

RISK MANAGEMENT OF GREEN RETROFITTING PROJECTS IN SRI LANKA

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ABSTRACT

The comparison made upon other developed and developing countries proves that green retrofitting projects are entirely new to the Sri Lankan construction industry. Green retrofit can be defined as an upgrade, extension and alternation, change the use of building, renovation of existing buildings. In such, partially or wholly occupied existing buildings are upgraded by integrating sustainable or green features to achieve its foremost benefits. However, green retrofitting of existing buildings are riskier than constructing a new building as where it requires a proper strategy to manage the risk. Hence, evaluating the risk in green retrofit projects is very helpful to construction industry as it may assist to get right decision about the project and also to well handle and manage it. Thus, this research aims to propose probable risk responsive strategies through a comprehensive risk assessment of green retrofitting projects in Sri Lanka.

As the first step in research process, thirty risk factors were identified by reviewing key literature relating to five major categories, such as, financial, market, industry, performance and legislative risks. The identified factors are evaluated through questionnaire survey which was conducted among forty experienced green professionals in three selected green retrofitting projects in Sri Lanka. The survey data are analysed based on its criticality by using descriptive statistical analysis techniques to identify high, moderate and low risk factors. According to overall results, ten risk factors are determined as 'critical' factors, such as, construction cost, inflation, energy saving uncertainty, warranty risk, delay in project completion, requirement of permits and their approval, design changes, procurement delay, damage to structure or property etc. Finally, risk responsive strategies are proposed to avoid, reduce, retain and/or transfer the identified risks of green retrofit projects as the final outcome of this research. Further, this research implies a way of ensuring an effective risk management of green retrofit projects in Sri Lanka and other developing countries.

Keywords: *Green Retrofitting; Risk Assessment; Risk Responsive Strategies; Sri Lanka.*

1. INTRODUCTION

The governing concern of today's world is to reduce the effect of greenhouse gas emission and its contribution towards global climatic challenges. As the third responsible party who increase greenhouse gas emission in the world, buildings and construction industry are looking towards a new era with modern and environmentally friendly building approaches. Bu *et al.* (2015) mentioned that today most of the organizations tend to convert their existing building into green due to its foremost benefits. Therefore, many organizations get their maximum effort to achieve energy efficiency through green retrofitting.

As explained by Al-Kodmany (2014), green retrofitting is a "any kind of upgrade at an existing building that is wholly or partially occupied to improve energy and environmental performance, reduce water use, and improve the comfort and quality of the space in terms of natural light, air quality, and noise; all done in a way that it is financially beneficial to the owner". Therefore, retrofitting of existing building into green building represents a major part of the construction industry. Now Sri Lanka has started to increase the development projects with green retrofitting. Green Building Council of Sri Lanka appeared as a consequence of a

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developing pattern towards applying the greener ideas for manufactured environment (Green Building Council of Sri Lanka - GBCSL, 2015).

As Baek and Park (2012) mentioned, green retrofitting of an existing building can be a high risky process than constructing a new building. Eichholtz *et al.* (2010) further stated that green retrofitting of existing buildings can be associated with many challenges and risk factors, such as, climate changes, service changes, policy and regulation changes and human behavioral changes etc. Even though, various factors may influence green retrofitting, most of the occupants have identified that green retrofit building could achieve productivity through energy saving and therefore current demands for the green retrofitting existing building has increased. Thus, risk assessment is essential to identify probable responsive strategies for risk factors associated to green retrofit projects. Further, having an effective risk management plan for green retrofitting projects is also essential to achieve its foremost benefits, to get correct decisions on project investments and to well handle the risk events in retrofitting projects invested (Menassa, 2011). In response to above concerns, evaluating the risk associated to green retrofitting projects in Sri Lanka is more appropriate and it will be more worthwhile to establish an effective risk management plan for increasing future investments on green retrofitting.

2. LITERATURE REVIEW

2.1. RISK MANAGEMENT FOR GREEN RETROFITTING PROJECTS

Green Retrofit is a building system renovating process and how creates structure of a building to improve energy efficiency, resource consumption decrease in the building, and create indoor air quality in good condition (Roper and Pope, 2014). Douglas (2006) also defined that "Green retrofit is an adaption of existing building to the new condition through changing maintenance activities, changing functions and performance of the building". Moreover, Ma *et al.* (2012) explained that green retrofit creates environmental responsible, efficient resource structures and process for building life cycle. As a developing country, Sri Lanka shows a movement over various foundation improvements which joined by some measure of environmental prolapsed and expanded carbon emission (Dissanayake, 2015). As the green building concept is entirely new to Sri Lankan construction industry, it is quickly extending all over various enterprises while scanning for more vitality effective structures for their use. Sri Lanka has started to change the development business with green retrofitting projects.

There are many kind of risks associated with green retrofitting projects, including common risk of construction project because green retrofitting is a risky process as where it requires proper strategy to manage the risk for achieving its foremost benefits. Risk management is the identification, assessment, and prioritization of risks. Risk management process refers approach, so that timely mitigation actions are initiated to avoid risk, transfer risk, reduce risk likelihood or reduce risk impact (Ahamed *et al.*, 2007). Risk management is a systematic approach to minimizing an organizations exposure to risk. Risk management system includes various policies, procedures and practices that work in unison to identify, analyze, evaluate, address and monitor risk (Finch, 2004). The systematic risk management in any project has long been recognized as an effective approach to minimizing risk impacts.

2.2. RISK FACTORS ASSOCIATED TO GREEN RETROFITTING PROJECTS

Most of the construction projects are associated with risks. Green retrofitting projects generate more benefits to the environment, occupants and the economics hence there are risks associated with the project. In Sri Lanka many organizations need their building structures to be "green" and they face set of risk exposures. As a developing nation, Sri Lanka move towards existing building green retrofitting idea to reduce environmental effect. Compared to other construction projects there are numerous risk factors connected with the green retrofit projects, in Sri Lanka. The combination of risk such as, financial, legal and industry risk are affected to the most of the green projects (Mallikage, 2015). Further, risk management process contributes to reduce energy consumption and management cost.

These risks can be divided in to five categories such as financial risks, market risks, industry risks, performance risks, legislative risks (Eichholtz *et al.*, 2010). There are thirty (30) risk factors were identified relating to above risk categories by reviewing key literature (Davidson *et al.*, 2012; Drew, 2011; Chanter and Swallow, 2007; Drew, 2011; Miller and Buys, 2008).

Table 1 presents the key risk factors associated to green retrofitting of existing buildings.

Table 1: Risk Factors Associated to Green Retrofitting

Risk factor	Sub factors
Financial risk	Inappropriate financial model Inadequate return investment and payback Higher cost than anticipated operating expenses Inflation
Market risk	Unable to achieve expected value Not meeting benefits of the green building Reliability and accuracy bench mark lack of consensus in the market
Industry risk	Man-power supply and availability risk Material supply availability risk New and untested product and material Lack of experience of consultant and subcontractor
Performance risk	Failure to meet green code or green certification Energy saving uncertainty Warranty risk Delay in project completion Accreditation of energy saving companies Team performance risk Indoor air quality issues Productivity and quality risks Pre-retrofit tenant cooperation risk Post retrofit tenant cooperation risk Lack of knowledge regarding structure
Legislative risk	Tax changes Regulatory incentives changes Change of green building codes and mandate Requirement of permits and their approval

According to key literature reviewed, financial risk category includes, inappropriate financial model inadequate return investment and payback, higher cost than anticipated operating expenses, inflation and loan interest while, unable to achieve expected value, no meet client expectation, productivity risk and new compliance requirement are identified as market risk factors. Man power supply and availability risk, material supply availability risk, new and untested product and material, lack of experience of consultant and subcontractor are the industry risk factors reviewed. Failure to meet green code or green certification, energy saving uncertainty, warranty risk, accreditation of energy saving companies, team performance risk, indoor air quality issues, reliability and accuracy bench mark, quality risks, pre retrofit tenant cooperation risk, post retrofit tenant cooperation risk and lack of knowledge regarding structure are identified as performance risk factors while legislative risk category includes four key factors such as tax changes, regulatory incentives changes, change of green building codes and mandate and requirement of permits and their approval.

3. RESEARCH METHODOLOGY

Qualitative and quantitative research approaches are the two main approaches of research design. As this research aimed to conduct a risk assessment for green retrofit projects in Sri Lanka, quantitative research approach was selected. It was further justified by several other facts, such as, investigating significant risk factors and developing a risk matrix by using impact and probability calculation. Further, it involves collecting data from a fraction of population and generalizing the findings to the population with quantitative descriptions. Therefore, considering all factors quantitative research approach was executed in the research.

As a systematic method of collecting data based on a literature review, the questionnaire survey technique was used to collect professional views on green retrofitting. Before having a questionnaire survey, a preliminary survey was carried out in order to understand the risk factors affecting to the green retrofit projects. It was focused to identify green retrofitting projects in Sri Lankan Context and, risk factors associated with them. Accordingly, three additional factors are added to the profile of risk factors such as loan interest, delay in project completion and construction cost.

For the main survey, forty (40) respondents consisting the professionals of green retrofit projects namely architects, engineers and managers including project managers and maintenance managers who had experience above three years in the field of green buildings were randomly selected from green retrofit projects in Sri Lanka. From the respondents to whom that the detailed questionnaire was distributed, 32 were returned by maintaining the 80% of response rate.

As the choice of multiple data collection techniques over single method generates benefits to research, both questionnaire and semi-structured interview techniques were used in this research. As this research focused on quantitative phenomenon, questionnaire survey was selected as primary data collection technique. Five semi-structured interviews were conducted among selected respondents in the main survey to validate the results and to propose probable risk responsive strategies. The survey data was analysed by using descriptive statistics. Mode value of each factor was used for risk assessment. The respondents were asked to rank each risk factor, according to 1-5 scale for impact and probability of each risk. The mode value of each risk factor is counted for subsequent analysis.

According to the Elmontsri (2014), risk matrix can be used to rank risk factors by using 4x4 or 5x5 matrices having event consequences along the other axis. Thus, in this research, the risk rating matrix was used to characterize and rank the identified risk factors.

The findings derived in risk assessment are described subsequently.

4. RESEARCH FINDINGS AND DISCUSSION

The analysis and key findings are derived in two sub sections, namely, risk evaluation and risk rating matrix of green retrofitting projects in Sri Lanka.

4.1. RISK EVALUATION

In risk evaluation, the risks associated to green retrofit projects are evaluated in related to the risk categories of financial, market, industry, performance and legislative risk. The probability and impact of each risk factor are calculated by using mode value in statistical data analysis. The risk score for each factor was determined based on 'severity of its impact' as shown in Table 2.

Table 2: Probability and Impact of Risk Factors

Category	Risk factor	Probability	Impact	Risk score
Financial Risk	RF1 Construction cost	3	4	12
	RF2 Inappropriate financial model	1	4	4
	RF3 Inadequate return investment and payback	3	3	9
	RF4 Higher cost than anticipated operating expenses	2	4	8
	RF5 Inflation	4	4	16
	RF6 Loan interest	1	2	2
Market Risk	RF7 Unable to achieve expected value	2	2	4
	RF8 No meet client expectation	1	3	3
	RF9 Productivity risk	1	3	3
	RF10 New compliance requirement	3	3	9
Industry Risk	RF11 Man power supply and availability risk	2	2	4
	RF12 Material supply availability risk	2	3	6

Performance Risk	RF13	New and untested product and material	3	3	9
	RF14	Lack of experience of consultant and subcontractor	1	3	3
	RF15	Failure to meet green code or green certification	1	3	3
	RF16	Energy saving uncertainty	4	5	20
	RF17	Warranty risk	4	3	12
	RF18	Delay in project completion	2	5	10
	RF19	Accreditation of energy saving companies	2	2	4
	RF20	Team performance risk	3	3	9
	RF21	Indoor air quality issues	2	2	4
	RF22	Reliability and accuracy bench mark	1	3	3
Legislative Risk	RF23	Quality risks	4	4	16
	RF24	Pre retrofit tenant cooperation risk	3	1	3
	RF25	Post retrofit tenant cooperation risk	3	3	9
	RF26	Lack of knowledge regarding structure	3	2	6
	RF27	Tax changes	1	2	2
	RF28	Regulatory incentives changes	1	2	2
	RF29	Change of green building codes and mandate	2	3	6
	RF30	Requirement of permits and their approval	3	5	15
Other	RF31	Design changes	4	5	20
	RF32	Procurement delay	4	4	16
	RF33	Damage to structure or property	3	5	15
	RF34	Delay payments on contract	3	3	9
	RF35	Design errors	3	3	9

According to the statistical analysis, inflation showed high probability (mode = 4) and impact (mode = 4) among the other factors where inappropriate financial model and loan interest showed low probability and impact to green retrofitting. In the market risk category, new compliance requirement showed high probability (mode = 3) and impact (mode = 3) whilst new and untested product and material was the one which received high risk score in the industrial risk category (probability = 3; impact = 3).

Among the performance risk factors, energy saving uncertainty, quality risk, delay in project completion and warranty risk showed respectively high probability and impact on green retrofitting. The requirement of permits and their approval in the legislative risk category is other significant factor, which showed high probability (mode = 3) and impact (mode = 5) values. As the other factors identified, design changes, procurement delay and damage to structure and property are identified as another significant risk factors which showed high probability and impact on green retrofitting as shown in Table 2.

4.2. RISK RATING MATRIX OF GREEN RETROFITTING PROJECTS IN SRI LANKA

The common score calculated for each risk factor is used to assign relevant values in risk matrix by multiplying the impact and probability. The overall risk matrix is developed for green retrofitting projects is presented in Figure 1.

All the resulted were presented to determine a common score for risk factor.

$$\text{Risk score} = \text{Probability} \times \text{Impact}$$

Probability of Occurrences		Severity of Impacts				
		Low	Minor	Moderate	Significant	Severe
Definition	Value	1	2	3	4	5
Probable	1		RF6, RF27, RF,28	RF22, RF 24		
Seldom	2		RF7, RF21	RF26, RF29		
Occasional	3	RF8, RF9, RF15	RF11, RF12, RF21	RF3, RF10, RF13, RF20, RF25, RF34, RF35	RF1	RF33
Likely	4	RF2, RF19	RF4	RF17	RF5, RF23, Rf32	
Frequent	5	RF5, RF14	RF18	RF30	RF16, RF31	

Figure 1: Risk Rating Matrix of Green Retrofitting Projects in Sri Lanka

Accordingly, the low, medium, high and extreme risk factors are determined based on the risk rating matrix.

Table 3: Risk Score and Related Risk Ratings

Risk Score	Risk Rating	Risk Factors
1-4	Low Risk	RF22, RF24, RF6, RF27, RF28, RF7, RF21, RF8, RF9, RF15, RF2, RF19
5-9	Medium Risk	RF26, RF29, RF11, RF12, RF21, RF4, RF5, RF14, RF3, RF10, RF13, RF20, RF25, RF34, RF35
10-16	High Risk	RF17, RF18, RF30, RF1, RF33
16-25	Extreme Risk	RF5, RF23, RF32, RF16, RF31

According to overall results shown in Table 3, ten (10) risk factors were determined as critical risk factors which are included in high (brown) and extreme (Red) risk levels of risk matrix. Under performance risk and other category, energy saving uncertainty and design changes became most critical risk factors in green retrofitting projects. As per the severity of risk factors, the risk responsive strategies are determined accordingly.

4.3. PROPOSED STRATEGIES

Based on the ideas gathered through literature and semi-structured interviews conducted, the risk responsive strategies are proposed to mitigate low, medium high and extreme risks of green retrofitting project in Sri Lanka by relating to four risk responsive strategies which are available for dealing with risks, such as, avoid, retain, reduce and transfer (refer Table 4).

Table 4: Risk Responsive Strategies Proposed

Category	Risk Factor	Risk Rating	Risk Response	Proposed Strategies
Financial Risk	Construction cost	High risk	Transfer	Re structuring the financial cost Use the expertise team to the project Adopting green strategies and including them in the budget from an early stage
	Inappropriate financial model	Low risk	Retention	Retrofit in stage
	Inadequate return investment and payback	Medium risk	Reduction	Document building performance Proper plan on which area to be concern for LEED accreditation

Market Risk	Higher cost than anticipated operating expenses	Medium risk	Reduction	Follow project life cycle as planned Conduct progress meeting with all supported staff
	Inflation	Extreme risk	Avoid/Transfer	Accept the risk
	Loan interest	Low risk	Retention	Keep Relationship with bank
	Unable to achieve expected value	Low risk	Retain/Reduction	Use Geographic Information Systems to analyse the market Aware all team members to explore market
	No meet client expectation	Low risk	Retain/Reduction	Aware about all client and their expectation
	Productivity risk	Low risk	Retain/Reduction	Create new performance schedule Plan to maximize productivity Improve work environment
Industry Risk	New compliance requirement	Medium risk	Reduction	Documenting performance and savings data
	Man power supply and availability risk	Medium risk	Reduction	Develop machinery and automation usage Get the service of a qualified and licensed contractor
	Material supply availability risk	Medium risk	Reduction	Schedule material supply carefully Industry institutions and government to provide a portal or list of green materials available Get government support to invest and develop in green material and the researches Get materials from approved suppliers
	New and untested product and material	Medium risk	Reduction	Preparing database for green materials Use modern technologies to collect timely data Use tested green materials
Performance Risk	Lack of experience of consultant and subcontractor	Medium risk	Reduction	Hire experienced consultant and sub-contractors based on history rewards/profiles Establish educational programs for industry professionals Retain experienced and knowledgeable team members
	Failure to meet green code or green certification	Low risk	Retention/Reduction	Get the services from experience and green - consultant Change the structure or material to overcome identified problems
	Energy saving uncertainty	Extreme risk	Avoid	Establish a performance based contract with the consultants Proper energy simulation Insurance cover and
	Warranty risk	High risk	Transfer/Reduction	Purchase insurance Material quality test
	Delay in project completion	High risk	Transfer/Avoid	Using MS project create project schedule Motivate the project members Proper time management Daily meeting with contractors

	Accreditation of energy saving companies	Low risk	Retention/Reduction	Check Energy Saving companies' credibility with reference to the list of ESCOs provided by the government
	Team performance risk	Medium risk	Reduction	Improve team members communication and integration Select the Design and Build delivery method Provide proper leadership to the project Allocate daily target to project team
	Indoor air quality issues	Low risk	Retention/Reduction	Establish proper evaluation criteria Proper designing and commissioning
	Reliability and accuracy benchmark	Low risk	Retention/Reduction	Prepare a "knowledge portal" for historical data
	Quality risks	Extreme risk	Avoid	Use tested and certified green materials Conduct routine checks to ensure the desired level of workmanship are met
	Pre retrofit tenant cooperation risk	Low risk	Retention/Reduction	Perform retrofit work outside standard working hours Arrange relocation for the tenants Explain the rationale for retrofitting existing building to green building
	Post retrofit tenant cooperation risk	Medium risk	Reduction	Increase awareness of the benefits of retrofitting existing building to green building Provide incentives and rebates to the tenant
	Lack of knowledge regarding structure	Medium risk	Reduction	Provide knowledge regarding to the existing structure Contractor awareness
Legislative Risk	Tax changes	Low risk	Retention	Accept the risk
	Regulatory incentives changes	Low risk	Retention/Reduction	Tap on government and financial incentives
	Change of green building codes and mandate	Medium risk	Reduction	Accept the risk Comply with mandates and codes
	Requirement of permits and their approval	High risk	Transfer/Avoid	Obtain legal advice Institution aspect properly address in project preparation Better coordination among stakeholders and various implementing agencies
Other	Design changes	Extreme risk	Avoid/Transfer	Insurance cover Adhere to proper design norms
	Procurement delay	Extreme risk	Avoid	Ensure assurance and completeness of documentation Prepare a realistic procurement plan
	Damage to structure or property	High risk	Avoid/Transfer	Physical protection to reduce risk Transfer risk to insurance company
	Delay payments on contract	Medium risk	Reduction	Prepare a proper financial plan
	Design errors	Medium risk	Reduction	Adhere to construction practice Use experienced architects and engineers

In green retrofit project, it has been noticed that the project consists of extreme, high, medium and low risks. Finally, based upon the level of each risk, proper risk response strategies were suggested together with their responsible parties. Prior identification of green retrofitting risks contributes to reduce its impacts to a greater extent by taking appropriate risk response strategies. Moreover, the project managers, architects and engineers on the respective green retrofit projects should be made responsible for managing project risks associated with that particular project and the project team members have to be assigned to specific areas of responsibility for reporting to the project manager. This may ensure the proper identification of risks throughout the project and thereby ensures the success of the project to a greater extent.

By enhancing the value of this research, following implications are highlighted as major outcomes derived from this research.

- The research outcome can use as a guideline for green retrofitting of existing building projects in Sri Lanka.
- Green retrofitting project team can carry out awareness programs to ensure project success and introduces risk response strategies would help to overcome risks and improve performance achievement of the project.
- Having a proper plan for managing risks in green retrofitting project could reduce the cost of the project and achieve the continuous improvement of the project process.
- Implementing green retrofitting of existing building can have to face various risks than new constructions. Therefore, the findings may help to allocate sufficient budget, provide proper communication and allocate responsibility for managing risks in green retrofit projects.

5. SUMMARY

The aim of this research was to propose probable risk responsive strategies through a comprehensive risk assessment of green retrofitting projects in Sri Lanka. The thirty (30) risk factors which were identified by reviewing key literature are evaluated by using descriptive statistical techniques; calculating the "Mode" value. The risk score for each factor was determined based on risk rating matrix. The low, medium, high and extreme risk factors are determined based on the overall risk rating matrix developed where, ten factor were determined as critical factors, such as, construction cost, inflation, energy saving uncertainty, warranty risk, delay in project completion, quality risks, requirement of permits and their approval, design changes, procurement delay, and damage to structure or property. Accordingly, probable risk responsive strategies are proposed as those factors could negative affect the project life cycle, financial status and performance issues of green retrofit projects in Sri Lanka.

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