to architectural innovation in which interrelationships are changed compared to original approach.

The choice of a PDM impacts project innovation because coordination among project team members is strongly influenced by PDM. Traditional lump-sum contract is considered the most detrimental to innovation. It typically involves the highest cost risk, the highest occurrence of adversarial relationships, lowest integration level across the supply chain, and poorest innovation outcomes. From innovation perspective, it is the presence of a well-integrated team that is of most importance, as it is a key to driving the achievement of innovative features (Blayse and Manley, 2004).

Project Delivery Methods and Their Characteristics

PDMs to be discussed in this paper are grouped into three, based on their most salient characteristics: Design-Bid-Build (DBB), Construction Manager at Risk (CMR) and Design-Build (DB), and Integrated Project Delivery (IPD).

Category 1: The conventional delivery system- Design-Bid-Build (DBB)
In DBB, bidders have a clear understanding of project scope since design and construction phases are separate and sequential. It is the most simple and popular PDM; the owner contracts with designers, and then when design is 100% complete the owner contracts separately with a General Contractor (GC) to build the facility. The design is restricted and the contractual structure does not promote collaboration between the design team and contractor leaving bidders and the contractor with little or no room for innovation. Though the early involvement of contractors is possible with DBB, it is typically not to the extent of a more integrated PDM (Mollaoglu-Korkmaz *et al*., 2011). DBB typically uses one of the most basic payment options i.e. lump sum payments (interim or milestones).

Category 2: Fast-tracking-orientated delivery system - Construction manager at risk (CMR) and Design-Build (DB)
Fast-tracking means overlapping of design and construction phases. Construction Manager at Risk (CMR) and Design-Build (DB) are the common approaches. Although they are fundamentally different, in both, collaboration among the owner and other parties is not based on a multi-party contract. In DB, the general contractor (GC) is engaged when the design is not complete, and the designer will be novated to the GC, thereby providing a single point of responsibility for owner. With the CMR system, the constructor is involved early on in the project; the system usually includes a reimbursement solution based on incentives (Kenig, 2011). Although, DB and CMR are suitable for fast-tracking, they lack a particular focus towards project integration.

Category 3: Integrated delivery approach
IPD is a relatively new concept and evolving, having multiparty agreement, shared risk and rewards, and early involvement of all parties whereby all key project stakeholders sign one multiparty contract before the start of design. It is based on the assumption that a project will suffer from lack of innovation if everyone is held solely responsible for their own scope and price. Thus parties agree to share project gains and lack of performance according to their participation (Matthews and Howell, 2005).

METHOD

Using a systematic review of previously published GB case studies, this paper identifies the role of project delivery approach on GB project outcomes, from innovation perspective. However, due to the lack of research linking GB project innovation with process innovation, the substitute technique used in this paper is to review studies that have related GB project success/performance with different delivery approaches. This paper uses an assumption that green performance of GB projects is directly proportional

to innovativeness. It is also assumed that some PDMs are more innovative than others depending on their history and popularity of use. Thus, comparative studies relating the use of different delivery techniques for GB projects are reviewed. Relevant publications were obtained through a systematic and extensive search of thesis, and refereed journal, conference, and review articles using the title/abstract/keyword' fields in major databases such as "Web of Science (ISI)", "Scopus (Elsevier)". Publications issued until October 2016 were considered. Originally developed code used include: (("green" OR "sustainable" OR "high performance" OR "energy efficient "OR "sustainability" OR "nZEB" OR "ZEB" OR "zero carbon" OR "low carbon" OR "LEED") AND ("building") AND ("project") AND ("delivery" OR "procurement") AND ("performance" OR "success")). 518 publications were obtained in the "the first round". They were scrutinized using their titles and keywords and 75 publications were shortlisted in "The second round". By scrutinising the abstract and conclusion sections in the "The third round", 13 relevant publications were finally shortlisted for qualitative review. Publications were selected only if they relate to the delivery of GB projects; and if they relate different delivery approaches for successful GB project delivery.

FINDINGS

The search results show that not many studies have examined the link between PDAs and performance outcomes of GBs. In order to investigate trends of GB delivery processes in terms of innovation, the review findings are now presented. The only available literature relates PDAs with project success/performance (i.e. level of green performance, etc.) - conceptualised as the level of innovation. The current trends of innovation in GB delivery process are then identified. The effectiveness of different PDMs for successful delivery of GB projects is examined first, followed by the reasons for the associated increase in project performance. Finally the role of PDAs (Project Delivery Attributes) other than PDM is highlighted.

Effect of PDMs on GB project outcomes

In terms of Conventional DBB vs. Fast-tracking delivery systems, using inductive reasoning, Gard (2003) argued that the DB method of infrastructure delivery capitalizes on synergies between designer and builder, rather than exacerbating the conventional antagonism between these two actors, as typical in the DBB method. GB projects delivered by CMR and DB outperform DBB projects on different performance criteria particularly in terms of delivery speed (Korkmaz *et al*., 2010a). Defining GB project success as a measurement of a project meeting or exceeding its initial LEED rating goals, Molenaar *et al*., (2009) found that all PDMs (DB, DBB, CMR) could lead to all levels of LEED certification. However, success differs for each PDM. The majority of projects (75%) used DB and CMR as PDMs. CMR was identified as the most successful PDM with 94% success rate and exceeding owners' expectations 50% of the time. Furthermore, the use of DB approach in building mechanical systems of GB projects was found to result in better outcomes when compared to DBB approach (Riley *et al*., 2005). Some US-based GB office projects were discussed in another study (Swarup *et al*., 2011, Korkmaz *et al*., 2010a). Table 1 summarises their findings. The total score provides the overall GB performance and is a sum of the scores a project has in the performance metrics of High Performance Green, Intended vs. Achieved green status, Post Occupancy Evaluation, as well as Cost, Schedule and Quality performance. In case a project performs up to the mark/expectations, then it gets a score of 0. However, if it performs better or worse, it gets +1 and -1 scores respectively. Table 1 shows that different PDMs

are related with different levels of integration in delivery process and this consequently affects final project outcomes, particularly sustainability goals.

Although many studies relate the difference in project performance with the PDM used, a unanimous agreement does not exist about differences in the effectiveness of PDMs. For instance, using US NAVY projects Carpenter (2005) found no noteworthy difference between DB and DBB in terms of LEED scores at the FACD (Functional Analysis and Concept Design) and design completion stages. Similarly, Bilec (2008) could not establish any explicit relationship between DB and green design.

Table 1: PDAs and Performance for GB projects (Swarup et al., 2011, Korkmaz et al., 2010a)

Proj. Code	PDM	LEED Certification	Owner's commitment	Total Score	Level of integration	Contractual Terms		
						Des.	Con.	D-B
A1	DBB	Certified	Low	-2	Low	LS	LS	
A2	CMR	Certified	Medium	-1	Medium		LS	
A3	CMR	Certified	Medium	-1	Medium	LS	GMP	
B1	DBB	Silver	Medium	-1	Medium	LS	LS	
B2	CMR	Silver	Medium	-4	Medium	LS	GMP	
C1	DB	Gold	High	3	High			C+F
C2	DB	Gold	High	3	High			C+F
D1	DB	Platinum	High	4	High	C+F	C+F	
D2	CMR	Platinum	Medium	1	Medium	C+F	C+F	
D3	DB	Platinum	Medium	0	High			LS
D4	DBB	Platinum	High	0	Low	C+F	LS	

Note: LS= Lump Sum; GMP= Guaranteed Maximum Price; C+F= Cost+Fee; Des.= Designer; Con.= Constructor; D-B= Designer-Builder

In terms of Integrated vs. Conventional and Fast-tracking delivery systems, IPD as a PDM is remarkably different from other PDMs. Kantola and Saari (2016) argued that IPD is the most suitable PDM for GB projects. El Asmar *et al*., (2013) evaluated the performance of 35 IPD projects in comparison to projects delivered using other PDMs (i.e. DBB, DB, CMR), and showed statistically significant performance outcomes in the case of IPD. In another study, Matthews and Howell (2005) found that the use of IPD resulted in successful project delivery in a chilled water plant project. The project demonstrated how the increased coordination, innovation, and skill set resulting from the application of IPD helped materialize a successful project execution. Hanks (2015) compared 8 DBB projects to 8 IPD projects and found that 75% of the DBB case studies achieved the LEED target while 63% of the IPD case studies exceeded LEED target. Important attributes responsible for the outcomes are: the early involvement of key project participants, collaboration, and the use of technology. Although these attributes can be incorporated into both DBB and IPD methods, IPD facilitates the use of technology and incentivizes early participant involvement and collaboration. Thus, using IPD tends to provide higher assurance that project performance targets (e.g. LEED certification) will be met or exceeded.

Some studies examined, in detail, the factors that make some PDMs more effective than others. For instance, Molenaar *et al*., (2009) found that success rates favour PDMs that do not seek pricing before selection and that use GMP payment provisions. According to the studies (Swarup *et al*., 2011, Korkmaz *et al*., 2010a) shown in Table 1, GB projects with high overall scores and also high levels of green certifications tend to have Cost+Fee contractual terms instead of GMP or Lump Sum terms. The difference in project

performance because of the difference in payment terms is reasonable because the payment systems used in PDMs are of much significance since it can minimize the principal-agent problem by aligning the interest of principal and agent parties. However, one of the owners of a project in Korkmaz *et al*., (2010a) study stated that GMP and lump sum are ineffective, old school, old thinking, and a hindrance towards innovation and new technologies as they tend to make the stakeholders focus more on protecting their own interests. Cost+Fee structure can also be problematic. For instance, one designer in the study stated that Cost+Fee for the most part implies a percentage of the construction cost. Therefore, there are disincentives to achieve high performance: if the idea is to try to reduce system size, the associated cost will reduce and if fees are based on cost, there is no incentive for reducing costs and achieving a higher efficiency. Thus, it can be stated that some of the existing payment contractual terms are more effective than others in aligning the interests of project team members. However, there is room for further improvements in these contractual terms. The findings suggest that constituent elements of different PDMs set them apart when it comes to their ability of successfully delivering GBs.

Effect of PDAs on GB Project Outcomes

The review also shows that there are many PDAs other than PDM which influence GB project success and innovation. For instance, Bilec (2008) study provided a series of best practices for GB delivery, which in some cases are related to a specific PDM, but in other cases are independent of the PDM used. PDAs such as timing of project participants' involvement in the delivery process and owner type can be important factors for successful project outcomes compared to the PDM used (Korkmaz *et al*., (2010b). In Korkmaz *et al*., (2010a) study it was realized in 3 out of 11 cases that a certain level of project performance is not entirely based on the PDM being used. For instance (as shown in Table 1), D4 was an outlier project, since it had low level of integration, was delivered by conventional DBB but still performed significantly better because of the contractor's commitment and early involvement in the project; B2 was also an outlier since it had a medium level of integration, was delivered by CMR but still had low performance outcomes because of the lack of contractor's commitment; A2 was also an outlier since it had a medium level of integration, was delivered by CMR but still had a low sustainability performance because of the team's lack of experience with LEED. It was also realized from the study that there are some aspects differentiating gold certified (good), Platinum certified (exceptional), or low and high innovation projects.

From Table 1, the difference between low and high innovation projects is not only because of PDMs used but also because of other attributes (i.e. PDAs) under the partial influence of PDMs. Unlike low innovation projects, the high innovation projects used Collaboration Sessions, Green Design Coordinator and Design Charrettes. In comparison with low innovation projects, the high innovation projects had earlier constructor involvement, earlier introduction of green concept in the project and the green concept incorporated by the owner rather than designer. Although DB and CMR have better chances of facilitating integration, results show that DBB also has the potential to provide higher levels of integration if it informally involves the constructor in the earlier phases of the project. Design charrette, compatibility of team members, and commitment to project sustainability goals were also found to be crucial in achieving team integration and overall project success and innovation (Swarup *et al*., 2011, Korkmaz *et al*., 2010a, Mollaoglu-Korkmaz *et al*., 2011). Using quantitative methods on 51 GB projects, Gultekin *et al*., (2013) identify statistically significant correlation between in-process indicators (i.e. PDAs) with GB project performance outcomes (i.e. green level, cost, and

schedule). Besides the use of DB as a PDM, the other indicators, include: setting owner-initiated sustainable goals, having all major project parties attending design charrettes, running energy and lighting simulations no later than the schematics-design phase, adequacy in owner capabilities for scope definition and decision making, selecting contractors from a restrained pool, and enabling contractor involvement in the delivery process no later than the design-development phase.

The research highlights that although PDM is an important attribute, it is in fact one among many other attributes which cumulatively affect the success of GB projects. Although the selection of a certain PDM also influences other PDAs, the attributes (i.e. design integration, etc.) can still be optimized, selected and controlled even when a conventional PDM (DBB) is being used. This emphasizes that fate of a project is not decided with selection of a PDM only. Through localized innovation within the PDM and individual PDAs, remarkable performance results can be expected in GB projects.

DISCUSSION

Findings show that the GB projects delivered through integrated and innovative delivery method (i.e. IPD) tend to result in more consistent successful outcomes in comparison with projects delivered through a conventional delivery method (i.e. DBB). Fast-tracking delivery methods (i.e. DB, CMR) perform better than conventional but worse than integrated delivery method in delivering various project outcomes including innovation. For assessing the delivery process innovation in different GB projects, the overall successful GB case studies can be divided in three types: Type-A in which conventional PDM (i.e. DBB) is used with adequately controlled PDAs; Type-B in which fast tracking PDMs are used and; Type-C in which integrated PDM is used. Type-A (conventional PDMs) qualifies as incremental innovation since it is based on traditional practice while linkages among core components of the system are unchanged. Type-B (fast-track PDMs) lie in-between incremental and radical innovation since core concepts/components are subjected to a medium level of change. Type-C (integrated PDM) can be considered as radical innovation as it is subjected to high level of change in core concepts/components.

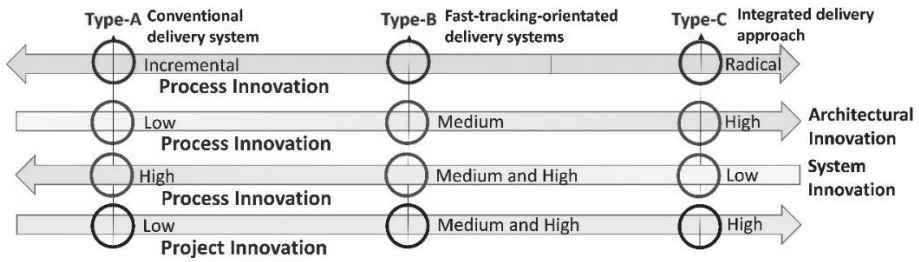

Figure 1: Process and Project innovation for Green Building Projects

The radical innovation of Type C can be attributed to its high level of architectural innovation (Figure 1). Similarly incremental innovation of Type A can be attributed to its high level of system innovation. The intermediate innovation status of Type B is between incremental and radical innovation, and can be attributed to its medium level of architectural and system innovations.

Depending on the number of total points achieved, LEED endorses GB projects as Certified (lowest level certification), Silver, Gold, and Platinum (highest level certification). These different levels of green performance directly correspond to the level of innovation in a project. Type-A (Conventional PDM) is majorly associated with low green performance in projects (i.e. certified or silver) and therefore a low level of

project innovation. Type-B (Fast-track PDMs) is typically associated with a mixed green performance in projects and therefore a medium to high level of project innovation. Type C (integrated PDM) is successfully applied on complex and large scale projects and exhibit better project performance in comparison to Type B, therefore it is related with a high level of project innovation as shown in Figure 1.

Different PDMs have capacities to deliver GB projects under varying constraints and needs. The constraints will vary from project to project and therefore an ideal PDM for one GB project may not be ideal for another project. For instance, Molenaar *et al*., (2009) provided an account of best practices in GB project delivery not limited to a certain PDM: Owners that desire to achieve a specific LEED level at a fixed price prior to construction use DB-Lump Sum (LS) or DBB to specify the LEED level in procurement documents; CMR or DB-Guaranteed Maximum Price (GMP) provide the greatest likelihood of success in case level of green is to be maximized within the available budget; and DB allows for a transfer of the green liability while DBB and CMR maintain the liability with the designer/owner.

In IPD, the Primary Team Members (PTMs) may have different understanding and may be under pressure to revert back to old self-preservation concepts as the environment may not suit everyone (Matthews and Howell, 2005). Teams in IPD need to be carefully selected and must be prepared for new roles. An evident drawback of the IPD system is its dependence on individuals. Being unconventional, many times it is not understood correctly, which might cause difficulties (Kantola and Saari, 2016). New and innovative PDMs increase the number of PDMs that decision-makers can select from, for their particular project. Since the construction industry is slow to innovate, incremental rather than radical innovation would appear pragmatic. Although in comparison with traditional PDMs, innovative PDMs (i.e. IPD) can produce more innovative GB projects with better outcomes, innovation within the existing PDMs has better prospects of delivering GB projects than introducing new PDMs for every project. This is because IPD may not be suitable for some class of projects. However, it is possible that incremental innovation makes way for radical innovation. For instance, CMR system is already a well-known system; thus, a good way to move towards the unfamiliar IPD system would be to gradually add new features from the IPD system to the CMR or IPD lite in new projects (Kantola and Saari, 2016). CMR can help a project team to trial IPD features and understand how it can be implemented in practice.

In cases where radical innovation cannot be pursued by developing/using new PDMs (a case of architectural innovation), incremental innovation can be accomplished by making appropriate changes in traditional PDM along with other associated PDAs in the delivery process (a case of system innovation). The performance of a contract can be enhanced through the application of relationship management techniques, particularly the adoption of partnering concept or alliancing on projects. Even the performance of lump sum contracts can be improved through the application of a partnering concept (Blayse and Manley, 2004, Winch, 1998). The shift from competitive tendering to partnering and alliancing is an important opportunity to move towards a gain/risk sharing approach. Those in a position to innovate need to be rewarded for taking such risks. If they are so rewarded, they will have incentives both to adopt new ideas from outside the firm, and to capture the learning from problem solving to propose better ways of doing things for client (Blayse and Manley, 2004).

CONCLUSION

Based on the review of previously published literature, this paper explored the effect of different delivery approaches on the green performance and therefore innovation of GB projects. The more innovative delivery approaches tend to result in more innovative GB projects. Different types of delivery approaches incorporate different levels of innovation and result in different GB innovation and performance. There are many factors that govern the use of innovative and radical delivery approaches. These factors can include project type, project sector, project team, complexity, etc. For instance, in case of a non-complex GB project in which design and construction stages need to be kept separate and for which low to medium level of green performance and innovation is acceptable, an incremental innovation approach in terms of DBB method can be used. In cases where a complex GB project is to be delivered with medium to high level of green performance and innovation, and where it is necessary to reconcile design and construction activities for expediting project development, fast-tracking PDMs i.e. DB and CMR seem as the reasonable choices. For delivering highly complex GB projects with high level of innovation and green performance, and where stakeholder firms are willing to show high level of collaboration under a non-traditional setup, a radical innovation approach in terms of IPD is preferable.

Some previous review studies on GBs have investigated different research trends and future directions, however the perspective of process and project innovation in GB projects as used in this review paper sets it apart from others. The paper is limited in terms of its methodology as it relied on case studies from previously published literature. While a substantial number of case studies have compared DBB, DB, CMR, and IPD delivery methods for successful GB project delivery, no studies are found that have compared life cycle oriented delivery methods (i.e. PPP/PFI) with other PDMs for GB project delivery. Future research needs to pay equal attention towards all kind of delivery processes/methods being used in GB projects. This paper used secondary data to explore the relationship between process innovation and project innovation and therefore used many assumptions. Future research relating innovation in GB projects should make use of primary data to minimize the use of assumptions and to extend the scope of research in this area to all the PDMs being used for GB projects.

REFERENCES

Bilec, M M (2008) Investigation of the Relationship between Green Design and Project Delivery Methods. Lawrence Berkeley National Laboratory.

Blayse, A M and Manley, K (2004) Key influences on construction innovation. Construction Innovation, **4**(3), 143-154.

Carpenter, D S (2005) *Effects of Contract Delivery Method on the LEED™ Score of US Navy Military Construction Projects (Fiscal Years 2004-2006)*. Monterey, California: Naval Postgraduate School.

El Asmar, M, Hanna, A S and Loh, W-Y (2013) Quantifying performance for the integrated project delivery system as compared to established delivery systems. *Journal of Construction Engineering and Management*, **139**(11), 04013012.

Gard, P T (2003) Fast and innovative delivery of high performance building: Design-build delivers with less owner liability. *Strategic Planning for Energy and the Environment*, **23**(4), 7-22.

Gultekin, P, Mollaoglu-Korkmaz, S, Riley, D R and Leicht, R M (2013) Process indicators to track effectiveness of high-performance green building projects. *Journal of Construction Engineering and Management*, **139**(12), A4013005.

Hanks, N M (2015) *Investigation into the Effects of Project Delivery Methods on LEED Targets*. Unpublished MSc Thesis, College of Arts & Sciences: Indiana University Bloomington

Kantola, M and Saari, A (2016) Project delivery systems for nZEB projects. *Facilities*, **34**(1/2), 85-100.

Kenig, M E (2011) *Project Delivery Systems for Construction*. Arlington, Virginia: Associated General Contractors of America.

Korkmaz, S, Horman, M, Molenaar, K and Gransberg, D (2010a) *Influence of Project Delivery Methods on Achieving Sustainable High Performance Buildings Report on Case Studies*. Research Sponsored by the Charles Pankow Foundation, DBIA.

Korkmaz, S, Riley, D and Horman, M (2010b) Piloting evaluation metrics for sustainable high-performance building project delivery. *Journal of Construction Engineering and Management*, **136**(8), 877-885.

Li, Y Y, Chen, P-H, Chew, D A S, Teo, C C and Ding, R G (2011) Critical project management factors of AEC firms for delivering green building projects in Singapore. *Journal of Construction Engineering and Management*, **137**(12), 1153-1163.

Matthews, O and Howell, G A (2005) Integrated project delivery an example of relational contracting. *Lean Construction Journal*, **2**(1), 46-61.

Molenaar, K, Sobin, N, Gransberg, D, McCuen, T, Korkmaz, S and Horman, M (2009) *Sustainable, High Performance Projects and Project Delivery Methods: A State-Of-Practice Report*. White Paper for the Design-Build Institute of America and the Charles Pankow Foundation.

Mollaoglu-Korkmaz, S, Swarup, L and Riley, D (2011) Delivering sustainable, high-performance buildings: Influence of project delivery methods on integration and project outcomes. *Journal of Management in Engineering*, **29**(1), 71-78.

Riley, D, Sanvido, V, Horman, M, McLaughlin, M and Kerr, D (2005) Lean and green: The role of design-build mechanical competencies in the design and construction of green buildings. *Construction Research Congress 2005*, April 5th-7th, San Diego, California, USA, 1-8.

Slaughter, E S (1998) Models of construction innovation. *Journal of Construction Engineering and Management*, **124**(3), 226-231.

Swarup, L, Korkmaz, S and Riley, D (2011) Project delivery metrics for sustainable, high-performance buildings. *Journal of Construction Engineering and Management*, **137**(12), 1043-1051.

Tidd, J (1995) Development of novel products through intraorganizational and interorganizational networks the case of home automation. *Journal of Product Innovation Management*, **12**(4), 307-322.

Winch, G (1998) Zephyrs of creative destruction: Understanding the management of innovation in construction. *Building Research & Information*, **26**(5), 268-279.