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SCHEDULE RISK ASSESSMENT IN GREEN BUILDING PROJECTS

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Construction projects are subjected to a variety of risks eventually affecting the overall duration and green building projects are no exception. Use of risk assessment means in such projects is also critical to complete them within aimed schedule. In this study, risks that have potential schedule impacts in certified green building projects are identified and their impact and likelihood of occurrence values are researched. For this purpose, a survey is administered to construction professionals with green building experience. Based on the responses, risks are plotted to draw their potential impact on schedule/likelihood of occurrence in a graph to identify the most significant risk factors. This tool may help the practitioners to identify and prioritize potential risks and allocate resources in projects accordingly to prevent or minimize their possible impacts.

Keywords: Sustainable construction, Certified buildings, Duration, Project planning, LEED.

1 INTRODUCTION

As the interest in sustainable construction expands, the number of certified green building projects also increases. Green building means and methods are becoming contract requirements and the parties involved in green projects are subjected to risks that they did not encounter before (Coglianese 2009). Failures in achieving schedule objectives can be encountered frequently as the results of undesired risks inherent in such projects. Construction projects are normally subjected to several risks due to a variety of sources. There are additional risk factors in green building projects causing challenges for timely completion of them. For this reason, it is essential to understand these risks and factor them in project management processes to maintain schedule boundaries.

This study presents the findings of a survey study carried out in the U.S. that seek risks specific to LEED certified green buildings and their potential impacts on project schedule. Likelihood of occurrence and impact values are plotted to present analysis results. It is aimed to facilitate multiple insights to practitioners about schedule risk management in green building projects by providing a tool for:

- Prioritizing risks and allocate project resources accordingly during planning phase
- Bringing project stakeholders to a common understanding about project details including specific risks

- Organizing project control mechanisms.

2 RISKS IN GREEN BUILDING PROJECTS

Green buildings distinguish from conventional buildings in terms of risks. Green building construction processes may accommodate different set of risks tending to result with bottlenecks, cost and time overruns related to their meticulous selection of the construction processes, participants, systems and materials (Iqbal *et al.* 2015, Kibert 2013, Tserng *et al.* 2009). The common risks identified after a diligent literature survey and included in this study can be seen in Table 1. Gurgun *et al.* 2016 studied impacts of risks on projects costs provided in this table. On the other hand, this study focuses on analyzing same risks but for schedule impacts.

Table 1. Risk factors (Gurgun *et al*. 2016).

Risk Category	Description
Consultant, contractor and subcontractor related issues	CCSI1 - Lack of green construction experience and qualification
	CCSI2 - Contractors and subcontractors agreeing to standards that are not within their expertise and competence
Material related issues	MPPI1 - Doubts about long-term viability and performance of new and untested products, materials and technologies
	MPPI2 - Faulty performance of HVAC/electrical/plumbing systems and alternative water systems/alternative power generating equipment
	MPPI3 - Failure to receive materials/products in a timely fashion causing delays
	MPPI4 - Lack of expertise in new products/technologies
Legal and contractual issues	LCI1 - Inadequate definition of project parties' contractual roles and responsibilities
	LCI2 - Inconsistencies between formal regulations (e.g., existing federal, state and local legislation) and LEED
	LCI3 - Concern that project owners and participants lose potential benefits because of the stringent standards of LEED
Financial and economical issues	FEI1 - High cost of certification process
	FEI2 - Scarcity of insurance solutions
	FEI3 - Rental or resale value loss due to delay related to green construction procedures and conditions
	FEI4 - Failure to use of financial incentives (tax/loan discounts, low financing rates) because of delays or lower certification levels than expected

2.1 Consultant, Contractor and Subcontractor Related Issues

Consultants are most of the time the key members of the green construction organization because of their important missions of offering appropriate suppliers, fulfilling the knowledge gap between parties, helping to create an effective communication web and directing the project to desired certification level. After deciding on desired LEED certification level according to the specified resource limitations, first thing is to develop a team and create an effective communication web.

Experience and knowledge of green building systems are important components for green certification (Gurgun *et al.* 2016). The possibility of delays in projects decreases, if project participants such as subcontractors and consultants are familiar with activities and requirements of green building certification processes.

As the demand in green buildings and sustainable construction grows, contractors' interest also increase whether or not they are experienced. Contractors and subcontractors agreeing to standards that are not within their expertise and competence may cause delays and as well as cost overruns in projects.

2.2 Material Related Issues

Availability and selection of the appropriate environmental-friendly materials is important in green building projects. Use of new and recently developed materials and products is common and some of these materials and products are not analyzed over long-term assessments and tests (Gurgun *et al.* 2016). As buildings are designed for certain design periods, project participants should consider the uncertainties related to the performance and long term durability of new and untested products, materials and technologies (Hwang *et al.* 2017).

One of the major objectives of sustainable buildings is to improve energy and water efficiency in the structures. Green building certification systems encourage use of advanced systems for energy and water efficiency, which contributes to the minimization of adverse environmental impacts. Credit points regarding energy efficiency particularly share the largest portion of total collectable points. There are many alternative implementations such as occupant monitoring systems, renewable energy technologies, replacement of plumbing and power generating systems, waterless urinals, and sensor-activated faucets and electrical systems improve energy and water efficiency in operating buildings. Faulty performance of such systems can cause delays in project schedule, as certification systems need additional check-ups before their usage.

On the other hand, meeting schedule objectives requires careful planning of sustainable materials that are to be used for sustainability goals. Utilization of environmental-friendly materials, products and technologies is encouraged and rated in certification systems. Projects can qualify for substantial amount of credit points by including such materials and products. The uncertainties related to availability and on-time delivery of materials can be much more difficult depending on the local conditions.

Lack of expertise has been reported as another source of liabilities in green building projects (BCCA 2011, Ofori-Boadu 2012). Therefore, insufficient expertise and being unfamiliar in new products, materials and technologies is another factor that should be considered as a risk in green building projects.

2.3 Legal, Regulatory and Contractual Issues

As in conventional projects, defining project party roles and responsibilities in contract prevents task conflicts in green building projects. Today, it is easier than ever to decide on these definitions with the help of contract standards. For example, American Institute of Architects (AIA) publishes numerous standards. AIA B214-2007 includes preparation of a LEED certification plan, conducting a pre-design workshop where the LEED rating system to be reviewed and LEED points to be targeted. Preparing and monitoring a LEED certification plan, providing LEED specifications for inclusion in the contract documents, preparing a LEED certification report, detailing the LEED rating the project achieved is also available in this document (Dingwell 2010). B214-2012 is the newer version of "Standard Form of Architect' Services: LEED Certification". In this contract LEED certification services and agreements, drawings and specifications, LEED workshop, certification plan, project registration and submission of LEED documentation to GBCI, certification services during bidding or negotiation, construction for prime and consultant architect, additional services, owner's

responsibilities, compensation and miscellaneous provisions are included. A detailed contract is the best option to avoid delays due to some complex processes of green building construction and certification that can be time challenging for parties.

2.4 Financial and Economical Issues

Financial and economical concerns are inherent in building projects including green ones. These concerns may depend on a variety of reasons. Decreasing bureaucratic procedures (license, approval, permit) priorities/fees, adjustment of tax rates based on achieved certificate level, grants and low interest loans some of the financial are factors encouraging projects owners investing in sustainable construction projects.

Schedule planning of projects is strongly related with cost estimations. Decision of building green construction might impose specific set of risks affecting both schedule and cost calculations. Insurance solutions that would help mitigation or minimization of results of undesired events are important as a financial instrument. Yet, policies developed for green building projects can still be scarce and the market is still improving.

The concept of being green is commonly used as marketing factor that might positively increase the perception of the buildings as in higher quality of living (Zhang *et al.* 2018, Kok *et al.* 2012). It is not unlikely to rent or sell sustainable buildings at rates higher than usual. Appraisal Institute reported that rental premiums of green commercial buildings raised ranging from 2% to 27% and sale premiums raised ranging from 9% to 25% (IMTAI 2013). When these numbers combined with lower operating expenses, investors are more likely to build green. But the unavailable materials, systems, paperwork and processes mixed with inexperience resulting delays can be encountered.

In the US, there are many financial incentives ranging from green density bonuses to priority to green buildings in bureaucratic procedures. To get use of these incentives, certain level of certification systems should be achieved. The construction design must qualify for a certain certification value and receive the certification level expected in order to be able to get the desired incentive. For example, in Cincinnati, 100% tax abatement is applicable for 15 years for new residential construction, and 10 years for renovation. Another incentive program was initiated in Washington D.C. that requires achievement of certification through LEED NC and LEED CS in new construction and major renovation of privately-owned non-residential buildings over 50,000 square feet starting in 2012 (Department of Energy 2012). Also, North Carolina provides a corporate or personal income tax credit in the amount of 35% of the cost of renewable energy systems, Indiana provides a property tax assessment exemption in the amount of 100% of the cost of systems that generate energy using solar, wind, hydropower or geothermal resources in New Jersey, the tax exemption amount is %100 of the property tax due and in Chicago, it is possible to take building license as short as 15 days (Garciano 2014). It is clear that project delays could cause loss of incentives resulting with extra time overruns on planned schedules.

3 ANALYSIS AND FINDINGS

According to answers collected from 402 different respondents, the results of likelihood of occurrence, impact on schedule and order of importance values are given in Table 2. Analysis results indicate that top five risks that have the highest effect on project schedule are:

i) contractors and subcontractors agreeing to standards that are not within their expertise and competence

ii) lack of expertise in new products/technologies

iii) lack of green construction experience and qualification

iv) high cost of certification process, and

v) doubts about long-term viability and performance of new and untested products, materials and technologies

Table 2. Results of the study.

Risk ID	Likelihood of occurrence	Rank	Impact on Schedule	Rank	Likelihood*Impact Rank
CCSI2	3.32	2	3.11	1	1
MPPI4	3.23	3	2.89	2	2
CCSI1	3.07	5	2.83	4	3
FEI1	3.28	1	2.65	8	4
MPPI1	3.14	4	2.66	7	5
LCI1	2.94	6	2.71	6	6
LCI2	2.93	7	2.57	9	7
MPPI3	2.66	8	2.88	3	8
MPPI2	2.61	9	2.75	5	9
FEI2	2.59	10	2.23	11	10
FEI4	2.50	11	2.27	10	11
LCI3	2.41	12	2.17	12	12
FEI3	1.68	13	1.67	13	13

In Figure 1, impact and likelihood of occurrence values of risks are shown using a graph.

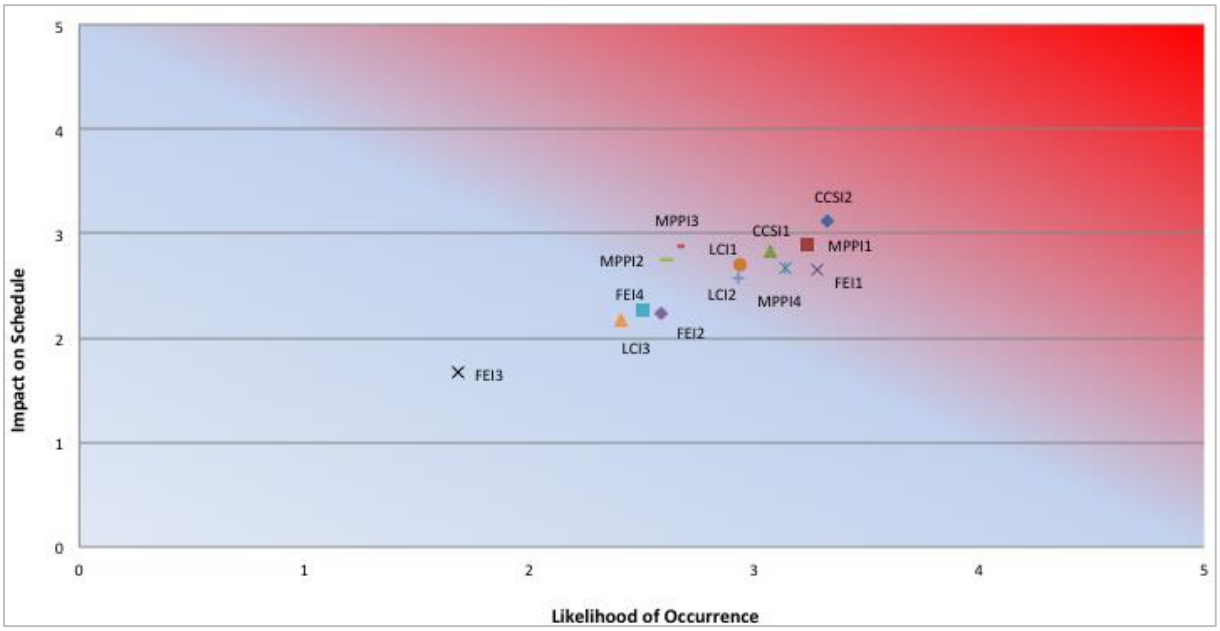

Figure 1. Impact of risks in green building projects on schedule.

This study aimed to reveal risks in green building projects for potential schedule impacts and facilitate insights to practitioners about schedule risk management in green building projects by

providing a tool for prioritizing risks and allocate project resources accordingly during planning phase and organizing project control mechanisms.

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