Developing a Framework for Implementation of Sustainable Rating Systems in the Building Construction Using Systems Thinking Approach

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science

In

Construction Engineering & Management

By

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Developing a Framework for Implementation of Sustainable Rating Systems in the Building Construction Using Systems Thinking Approach

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Master of Science in Construction Engineering and Management

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DEDICATION

This thesis is dedicated to my beloved Parents, My Uncle Muhmmad Zahid Absal, Sisters, Brothers, Friends, and my respected Teachers!

ACKNOWLEDGEMENTS

Countless gratitude to Almighty ALLAH, who is almighty, ever-present, and blessed with the chance and choice, health, courage, strength, patience, and knowledge, enabled me to complete my research work.

I am in debt of gratitude to my research supervisor **Dr. Khurram Iqbal Ahmad Khan** for his guidance, motivation, and constant encouragement throughout this journey. I sincerely appreciate the valuable time and personal support accorded by him. I am also extremely grateful to the committee members, Dr. Abdur Rehman Nasir, Dr. Abdul Waheed for their sincere guidance to complete this research work.

I owe my special thanks to the survey respondents who gave their full support and cooperation in completing my thesis. In the end, I would like to especially thank my parents, Mrs. Mehboob Karim; my sisters; my uncle Mr. Muhammad Zahid Absal; my brothers Dr. Sajid Iqbal, Dr. Amjad Iqbal and Engr. Rashid Iqbal, and last but not least, my friends Dr. Wali Ullah, Dr. Abid Ullah Umer, Mr. Abdul Nasir, Mr. Naveed Ur Rehman, Mr. Khalil Ur Rehman, Engr. M. Nauman, Engr. Muhammad Qasim, Engr. Suleman Saani, Engr. Atta Ur Rehman, Engr. Fahad Riaz, Engr. Sana Ullah and Engr. Syed M. Taimur Shah for their unconditional love, prayers, support, and continuous encouragement.

ABSTRACT

Traditional building methods were primarily concerned with the cost of the product, its performance, and ensuring that it reached a quality standard. The concept of sustainable development focuses on contemporary technologies while keeping current environmental concerns, socioeconomic issues, and human health in mind. Different stakeholders are involved in construction projects that creates issues like high unpredictability, miscommunication, and lack of the right information. These issues need to be managed effectively and efficiently to make the project successful especially to ensure sustainability. There are several Sustainable rating systems like LEED to manage the factors, in order to minimize the chances of project's failure by managing the issues. The reason for the selection of the topic is to determine the drivers that are essential in sustainable rating system and to develop and suggest an appropriate strategy for the implementation of sustainable rating system in construction industry to ensure sustainable development. This research will also help to build the interaction between the underlying drivers by using the System Thinking Approach with VENSIM software. The author performed a content analysis to identify the drivers first then performed the surveys successfully to attain the primary data to finalize the drivers, perform influence matrix and Casual Loop diagram. The primary data was collected from the experienced construction professionals. The final survey helped the author to identify the polarity between the drivers that shows the relationships between them. The findings showed that the selected drivers are interlinked but they have to be managed effectively with the help of the proposed framework. In a nutshell, managing sustainability in construction is not one step process and the aspects, discussed in the sustainable rating framework should be considered to ensure sustainable construction.

Keywords: sustainable development, sustainable rating system, system thinking, causal loop diagram, construction industry.

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List of Acronyms

- SC Sustainable Construction
- SRS Sustainable Rating System
- STA Systems Thinking Approach
- EPA Environmental Protection Agency
- GB Green Building
- USGBC United States Green Building Council
- LEED Leader in Energy & Environmental Design
- BREEAM Building Research Establishment Environmental Assessment Methodology
- RII Relative Importance Index
- CLD Causal Loop Diagram

Chapter 1

INTRODUCTION

1.1. Background Study

Sustainable construction (SC) is understood as that which serves the demands of the current generation without harming future generations' ability to meet their own needs (Gehlot and Shrivastava, 2021). Sustainable building rating systems are being developed to help reduce construction's environmental impact and contribute to long-term development (Aristizábal-monsalve et al., 2021). As global awareness of environmental issues grows, experts and professionals in several fields are looking for solutions to reduce the negative human impact on the environment. The building sector is a major leading industry in all nations, and it has gotten much attention because of its high effect and high consumption of critical resources, as well as its considerable emissions of dangerous gases (Abdelkader, 2020). Involvement of many stakeholders in the construction projects is one of the causes of high uncertainty and inherent complexities. This gap leads to have detrimental impact on the project cost, time, quality, safety, long term sustainability along with other detrimental impacts is faced by these construction projects (Tunji-Olayeni *et al.*, 2018).

The traditional methods of construction mainly focused on the cost of the good, its performance and making sure that it had a quality objective. On the other hand, notion of sustainable development focuses on modern methods keeping in mind the current environmental challenges, socio-economic issues and most importantly the healthy life of humanity. Throughout the life cycle of a building, approaches of sustainable construction are environmentally friendly and resource- efficient (Ametepey et al., 2020).

The main purpose of this study is to develop a framework for the implementation of sustainable rating systems by focusing the stakeholder's perception on the sustainable rating system (SRS) in building construction, minimizing the complexities in terms of adoption of sustainable rating system. System thinking is an approach that is used to address drivers of sustainable rating system using feedback mechanism, identification of drivers from literature using content analysis and questionnaire surveys to determine causality among variables that led to the development of causal loop diagram (CLD).

The findings of this study would be helpful for the stakeholders to adopt sustainability rating system in term of the implementation of sustainable development. It would not only increase productivity and performance but would be helpful in minimizing the chances of delays, ensure a good and long-term relations, promote safety, increase accountability, reduce waste, environmental, social, and economical effects.

1.2. Problem Statement

There are multiple factors that create issues in construction projects. Sometimes these factors not even create an issue but also could make the project fails (Bozicek et al., 2021; Cordero et al., 2019). There are several drivers and factors in sustainable rating systems that are interconnected with other and need to manage efficiently to complete construction projects. It is essential for the users of these sustainable rating system like LEED to know the actual linkages between these mentioned drivers and factors to develop an effective strategies (Bozicek et al., 2021; Wholey, 2015; Sartori et al., 2021; Bal et al., 2013). It is essential to know the connections between the drivers as these drivers act as critical success factors for the successful project delivery (Kaliba et al., 2008; Desai and Butt, 2013).

Illegal dumping has become an issue as the output of construction waste has increased. Human and environmental health are at danger as a result of this illegal dumping (Politi, 2017; Doan et al., 2017). All the mentioned issues could be solved by using sustainable rating system. It is necessary that this rating system must be implemented through effective strategies construction industry for sustainable construction.

1.3. Previous Studies

The construction industry mainly focuses on the cost of the project, timeline, and quality as vital components to assess the achievement level, especially in developing countries. That's why sustainability and environmental aspects are badly neglected. Housing, he observed, is a basic human requirement. Energy crises, climatic changes, and their impact is side by side encountered by our country. To cope with our country's financial and social challenges these crises need efficient green house (Baig, 2018). Khan et al (2020) conducted a study, in his paper, he discusses how in a developing country, an international green rating system, LEED, can be used. LEED focuses on challenges that arise following construction, which includes environmental, energy, and water challenges. In all stages of building life cycle, demolition process, designing process, operating process and assessment process, there are several factors that are involved in these processes (Abdelkader, 2020).

Nguyen and Altan (2011) performed a qualitative comparison about availability, applicability, diffusion, and development of five renowned sustainable rating systems, practiced in different countries. The authors gave the score as per their knowledge and opinions after the analysis. The score of BREEAM and LEED was 75 points. The study concluded and according to (Doan *et al* (2017) that LEED is one of the rating systems, used in approx. 160 countries. The analysis was done to assess the similarity and differences between the selected rating systems. The study also analyzed the effectiveness of these systems in assessing the sustainability of a project. The study found that BREEAM is effective in assessing the sustainability related to environment and society.

Politi and Antonin (2017) conducted a study in which they proposed model that compares different rating systems and their outcomes. This model help in mapping about the common elements and their relationship.

1.4. Research Gaps

Majority of research concentrate on comparing sustainable rating system and barriers in the implementation of sustainable rating system with no explicit focus on the implementation framework of sustainable rating system. Hence, there is lack of study on sustainable rating system in which a framework to ensure a sustainable development by focusing on the perception of involved stakeholders using system thinking approach.

1.5. Reasons / justification for selection of the topic

The issue of sustainable development has become more serious because of the impact of growing climate change and resource depletion, and it will continue to dominate the global development agenda. A substantial amount of greenhouse gases is emitted during infrastructure development. This emission affects the environment. As a result, the responsibility and challenge are to ensure that infrastructures are economically socially and environmentally responsible. The building industry's many stakeholders can work together to achieve green development. The sector's demand is represented through customers and developers in the construction industry. They should promote sustainable development at the most. The attitude and knowledge of the stakeholders involved in the construction process have a direct impact on the construction industry's performance.

There is an intensive need to research to reveal perception of the stakeholder on the sustainable rating system. The reason for the selection of the topic is to determine the drivers that are essential in sustainable rating system and to develop and suggest an appropriate framework for the implementation of sustainable rating system in construction industry to ensure sustainable development. This research will also help to build the interaction between the underlying drivers by using the System Thinking Approach (STA) with VENSIM software.

1.6. Objectives

I. To identify the drivers of sustainable rating system.

II. To assess stakeholder perception using drivers of sustainable rating system in building construction.

III. To determine importance, interconnectivity, and functionality of drivers using causal loop diagram.

IV. To develop a framework for the implementation of sustainable rating systems in construction industry of developing countries.

1.7. Relevance to national needs

Developing countries including Pakistan is severely lagging in the sustainable development in construction field. The research outcome of this research will prove beneficial for all the concerned stakeholders in Pakistan. The outcome could be used as a road map for achieving sustainable construction as mentioned below.

I. Adding and achieving value for money.

II. Get maximum output by investing minimum input

III. Attainment of long-term benefits like environmental, social, and economical

1.8. Advantages

The research has the following advantages:

I. It improves the design process
II. Ensure financial gains
III. Minimize the associated risk
IV. Provides a competitive advantage
V. Ensure accountability
VI. Improves the way of life

1.9. Areas of application

The major area of application of this research is

I. Economic Sustainability
II. Social Sustainability
III. Environmental Sustainability

Chapter 2

LITERATURE REVIEW

2.1. Importance of Construction Industry

Traditionally, the construction and habitation of buildings have been associated with a wide range of environmental consequences. The building sector consumed approx. Twenty percent of the globe's energy in 2018 that includes residential along with commercial structures. It is expected to continue to grow at 1.3 percent per year by 2050, reaching 22 percent. Developmental countries account for a substantial portion of the increase in the energy consumption of buildings, which is driven by expanding urbanization and improved access to power and income levels. Approximately 40% of global energy consumption, Industrial sectors were accounted for. However, the projected increase will be between 0.5 per cent and 1.1 per cent, resulting in the sector's total stake of energy utilization declining to 35% by 2050 from its current level of 40% in 2018 (US, 2019).

Building materials including iron, steel, aluminum, and paints come from the industrial sectors. Considering the manufacture and delivery of building materials, the energy utilization of structures would exceed 20% (Portalatin et al., 2010). Residential buildings utilize electricity for refrigeration, water heating and space heating and cooling whereas commercial buildings use electricity for computers, office equipment, refrigeration, space cooling, and ventilation. The adoption of Light-emitting diode (LED) and compact fluorescent lamps (CFL) has decreased and will continue to minimize lighting energy consumption (Shen, 2017).

2.2. Environmental Impact of Construction

Buildings not only consume a lot of energy but also emit greenhouse gases. According to government projections, installations and construction and upstream energy generation will account for 39% of total CO_2 emissions. Buildings also use water while treating wastewater. Buildings absorb 13.6 percent of full drinking water per year or 15 trillion gallons. Building structures creates a demand for building materials, which contributes to greenhouse gas emissions. Emissions of greenhouse gases occur during a building's lifetime. It begins with the extraction and processing of raw materials and terminates with the delivery of construction materials. Eventually the destruction of these structures is the ultimate solution. Furthermore, the destruction of a building generates a significant amount of waste (IEA, 2017).

According to the Environmental Protection Agency (EPA), 548 million tons of debris as a result of construction and demolition in 2015, produced by the United States, which was more than twice the size of municipal solid waste created in a similar year. Devastation garbage accounted for ninety per cent of all construction and demolition waste. Because of the environmental consequences of building construction, there has been an increase in interest in making buildings more energy-efficient and environmentally friendly. Green buildings (GB) became famous as it emphasizes and ensures the incorporation of sustainability in the whole construction process (European, 2021).

These tools were created to address expanding global concerns. Since the built environment contributes significantly to socio-ecological challenges, including climate change, adopting environmentally and socially responsible practices has been recognized as critical for decades (Say & Wood, 2008).

This is primarily due to the enormous impact the built environment has on energy and resource use and emissions. The building industry accounts for 31% of global final energy consumption, 54% of final power demand, and 23% of global energy-related CO2 emissions, with one-third of these emissions resulting from the direct consumption of fossil fuels (IEA, 2017).

Even in Europe, where much effort has been made to reduce the impact of construction, buildings continue to account for around 40% of total EU energy consumption and 36% of full greenhouse gas (GHG) emissions (European, 2021).

An estimated 40 percent of the world's raw materials are used in the construction industry, while over 35 percent of the world's garbage is generated (OECD, 2011). Construction and operation of structures consume roughly 17% of freshwater globally. A lack of open spaces, indoor VOC emissions, and thermo-hygrometric discomfort impair the health and well-being of building occupants (Say & Wood, 2008).

Even though the building sector has a higher energy demand than the industrial and transportation sectors, the construction sector has the most significant potential for emission reduction, primarily due to the flexibility of its demand (Berardi, 2012). According to Berardi, a considerable amount of space for improvement may arise from the adoption of more environmentally friendly building practices. This leads to the concept of ecologically friendly construction, which has increasingly gained popularity worldwide (Doan et al., 2017). It is impossible to overstate the importance of the benefits of environmentally friendly construction. Buildings harm the environment, both during their use and construction. During a year in the United Kingdom, the building industry generates approximately 70 million tons of garbage, of which about 13 million tons are discarded as waste. Buildings currently in use account for roughly half of all CO_2 emissions in the United Kingdom (European, 2021).

Buildings also use 40% of the country's energy (including 2/3 of its electricity) and 16% of its water. They produce 15-40% of waste in landfills based on geography. Achieving waste reduction and climate change mitigation requires building design innovation (US, 2019).

Global warming is widely accepted as a fact by the scientific community, and governments worldwide have joined forces to address the issue at the Kyoto Protocol and subsequent summits. For the damage already done to stop, greater energy efficiency and greener structures are required. There is a pressing need to incorporate green features into forms that are conceptualized, designed, specified, estimated, constructed, or maintained by the many stakeholders in the built environment. This will help reduce the total impact on the environment and human health by utilizing energy and water more efficiently, safeguarding occupants' health and increasing staff productivity, minimizing waste, pollution, and environmental degradation, and enhancing employee productivity (Shan & Hwang, 2018).

2.3. Construction Industry in Pakistan

As a developing country, Pakistan experiences a considerable increase in construction activity. Construction is now Pakistan's second-largest industry after farming. Constructing accounts for roughly 30-35 percent of all jobs. This has helped create jobs and stimulate the economy of Pakistan (Farooqui et al., 2007a). This, along with over a 2% population increase (Economic Survey of Pakistan, 2007), puts a strain on basic and advanced infrastructure. The recent power outages are a classic example of an outdated and inadequate power infrastructure failing to meet expanding demand, culminating in an energy crisis. This enforced the Government of Pakistan to respond to this demand by planning extensive infrastructure.

In Pakistan, a similar situation exists when it comes to providing transportation infrastructure. Following public demand, the government of Pakistan has responded by launching a massive infrastructure development programmed. Federal Medium Term Building Framework (MTDF) allots Rs2 162 billion (US$36 billion) to the development of significant infrastructure. The country is beginning on an ambitious program to upgrade road, railway infrastructure, irrigation system as well as other infrastructure. This will be achieved through the Public Sector Development Program, which will receive Rs. 993 billion (US$16.3 billion) (PSDP). The MTDF envisions a tripling of the infrastructure PSDP, from an average of Rs150 billion per year to Rs440 billion per year, as part of a larger infrastructure development strategy. The present PSDP allocation of Rs520 billion for the fiscal year 2008 has already exceeded this aim (Farooqui et al., 2007a).

The MTDF does not cover these programs. NTCIP, major water reservoirs (Kalabagh, Diamer and Bhasha), barrage renovation and clean water and power distribution to all (which alone require substantial investments over and above the MTDF). As a result of the rising urbanization of the provinces, districts, and towns/municipalities (Farooqui et al., 2007b).

2.4. Construction and Energy consumption

For our society to continue expanding and flourishing, we must invest in new infrastructure. Construction and infrastructure development are considered the "sunrise sectors" of all developing countries, including China. Worldwide, buildings utilize majority of all available energy. According to the research by the World Green Building Council, for 30 and 40% of total worldwide energy consumption and 70% of overall electricity usage around the world, buildings are account for (Bal et al., 2013).

Energy is consumed in buildings for multiple purposes, including lighting, space heating or cooling (depending on local climatic conditions), active ventilation, space air-conditioning (for rooms), cooking, water heating, and the operation of various electronic or electrical gadgets. Compared to a typical building that is not planned with energy efficiency and traditional renewable energy use optimization in mind, a well-designed building can significantly reduce operational energy consumption throughout its entire life (Le-Hoai et al., 2008).

To expect consistent performance in terms of energy efficiency, comfort, and sustainable resource management throughout a 30- to 50-year construction project, it is critical to choose a 30- to 50-year timeframe. Without taking the long view, we will most certainly fall short of the goals we have set for ourselves to move toward a more environmentally conscious society (Iyer & Jha, 2005).

2.4.1 Green building

A green building uses water, energy and other resources in the most efficient and least disruptive way possible. Passive design features and techniques for space heating, ventilation, cooling and daylighting are essential components of a green building for climate-responsive architectural design. It is renewable energy sources, efficient and environment friendly construction practices. The global building construction sector is currently facing two main difficulties. The first is the rising cost of conventional energy that includes soil pollution, carbon dioxide emissions, air, water and other greenhouse gases harm to adjacent flora and natural habitats (Doan et al., 2017; Satori et al., 2021; Wholey, 2015).

On the other hand, green design is becoming increasingly recognized as a means of assisting builders in responding to both of these difficulties. It helps in reducing operating costs, improve the marketability of buildings and organizations, raise tenant productivity, impact on public health as well as the environment, but and contribute to creating a more sustainable community. Green buildings can make a significant contribution to lowering current and future energy demands. Green building regulations must be in place to achieve this crucial goal. These policies must support, encourage, and enforce the development of every building as a green building (Fowler and Rauch, 2006).

This transformation relies heavily on green building rating systems. Some countries have developed and used green building rating systems. BREEAM is used in Europe, Green Mark is used in Singapore, CASBEE in Japan whereas Green Star and GRIHA in India. Aspects of global environmental and indoor environmental impact are often included in green (Burnett, 2007).

According to the EPA, sustainability of the site, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and creativity in design is the primary criteria covered in most green building rating systems. Most rating systems evaluate buildings using a point system of 100 or more points, with the number of points varying from one rating system to the next. Each category of buildings receives points for meeting the numerous criteria that have been established for that category; the total number of points assigned to each building determines the rating (Berardi, 2012).

Rating systems are popular because they seek to represent the concept of "total quality" (Berardi, 2012). However, there are still concerns that need to be addressed, such as that awarding marks is primarily a qualitative process that might lead to subjectivity issues (Chandratilake 2013).

2.4.2 Green Building Rating System Approach

The integration of sustainable building practices throughout the building life cycle allows for the investigation of the green practices. In green buildings, the methods, the technology, and the methods to reduce the eco-friendly and health impacts while utilizing renewable energy sources to provide electricity are essential aspects (Ali, 2009).

Aside from that, eco-friendly structures maximize plants and trees, reduce rainwater runoff, employ environmentally friendly materials, and encourage the recycling of waste materials (Shen, 2017).

The United States Green Building Council (USGBC) was created in 1993 to encourage the design, construction, and operation of sustainable buildings. The USGBC identified the necessary for green construction standards. In addition, it established Leadership in Energy and Environmental Design (LEED). The LEED has evolved into a thorough set of criteria that evaluates the design, operation, and maintenance of green buildings and their capacity to engage in social activities (Haapio, 2008). LEED is the most popular among all the rating system (Leed, 2019).

Other green building grading systems have now emerged. For example, the BEAM Steering Committee of Hong Kong formed the Hong Kong Green Building Council in collaboration with other essential players in 1996. (HKGBC). The HKGBC released BEAM Plus in 2010. Following LEED, regional green building rating systems such as Japan's CASBEE, Singapore's Green Mark, and Malaysia's Green Building Index (GBI) were introduced (Shan, 2018).

The rating systems encompass the most prevalent features that includes energy efficiency, indoor environmental quality enhancement, water efficiency, waste reduction, material efficiency and optimization of operations as well as maintenance (Shan, 2018).

On the other hand, Varied rating systems may place a different emphasis on different factors. More than a dozen studies have been carried out to analyze rating systems in-depth or compare varied rating systems. Numerous studies have compared LEED and BREEAM certifications (Wu, 2010; Awadh, 2017).

The comparison with regional grading systems was a part of other studies that went beyond the first two. Among the comparisons made by Aye and Hes were the Australian LEED, BREEAM, and Green Star (GS) certification systems, as well as the Chinese BEAM, CASBEE, and Assessment Standard for Green Building (ASGB) certification systems (Geng et al., 2012).

The green building grading system notion emerged in the early 1990s. According to Portalatin et al. (2010), BREEAM was developed in 1990, named as the British Research Establishment Environmental Assessment Method (UN-HABITANT, 2010).

Numerous research has demonstrated (Ali and Al Nsairat, 2009; UN-HABITAT, 2010; Portalatin and colleagues, 2010; and Adegbile, 2013) the relevance of green building assessment methods cannot be underestimated. Furthermore, according to Ali and Al Nsairat (2009), providing technical services and resources for measuring the "greenness" of a building based on an adequate green rating system is necessary to make green building practices more accessible and less challenging to adopt. Project stakeholders must consider green building assessment as the construction project progresses through the design and construction phases to avoid high energy consumption, GHE, solid waste generation and resource depletion.

2.5. System Thinking Approach (STA)

When it comes to system integration, systems thinking refers to a method of approaching integration predicated on the notion that the component components would behave differently when separated from the system's environment or other parts of the system. The goal of systems thinking is to see systems as a whole instead of positivist and reductionist thinking. Systems thinking, which is consistent with systems philosophy, is concerned with understanding a system by investigating the relationships and interactions between the pieces that make up the system as a whole (Arnold, 2015).

By exploring inter-relationships (context and connections), viewpoints (each player sees the situation differently), and boundaries (agreeing on scope, scale, and what constitutes an improvement) the stakeholders are ore encouraged (Nugroho et al., 2019).

When confronted with a difficult or wicked problem, systems thinking can be quite beneficial. These issues cannot be resolved by a single player, just as no single perspective on a complex system can provide a complete understanding of the system. Systems thinking can assist you in understanding the situation from a systems perspective when confronted with complicated and chaotic situations. It enhances the ability to perceive the greater view to find many leverage points that must be addressed in order to enable constructive change as a result of our efforts. It also assists us in seeing the interconnectedness of various factors in the situation in order to enable coordinated action (Fanta et al., 2020).

Systems thinking improves how we think and helps us deal with problems differently, thus giving us more ways to solve a problem. Systems thinking reminds us that there are no perfect answers and that our decisions would impact other parts of the system. We can reduce the severity of the effects or even use them to our benefit by predicting the consequences of each trade-off. Because of this, systems thinking helps us make better decisions. (Fanta et al., 2020).

2.5.1 System Thinking Approach in Sustainable Construction

Applying a system thinking approach to sustainability helps us to better understand and leverage the cause-and-effect relationships between our business decisions and their social and environmental consequences. Another benefit is identifying opportunities for innovation and design that works synergistically and solve multiple problems at the same time, eliminating trade-offs (Hofman, 2018; Brenna, 2019). Here's an example of how systems thinking approach worked for the built environment composed of multiple systems including a building site, structure, envelope, materials, mechanical, electrical, and plumbing systems and more. Let's say we are looking for efficiency upgrade solutions for a building's envelope.

An architectural element that defines the border between the exterior and interior is the building envelope. Examples of such characteristics include roofs, exterior walls, and window openings. And let's assume we're thinking about improving the insulation in the walls, installing more energy-efficient windows, and installing joints that are exceptionally tightly sealed. In contrast to a linear strategy, which would concentrate on these solutions just in the envelope, the systems thinking approach would recognize that these activities impact other building systems and the outer. In the case of an energy-efficient envelope, a smaller heating and cooling system is likely to result. Furthermore, because the size, style, and location of the windows will influence the amount of daylight and access to views, these improvements are likely to impact the indoor environmental quality.

Aside from that, if the structure is over-sealed and occupants cannot get enough fresh air, indoor air quality issues may arise even while the facility is in use. For example, suppose the building design and construction teams concentrate solely on the envelope without considering the other building systems. In that case, they will miss out on opportunities to optimize the mechanical systems. They will cause undesirable indoor environmental quality trade-offs by failing to correctly identify the interrelationships among these components. A method based on systems thinking allows design systems to cooperate rather than compete with one another.

2.6. Significant Drivers of Sustainable Rating System

Following are the drivers of sustainable rating system which are identified after a detailed literature review. A total of 32 drivers were identified from the literature review.

S. No	Drivers of Sustainable Rating System	Frequency
1	Competitive Advantage	13
2	Feedbacks	9
3	Proper Scheduling	11
4	Reinforcing process	11
5	Avoid Extra Labor	13
6	Save cost	14
7	Trust in safety	8
8	Avoid Delays	8
9	Collaboration between stakeholders	9

10	Integration	10
11	Simplify the needs	9
12	Reduce Efforts	4
13	Credibility of process	6
14	Energy Audits of Buildings	5
15	Scheduled estimates	5
16	Performance reporting	6
17	Continuous Support	11
18	Integration of new ideas	11
19	Performance Evaluation	5
20	Wastage	11
21	Minimize Complications	14
22	Right Information	15
23	Increasing occupant productivity	13
24	Improve indoor Environmental Quality	16
25	Eliminate toxic materials	14
26	Right Decisions	15
27	Protect nature	17
28	Awareness to global warming	16
29	Providing comfort, health, and well-being of occupants	14
30	Outdoor Environmental Quality	5
31	Maintenance Cost	5
32	Water Conservation	4

Table 1: Drivers of SRS

2.6.1 Ranking of factors based upon literature score

These Sustainable Rating Drivers are graded as shown in Table 2.6. and 2.6.1 based on their literature score derived by content analysis, in which the influence of each factor (high, medium, low) is determined via a thorough examination of the literature. The following formula was used.

$$\text{Literature Score} = \text{impact score} \times \frac{\text{frequency}}{A \times N} \qquad \textbf{Equation 2.1}$$

The next step was to transform this literary score into a normalized score. It is done by dividing each factors' individual literature score by the total literature score. After that, the normalized score is organized in descending order, and the cumulative score is computed. This method is used to eliminate less significant aspects. The ranking of drivers is made based upon literature and normalized score as shown below

S. No	Drivers of Sustainable Rating System	Literature Score	Normalized Score	Rank
1	Improve indoor Environmental Quality	0.380952381	0.055671538	1
2	Right Information	0.357142857	0.052192067	2
3	Right Decisions	0.357142857	0.052192067	2
4	Save cost	0.333333333	0.048712596	3
5	Minimize Complications	0.333333333	0.048712596	3
6	Providing comfort, health, and well-being of occupants	0.333333333	0.048712596	3
7	Competitive Advantage	0.30952381	0.045233125	4
8	Avoid Extra Labor	0.30952381	0.045233125	4
9	Proper Scheduling	0.261904762	0.038274182	5
10	Reinforcing process	0.261904762	0.038274182	5
11	Continuous Support	0.261904762	0.038274182	5
12	Integration of new ideas	0.261904762	0.038274182	5
13	Wastage	0.261904762	0.038274182	5
14	Protect nature	0.242857143	0.035490605	6
15	Integration	0.238095238	0.034794711	7
16	Feedbacks	0.214285714	0.03131524	8
17	Collaboration between stakeholders	0.214285714	0.03131524	8
18	Simplify the needs	0.214285714	0.03131524	8
19	Eliminate toxic materials	0.2	0.029227557	9
20	Avoid Delays	0.19047619	0.027835769	10
21	Increasing occupant productivity	0.185714286	0.027139875	11
22	Performance reporting	0.142857143	0.020876827	12
23	Energy Audits of Buildings	0.119047619	0.017397356	13
24	Scheduled estimates	0.119047619	0.017397356	13
25	Outdoor Environmental Quality	0.119047619	0.017397356	13

26	Maintenance Cost	0.119047619	0.017397356	13
27	Trust in safety	0.114285714	0.016701461	14
28	Water Conservation	0.095238095	0.013917884	15
29	Credibility of process	0.085714286	0.012526096	16
30	Awareness to global warming	0.076190476	0.011134308	17
31	Performance Evaluation	0.071428571	0.010438413	18
32	Reduce Efforts	0.057142857	0.008350731	19

Table 2: Ranking of drivers of SRS via Content Analysis

2.7. Summary

Construction sector has a significant place in overall economic growth of a country and sustainable construction has become crucial for green environment. There are several issues related to construction that must be addressed effectively. Several factors like cost run, timely and right decision making, scheduling and collaboration must be managed effectively. The identified 32 drivers are significant drivers that compel the project managers, construction engineers and other stakeholders to practice system thinking approach. This approach helps in managing the necessary factors and make construction projects successful as well as ensure overall sustainability.

Chapter 3

RESEARCH METHODOLOGY

3.1. Introduction

This study focuses on the system thinking approach in which sustainable rating system was selected. The author went through various stages to accomplish the objectives of the research. There will also be discussion of research flow charts, which organize goals and their associated tactics.

3.2. Research Methodology:

The research comprised four phases: initial study, content and factor analysis, system thinking and the framework, as shown in the figure. The detail of each phase is discussed below:

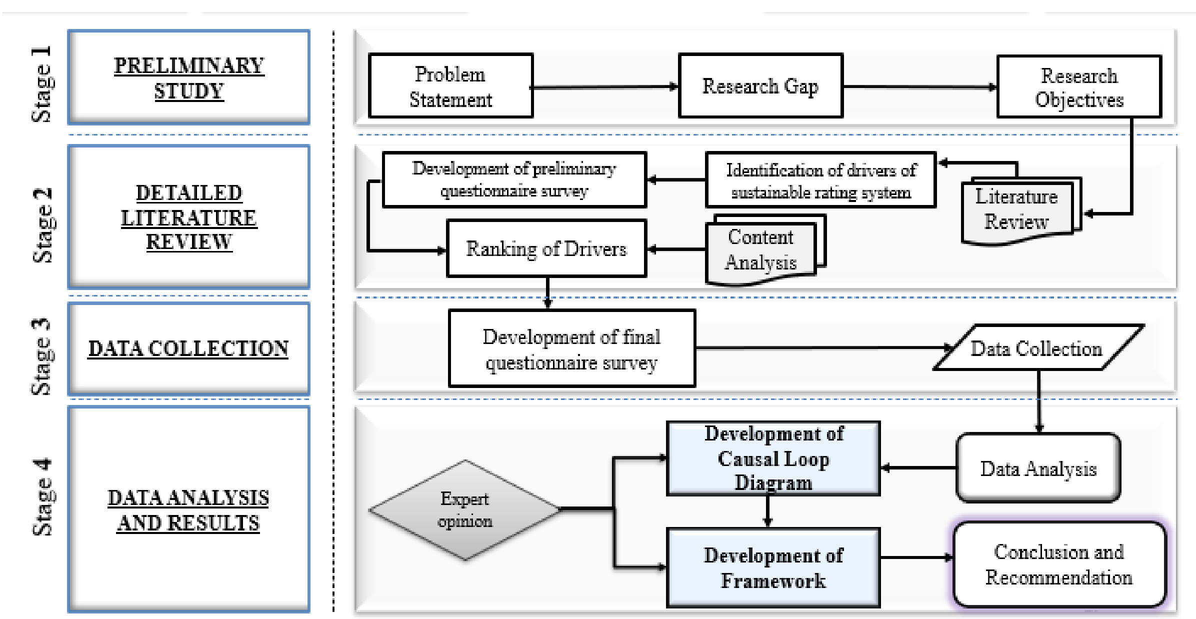


Figure 1: Research Framework

The research comprised four phases: initial study, content and factor analysis, system thinking and the framework, as shown in the figure. The detail of each phase is discussed below:

3.2.1 Initial Study: Identification of Research Objectives

First, the author performed intensive research to find the research gaps by analyzing the previous relevant studies. It helped the author to develop the title and the research objectives. The author carefully designed the research questions to achieve the aim. The author defined the scope and wrote a problem statement with the help of the gathered literature.

3.2.2 Factor Analysis:

A thorough literature review was conducted to identify the drivers of the sustainable rating system. A total of 32 drivers of sustainable rating systems were identified through literature studies of 44 research articles; after that, the author conducted the content analysis and assigned literature scores to each driver. The author performed a preliminary survey on a Likert scale ranging from 1 to 5 to shortlist the most significant drivers by getting the input from the experienced professionals in the construction sector. Data from 51 respondents was collected from developing countries, out of which 4 were invalid, and 30 were considered for analysis (Chan et al., 2018). Data's normality and reliability were checked by applying statistical tests on SPSS ®. The relative importance index of factors was calculated, and a field score was assigned to each factor. Literature scores and field scores were normalized and merged by a 50/50 ratio to avoid unbiased. After arranging factors in descending order concerning their merged score, factors having a cumulative percentage normalized score up to 51 per cent were shortlisted for further analysis.

3.2.3 System Thinking

A detailed questionnaire survey was carried out to determine the polarity and causal strength of each driver on the other. Respondents were asked to rank the causal strength of each driver on the other as Low (1), Medium (3) and High (5), along with polarity as Direct or Indirect. Data from 153 respondents from developing countries were collected, out of which 25 were invalid and 128 were considered for further analysis (Dillman et al., 2014, Cochran, 2007). Data's normality and reliability were checked by applying statistical tests on SPSS ®. Interrelations with mean values between 4 and 5 were taken into consideration (Chong et al., 2017). Using this information, systems thinking was developed through causal loop diagrams. VENSIM® was used to create a causal loop diagram based on the shortlisted interrelationships and modified by incorporating expert opinions to make it meaningful.

3.2.4 Framework Development

At this stage, the author develops a framework for implementing the sustainable rating system in building construction for developing countries with the help of the identified drivers and their causal relationship.

Chapter 4

RESULTS AND DISCUSSION

4.1. Preliminary Questionnaire Survey (Phase - 1)

The author performed preliminary questionnaire survey to finalize the drivers among the pool of the significant drivers, essential in sustainable rating system and to develop and suggest an appropriate strategy for the implementation of sustainable rating system in construction industry to ensure sustainable development. The author performed factor analysis after gathering the primary data using Microsoft Excel. The author used the sample size of 47 by taking the total population of 51, which is a sufficient sample size as per central limit theorem (Chan et al., 2018).

The author designed the survey using Google form and send via email address, WhatsApp, LinkedIn ® and Facebook ®. Respondents belonged to developing countries including Pakistan, India, Bangladesh, Azerbaijan, Sri Lanka, South Africa, Gambia, and Afghanistan. Before conducting the preliminary survey, the author performed content analysis of the gathered literature to assess the level of importance of the finalized drivers. The author used the value of the literature score in the factor analysis given below. The detail of the survey is discussed below by using graphical representation method. The author used Likert Scale (1 to 5) range from low to high to measure the primary data and the total number of drivers captured through a detailed content analysis were 32.

4.1.1 Respondent Details

The author organized the data of the recipients in excel sheet and generated the graphs for better understanding. The author targeted underdeveloped countries through snowball sampling method and convenience sampling. The author used nonprobability sampling technique to target the recipients with ease. The author used purposive sampling by targeting only the construction related professionals working in underdeveloped countries whereas in snowball sampling, the author requested other recipients to refer others in their social network.

4.1.1.1 Highest Academic Qualification

Majority of the recipients were master's graduate that is 51 % while the bachelors graduate was 43%. The remaining 6% includes B.Tech, doctorate and other technical management related degrees. All the recipients were highly qualified that enhances the reliability of the responses.

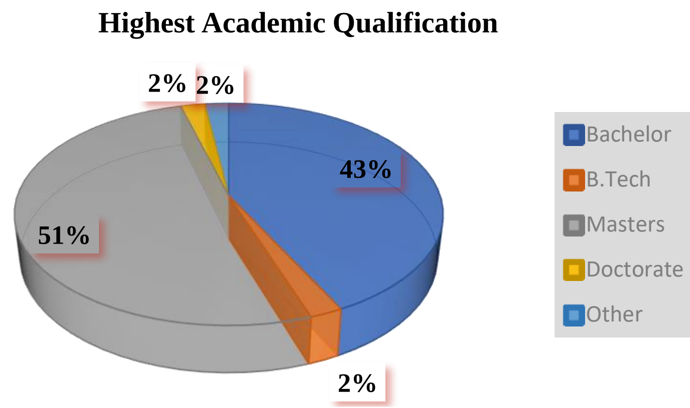
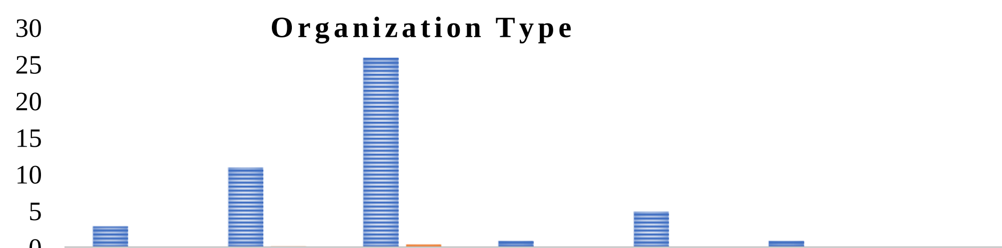


Figure 2: Preliminary Survey - Highest academic qualification

4.1.1.2 Organization Type

Majority of the recipients were contractors, providing construction service in the underdeveloped countries. Their competitiveness could be more or less as compared to others, but they engage in construction works directly. The 6 recipients belonged to academic field like teachers and university professors. The author also targeted clients who were taking services from others and their responses are also worthy about a sustainable construction. Only 1 supplier was targeted, and 13 consultants were targeted



	Client	Consultant	Contractor	Sub Contractor	Academia	Supplier	Other
Series1	3	11	26	1	5	1	0
Series2	6%	23%	55%	2%	11%	2%	0%

Figure 3: Preliminary Survey – Organization Type

4.1.1.3 Professional experience

23 out of 47 recipients possessed 2 to 5 years of experience which was good enough in fact to give the survey responses. The 5 of them possessed less than a year of experience. The 11 recipients possessed between 6 to 10 whereas the 5 had 11 to 15 years of experience. The recipients have experience above 20 is 1 in number.

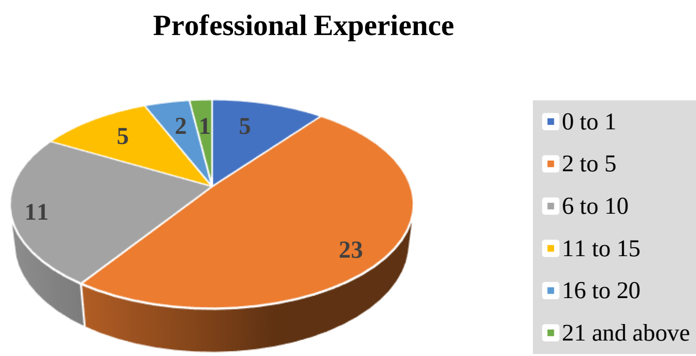


Figure 4: Preliminary Survey – Professional

4.1.1.4 Field of Work

The author targeted recipients working in different construction related fields. The 19% of recipients works as a building design, 26% of respondent from construction management, 21 % respondent from architectural type of work, 9% works as a project manager, 11% of respondent works in an infrastructure management and 15 % respondent works in different other related fields.

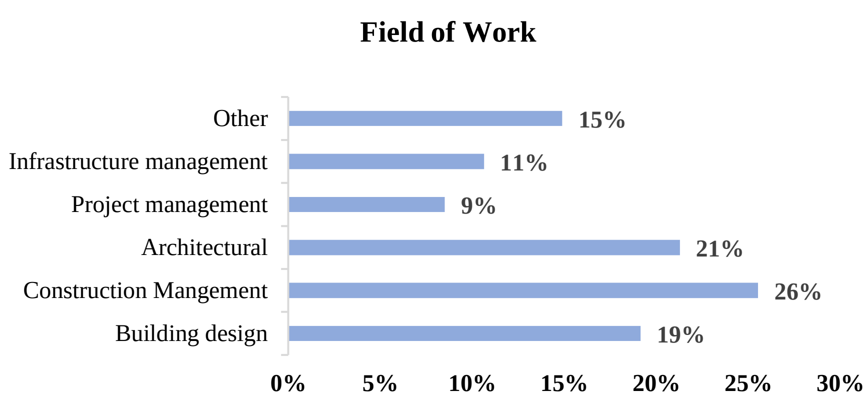


Figure 5: Preliminary Survey – Field of Work

4.1.1.5 Region of Respondents

The author targeted majority of the recipients in Pakistan and India that were 18 and 14 respectively. Others include 5 were from Bangladesh, 3 were from Afghanistan, 1 was from Azerbaijan, 3 were from Sri Lanka, 1 was from South Africa, and 2 were from Gambia

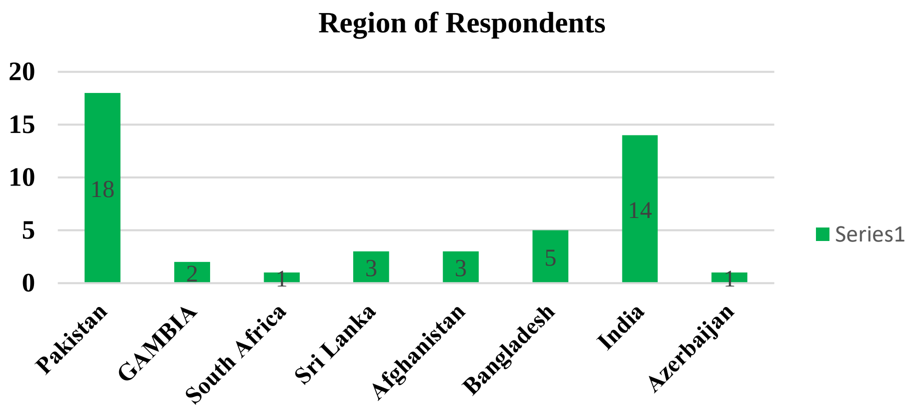


Figure 6: Preliminary Survey – Region of Respondents

4.1.2 Normality and Reliability Check

To check the normality of the data, Shapiro-Wilk test was conducted, and the value came out is less than 0.05, which indicated that data is not normally distributed and is non-parametric as shown in Table 3.

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Competitive Advantage	0.223	47	0.000	0.862	47	0.000
Feedbacks	0.333	47	0.000	0.812	47	0.000
Proper Scheduling	0.286	47	0.000	0.832	47	0.000
Reinforcing process	0.312	47	0.000	0.843	47	0.000
Avoid Extra Labor	0.319	47	0.000	0.844	47	0.000
Save cost	0.327	47	0.000	0.820	47	0.000
Trust in safety	0.209	47	0.000	0.902	47	0.001
Avoid Delays	0.238	47	0.000	0.893	47	0.000
Collaboration between stakeholders	0.307	47	0.000	0.756	47	0.000
Integration	0.173	47	0.001	0.899	47	0.001

Simplify the needs	0.201	47	0.000	0.873	47	0.000
Reduce Efforts	0.226	47	0.000	0.900	47	0.001
Credibility of process	0.268	47	0.000	0.813	47	0.000
Energy Audits of Buildings	0.296	47	0.000	0.860	47	0.000
Scheduled estimates	0.257	47	0.000	0.858	47	0.000
Performance reporting	0.250	47	0.000	0.857	47	0.000
Continuous Support	0.200	47	0.000	0.907	47	0.001
Integration of new ideas	0.212	47	0.000	0.864	47	0.000
Performance Evaluation	0.265	47	0.000	0.870	47	0.000
Wastage	0.346	47	0.000	0.745	47	0.000
Minimize Complication	0.226	47	0.000	0.900	47	0.001
Right Information	0.250	47	0.000	0.857	47	0.000
Increasing occupant productivity	0.255	47	0.000	0.868	47	0.000
Improve indoor Environmental Quality	0.315	47	0.000	0.730	47	0.000
Eliminate toxic materials	0.337	47	0.000	0.787	47	0.000
Right Decisions	0.309	47	0.000	0.809	47	0.000
Protect nature	0.268	47	0.000	0.804	47	0.000
Awareness to global warming	0.211	47	0.000	0.845	47	0.000
Providing comfort, health, and well-being of occupants	0.316	47	0.000	0.815	47	0.000
Outdoor Environmental Quality	0.221	47	0.000	0.872	47	0.000
Maintenance cost	0.237	47	0.000	0.883	47	0.000
Water Conservation	0.181	47	0.001	0.891	47	0.000

Table 3: Test for Normality

For checking the reliability and internal consistency of data, Cronbach's Alpha test was conducted, and its benchmark value is 0.7 (Polat et al., 2017, Gliem and Gliem, 2003), higher the value, the more data is reliable and internally consistent as shown in Figure. Cronbach's Alpha value came out to be 0.93 (Table 4), which indicated that data is sufficiently reliable and internally consistent is excellent (Tavakol and Dennick, 2011).

Variables	Description	value	Internal consistency
K	No. of items	32	Excellent
$\Sigma S^2 y$	Sum of item Variance	43.85604346	
S^2	Variance of total score	464.7043911	
α	Cronbach Alpha	**0.9348397**	

Table 4: Reliability test

Interpretation	
Cronbach Alpha	**Internal consistency**
≥0.90	Excellent
≥0.80 ≤ 0.89	Good
≥0.70 ≤ 0.79	Acceptable
≥0.60 ≤ 0.69	Questionable
≥0.50 ≤ 0.59	Poor
< 0.50	Unacceptable

Table 5: Benchmark value for Cronbach's Alpha

4.1.3 Ranking of Factors based upon Field Score + Literature Score

Field normalized score was calculated for each driver using field survey data. Field normalized score and literature score were merged to get the final ranking. The ratio used in this regard is 50R/50L to avoid any unbiased.

Rank	Drivers of Sustainable Rating System	50R/50L Normalized Score	Cumulative Score	%Age
1	Wastage	0.04602	0.04602	5%
2	Save cost	0.04586	0.09188	9%
3	Competitive Advantage	0.04412	0.13600	14%
4	Avoid Extra Labor	0.04412	0.18012	18%
5	Collaboration between stakeholders	0.04254	0.22266	22%
6	Simplify the needs	0.04254	0.26520	27%
7	Proper Scheduling	0.04064	0.30585	31%
8	Integration of new ideas	0.04064	0.34649	35%
9	Feedbacks	0.03716	0.38365	38%
10	Right Information	0.03685	0.42050	42%
11	Right Decisions	0.03685	0.45735	46%

12	Reinforcing process	0.03527	0.49261	49%
13	Minimize Complications	0.03511	0.52772	53%
14	Providing comfort, health, and well-being of occupants	0.03511	0.56283	56%
15	Integration	0.03353	0.59636	60%
16	Improve indoor Environmental Quality	0.03321	0.62957	63%
17	Credibility of process	0.03314	0.66272	66%
18	Scheduled estimates	0.03020	0.69292	69%
19	Avoid Delays	0.03005	0.72297	72%
20	Continuous Support	0.02989	0.75286	75%
21	Eliminate toxic materials	0.02537	0.77822	78%
22	Energy Audits of Buildings	0.02483	0.80305	80%
23	Trust in safety	0.02448	0.82753	83%
24	Increasing occupant productivity	0.02432	0.85185	85%
25	Protect nature	0.02312	0.87497	87%
26	Performance Evaluation	0.02135	0.89632	90%
27	Performance reporting	0.02119	0.91751	92%
28	Outdoor Environmental Quality	0.01945	0.93697	94%
29	Maintenance Cost	0.01945	0.95642	96%
30	Water Conservation	0.01771	0.97413	97%
31	Reduce Efforts	0.01493	0.98906	99%
32	Awareness to global warming	0.01094	1.00000	100%

Table 6: Ranking of Drivers based upon Field + Literature Normalized Score (50/50)

4.1.4 Shortlisted Factors

The author shortlisted the factors according to the cumulative normalized score. The author selected the factors based upon 51 percent of the cumulative normalized score (Rasul et al., 2019).

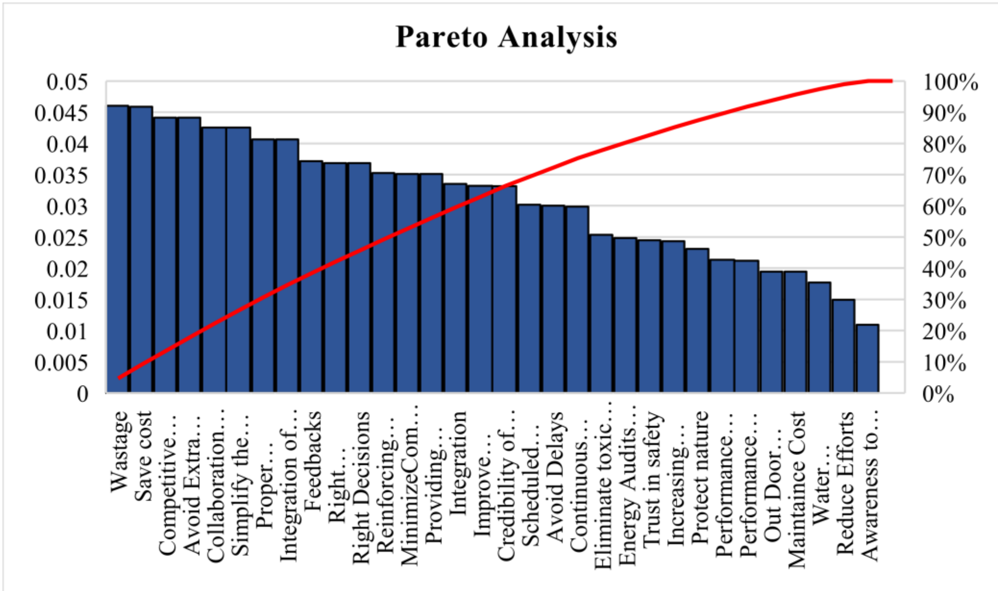


Figure 7: Pareto Analysis of Drivers

S. No	Code	Drivers of SRS	50R/50L	Cumulative	%Age
1	D1	Wastage	0.046019	0.04602	0.0460188
2	D2	Save cost	0.045862	0.09188	0.0918805
3	D3	Competitive Advantage	0.044122	0.13600	0.1360024
4	D4	Avoid Extra Labor	0.044122	0.18012	0.1801244
5	D5	Collaboration between stakeholders	0.042539	0.22266	0.2226637
6	D6	Simplify the needs	0.042539	0.26520	0.265203
7	D7	Proper Scheduling	0.040642	0.30585	0.3058455
8	D8	Integration of new ideas	0.040642	0.34649	0.346488
9	D9	Feedbacks	0.037163	0.38365	0.383651
10	D10	Right Information	0.036849	0.42050	0.4204997
11	D11	Right Decisions	0.036849	0.45735	0.4573484
12	D12	Reinforcing process	0.035266	0.49261	0.4926145
13	D13	Minimize Complications	0.035109	0.52772	0.5277235

Table 7: Shortlisted Drivers Based upon Literature + Field Normalized Score (50/50)

4.2. Detailed Questionnaire Survey (Phase – 2)

After attaining the finalized 13 drivers, the author designed the casual loop diagram to show the polarity between the variables. The author developed a detailed questionnaire to get the responses about the polarity between the drivers from the construction professionals. The recipients rated the polarity between the drivers by selecting direct or indirect relationship. The importance of the drivers was rated as low, medium, and high by the recipients. The author used the gathered data to attain Relative Importance Index (RII) by calculating the Mean Value of each driver. The author marked the driver as an important whose mean value came more than 4 to develop the influence matrix, given below. This influence matrix was used to develop the causal loop diagram to show the relationship between the variables as a positive and negative.

4.2.1 Sample Size:

The sample sizes for this research were determined through the following formula provided by (Dillman et al., 2014)

$$n_0 = \frac{Z^2 * p(1 - P)}{Z^2}$$ **Equation 4.1**

Variable	Description	Value
n_0	Sample Size to be calculate	**384**
z	critical value of desired level of confidence	1.96
p	maximum probability of variation in distribution	50%
E	margin of error	5%

Table 8: Unknown Sample Size

Table 8 shows the proportion from unknown population used as a sample size. The minimum sample size for this research can be calculated by a formula given by (Dillman et al., 2014).

$$n = \frac{n_0 * N}{n_0 + (N - 1)}$$ **Equation 4.2**

Variable	Description	Value
n	Sample size of known population	110
n_0	Proportion of unknown population	384

N	Known Population Size	153

Table 9: Minimum Sample Size

4.2.2 Respondent Details

The author organized the data of the recipients in excel sheet and generated the graphs for better understanding. The author targeted underdeveloped countries through snowball sampling method and convenience sampling. The author used nonprobability sampling technique to target the recipients with ease. The author used purposive sampling by targeting only the construction related professionals working in underdeveloped countries whereas in snowball sampling, the author requested other recipients to refer others in their social network

4.2.2.1 Highest Academic Qualification

Majority of the recipients were master's graduate that is 49 % while the bachelors graduate was 34%. The remaining 17% includes B. Tech, doctorate, and other technical management related degrees. All the recipients were highly qualified that enhances the reliability of the responses.

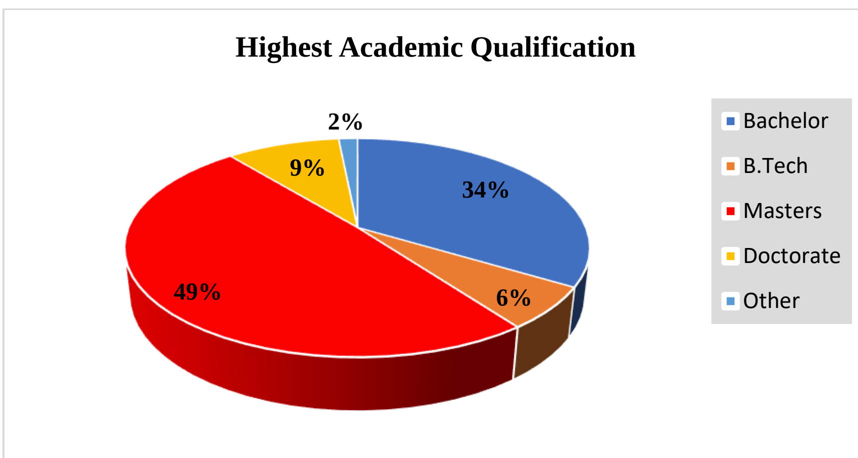


Figure 8: Detailed survey - Highest academic qualification

4.2.2.2 Field of Work

The author targeted recipients working in different construction related fields. The 7% of recipients works as a building design, 35% of respondent from construction management, 15 % respondent from architectural type of work, 23% works as a project manager, 5% of respondent works in an infrastructure management, 2% respondent from teaching background and 13 % respondent works in different other related fields.

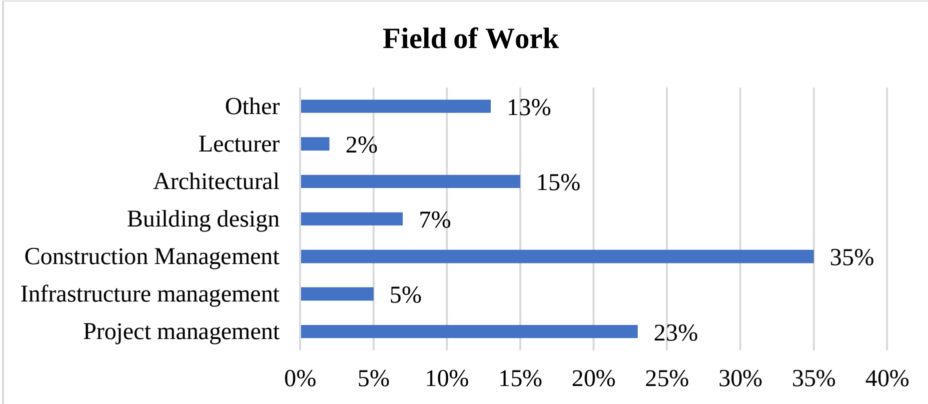
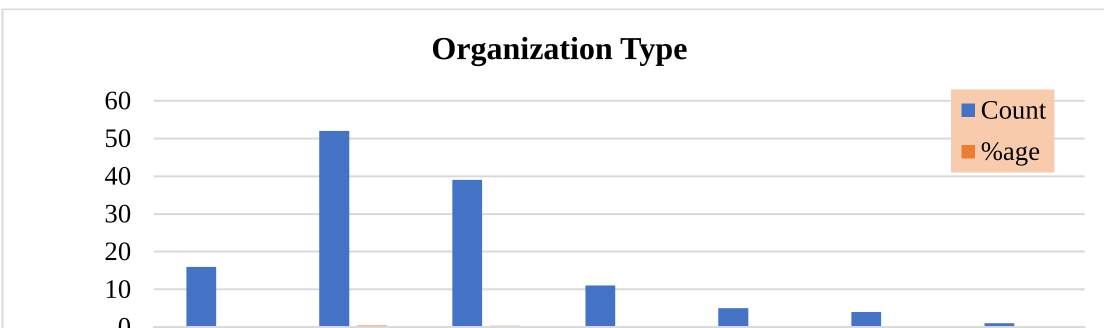


Figure 9: Detailed survey - Field of Work

4.2.2.3 Organization Type

Majority of the recipients were consultant that is 52%, providing construction service in the underdeveloped countries. Their competitiveness could be more or less as compared to others, but they engage in construction works directly. The 9% recipients belonged to academic field like teachers and university professors, 30 % of the recipients were from contractor organization while 16 % were from client side who were taking services from others and their responses are also worthy about a sustainable construction. 3% of supplier was targeted, 5% of sub-contractors were targeted and 1% respondent were targeted from other then the above-mentioned organization.



	Client	Consultan t	Contractor	Academia	Sub Contractor	Supplier	Other
Count	16	52	39	11	5	4	1
%age	13%	41%	30%	9%	4%	3%	1%

Figure 10: Detailed survey - Organization Type

4.2.2.4 Region of Respondents

The author Targeted respondents were from developing countries including Pakistan, India, Bangladesh, South Africa, Gambia, Afghanistan, Iran, Azerbaijan, Malaysia, Saudi Arabia, Sri Lanka, and Indonesia. In terms of percentage, 38% % of the respondents were from Pakistan, 18 % were from India, 12 % from Bangladesh, 3 % from South Africa, 3 % from Sri-Lanka, 2 % from Gambia, 6 % from Afghanistan, 4 % from Iran, 1 % from Azerbaijan, 2 % from Malaysia, 2 % from Indonesia and 9 % from Saudi Arabia.

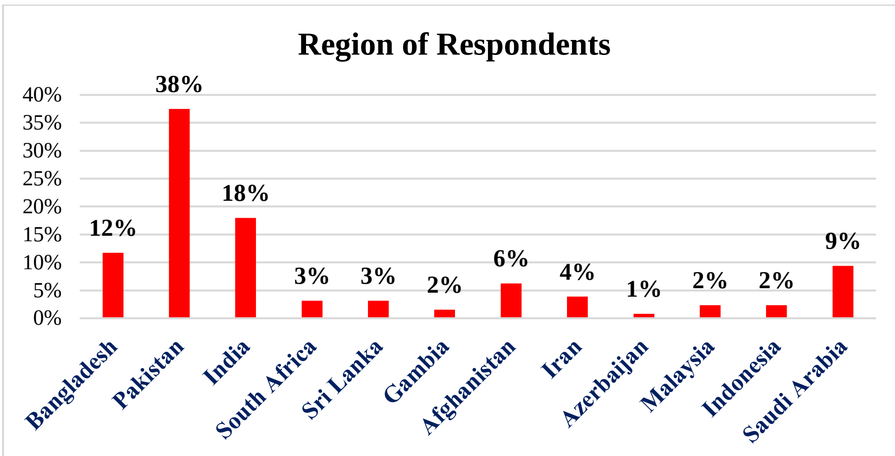


Figure 11: Detailed survey - Region of Respondents

4.2.2.5 Professional Experience

In terms of the amount of professional experience respondents had, 25% of respondents had between one and five years of experience, while 34% of respondents had between six and ten years of experience. In a similar vein, 13% of respondents had experience ranging from 11 to 15 years, and 13% of respondents had experience ranging from 16 to 20 years. The remaining 4% of those who responded had more than 21 years of experience in their respective fields.

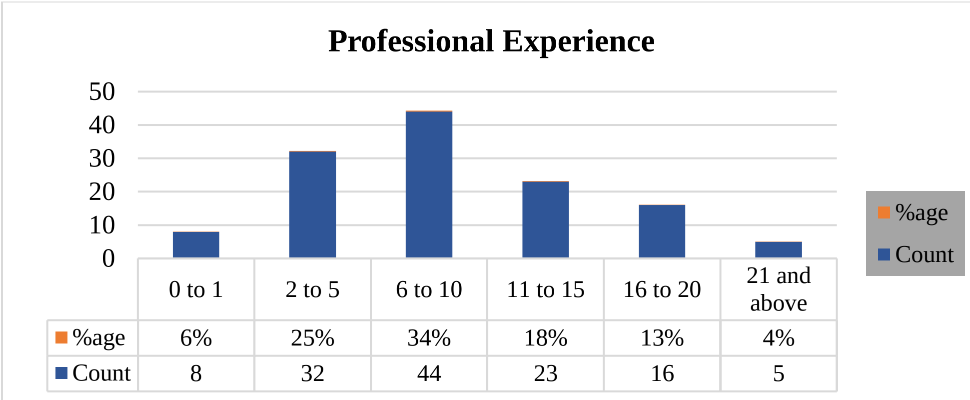


Figure 12: Detailed survey - Professional Experience

4.2.3 Normality and Reliability Check

To check the normality of the data, Shapiro-Wilk test was conducted, and the value came out is less than 0.05, which indicated that data is not normally distributed and is non-parametric.

For checking the reliability and internal consistency of data, Cronbach's Alpha test was conducted, and its benchmark value is 0.7 (Polat et al., 2017, Gliem and Gliem, 2003), higher the value, the more data is reliable and internally consistent as shown in Figure. Cronbach's Alpha value came out to be 0.90 (Figure), which indicated that data is sufficiently reliable and internally consistent is excellent (Tavakol and Dennick, 2011).

Variables	**Description**	**value**	**Internal consistency**
K	No. of items	156	**Excellent**
$\Sigma S^2 y$	Sum of item Variance	117.61	
S^2	Variance of total score	119.06	
α	Cronbach Alpha	**0.90**	

Table 10: Cronbach's Alpha value

Interpretation	
Cronbach Alpha	**Internal consistency**
0.90 & above	Excellent
0.80 - 0.89	Good
0.70 - 0.79	Acceptable
0.60 - 0.69	Questionable
0.50 - 0.59	Poor
Below 0.50	Unacceptable

Table 11: Benchmark value for Cronbach's Alpha

4.2.4 Significant Causal Relationships with Polarity

The author used mean value to get RII and only those drivers were considered whose RII was above 0.80 or have mean value 4<=m=<5 (Chong et al., 2017). The author used mean value instead of mode to get RII because all the questions in the survey are related to each other and not unique in nature (Boone and Boone, 2012). The author found 19 casual relationships, given below. The author used the following mean value formula.

$$\text{mean value} = \frac{(1 * \text{Low} + 3 * \text{Medium} + 5 * \text{High})}{\text{Number of Respondsents}} \qquad \textbf{Equation 4.3}$$

S. No	Impacting Factor	Impacted Factor	Mean	Polarity
1	Competitive Advantage	Collaboration with stakeholders	4.07813	Direct
2	Collaboration with stakeholders	Proper Scheduling	4.3125	Direct
3	Proper Scheduling	Simplify the needs	4.16406	Direct
4	Simplify the needs	Save Cost	4.25	Indirect
5	Save Cost	Competitive Advantage	4.28125	Direct
6	Collaboration with stakeholders	Integration of new ideas	4.25	Direct
7	Integration of new ideas	Competitive Advantage	4.84375	Direct
8	Collaboration with stakeholders	Right Information	4.8125	Direct
9	Right Information	Right Decision	4.0625	Direct
10	Right Decision	Competitive Advantage	4.21875	Direct
11	Collaboration with stakeholders	Complication	4.17188	Indirect
12	Complication	Labor	4.20313	Direct
13	Labor	Save cost	4.5	Direct
14	Save cost	Complication	4.59375	Direct
15	Complication	Reduce Wastage	4.23438	Direct
16	Reduce Wastage	Reinforcing process	4.54688	Direct
17	Reinforcing process	Save cost	4.53125	Direct
18	Complication	Feedback	4.8125	Direct
19	Feedback	Collaboration with stakeholders	4.19531	Direct

Table 12: Significant Interrelations having Mean Influence Value >= 4

4.2.5 Influence Matrix Diagram for CLD

The author developed the Influence matrix using the results of RII and Polarity. The author put the RII values above 0.80 as per the linkages between the drivers. The author put all the values first then analyzed the relationships between the drivers, using different secondary sources including relevant research articles. The author designed the Casual Loop Diagram with the help of this matrix, using Vensim software. The negative value in the matrix shows the indirect relation between the variables.

	D1	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D10**	**D11**	**D12**	**D13**
D1				0.82									
D2	0.86												0.92
D3		0.9											
D4						0.86	0.85			0.96			-0.83
D5		-0.85											
D6					0.83								
D7	0.97												
D8												0.91	
D9				0.84									
D10											0.81		
D11	0.84												
D12		0.91											
D13			0.84					0.96	0.96				

D1= Competitive Advantage, **D2**= Save Cost, **D3**= Avoid Extra Labor, **D4**= Collaboration b/w Stakeholders, **D5**= Simplify the Needs, **D6**= Proper Scheduling, **D7**= Integration of new Ideas, D**8**= Reduce Wastage, **D9**= Feedback, **D10**= Right Information, **D11**= Right Decision, **D12**= Reinforcing Process, **D13**= Complication

Figure 13: Influence Matrix for CLD

4.3. Causal Loop Diagram (CLD)

The author designed a causal loop diagram (CLD) with the help of interrelationships shown in influence matrix using VENSIM®. The CLD comprise on 4 reinforcing loops and 2 balancing loops. In fact, these loops were designed with the assistance of construction professionals who are working in this field for many years. This makes the loops reliable for future guidance. The author carefully designed the loops after analyzing the actual relationship between the drivers. The author found that all the drivers in the matrix have relationship. So, all the drivers were considered while making the loops. The detail of the loops is given below:

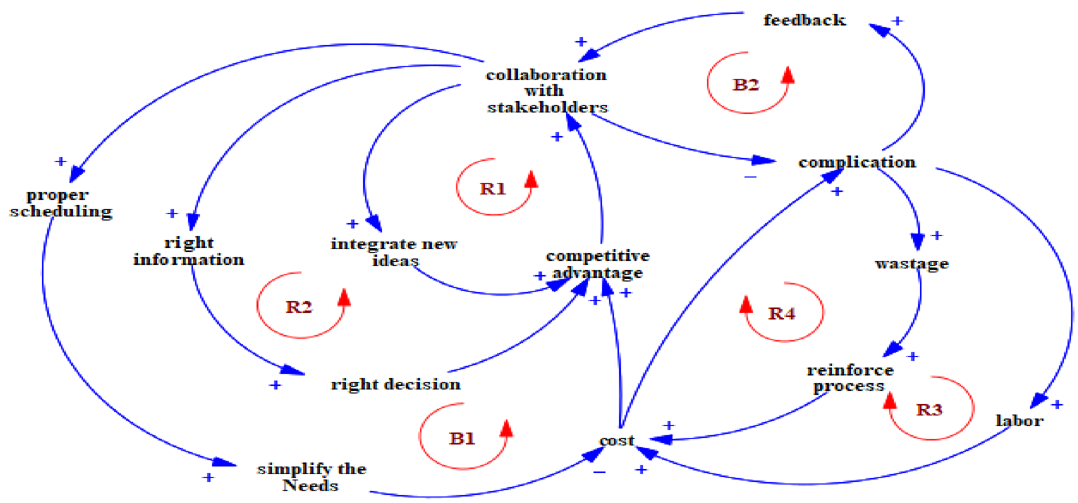


Figure 14: CLD for the drivers of SRS

4.3.1 Reinforcing Loop 1 (Enhance collaboration)

This loop shows the positive relationship between collaboration with stakeholders and integrate new ideas. It is obvious that when there is a collaboration between the stakeholders, working in the same project, having different experience and knowledge level, then they share knowledge and assist each other. Every stakeholder shares his or her own idea to deal with any issue or bring improvement as well as uniqueness in the working process that increase the overall competitive advantage for the construction company. Indeed, generation of new ideas is significant for continuous growth with excellency regardless of the business nature. It is another matter that to what extent the new idea would give strategic advantage to the company. However, construction companies could gain competitive advantage through new ideas that would help them in minimizing the cost, provide unique services, ensure high quality and enhance stakeholders' collaboration is shown in figure:

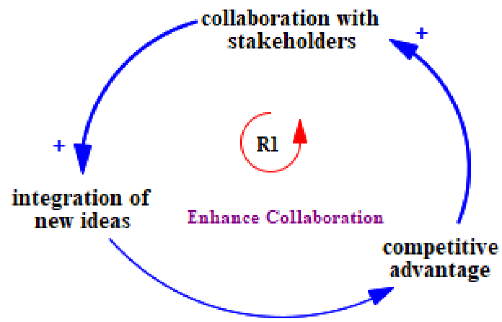


Figure 15: Reinforcing Loop 1 - Enhance Collaboration

4.3.2 Balancing Loop 1 (Cost Effective)

Collaboration with stakeholders is essential to do proper scheduling of the tasks, necessary to attain the targets and to complete the project. When the stakeholders engage with each other and communicate properly, making schedule become easier. Proper scheduling helps in simplify the needs to complete the projects. Simplification is necessary to avoid extra cost as it helps in avoiding misunderstandings between the stakeholders and it all depends on the proper scheduling like requirements of the labor, time, material, efforts, information, and assistance. Simplification of the needs ultimately helps in avoiding the extra cost that gives competitive advantage which eventually enhance the collaboration between stakeholders.

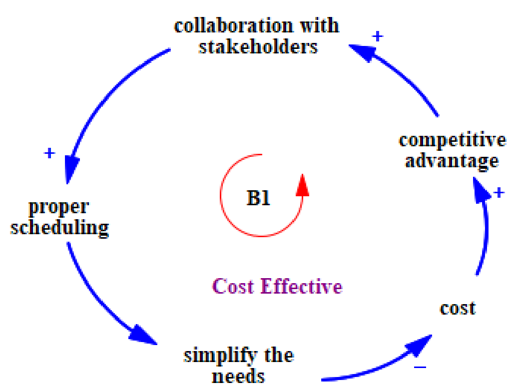


Figure 16: Balancing Loop 1 - Cost Effective

4.3.3 Reinforcing Loop 2 (Enhance Communication)

When the stakeholders engage and collaborate with each other, this generates a pool of information that must be managed effectively and efficiently. Here, the role of technologies that integrate and provide option to store valuable information of the stakeholders. Furthermore, communication tools to engage the stakeholders also helps in managing the valuable information. Indeed, the right information is necessary to make the right decisions. This information could be tacit or explicit in nature. The right relevant information helps in making the right decisions that dramatically, enhance the competitive advantage which increase the stakeholder collaboration. Indeed, the right decisions helps in delivering the quality sustainable constructed project.

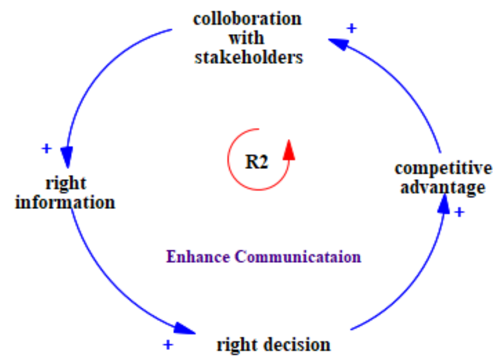


Figure 17: Reinforcing Loop 2 - Enhance Communication

4.3.4 Reinforcing Loop 3 (Resource Controlling)

Complications in constructions could happen due to any reason like improper scheduling, lack of collaboration between the stakeholders, lack of trust, lack of right information and wrong decisions. This ultimately delay projects that could results in extra labor requirement or extra working hours to achieve the task to complete the project within a timeframe. In fact, whether the complications require extra working hours or delay in the project by utilizing the preset labor numbers, it ultimately increases the cost.

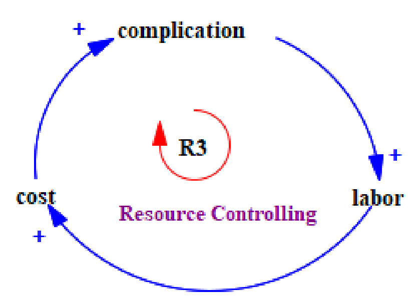


Figure 18: Reinforcing Loop 3 – Resource Controlling

4.3.5 Reinforcing Loop 4 (Wastage Creation)

Complications also generate construction wastage like redoing the work results in demolishing the previous construction that increases the construction wastage. The stakeholders need more material and other reinforcement to complete the project. Reinforced supplies and other assistance result in increase in the cost.

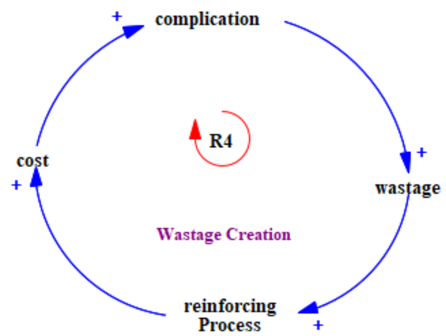


Figure 19: Reinforcing Loop 4 - Wastage Creation

4.3.6 Balancing Loop 2 (Enhance Project Performance)

Collaboration between the stakeholders brings several benefits as discussed in the reinforcing loops. It helps in minimizing the complications and this improves the overall performance of the construction processes. In fact, complications make the projects less competitive and sometimes results in failure of the projects. Feedbacks from the clients could be improved by reducing the complications

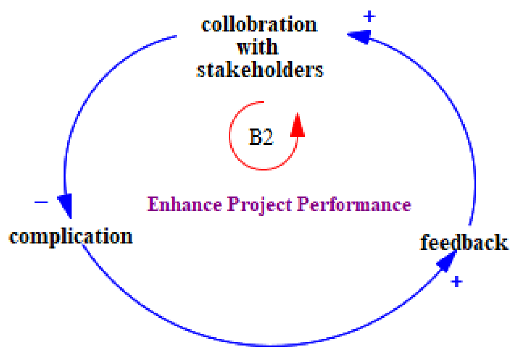


Figure 20: Balancing Loop 2 - Enhance Project Performance

4.4. Framework For the Implementation of Sustainable Rating System

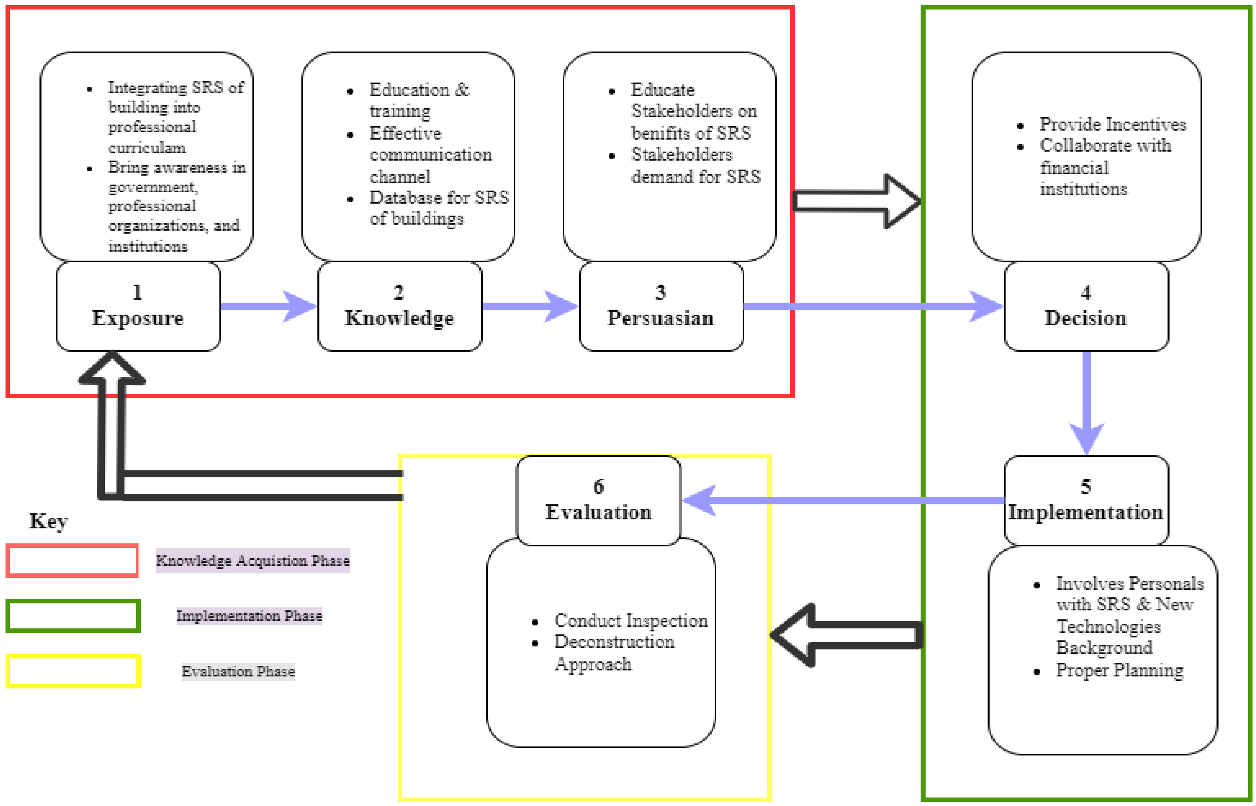


Figure 21: Proposed Framework for the implementation of SRS

The proposed implementation framework of SRS consists of three interconnected phases and six interconnected steps. The following are phases that have been detailed:

4.4.1 Knowledge acquisition phase

The knowledge acquisition phase comprises three steps, i.e., exposure, knowledge, and persuasion.

4.4.1.1 Exposure Step

In the construction industry, professional organizations and stakeholders should adopt SRS. These professional groups should collaborate with the Green Building Council (GBC) to educate their members on green building certification standards. Professional organizations and stakeholders can participate by incorporating their green building certification responsibilities into their code of ethics. Consequently, if they are incorporated into the code of ethics of professional organizations, members will be required to actively seek out information on how to implement this on construction projects. Including it in the curriculum is another method of exposure. Some professional organizations have collaborated with other institutions to educate their members on green building certification.

4.4.1.2 Knowledge Step

This step of the conceptual framework addresses questions such as "Where is information located?", "What is SRS?" and "How does it function?" More education is required regarding this SRS, how it can be utilized, and where to find reliable information. The professional bodies and stakeholders need more education and training about SRS. The training and education help to create ethical leadership among stakeholders, which helps to develop green behavior among stakeholders and employees and support the effective communication channel. To market green building accomplishments, websites and brochures must feature green building projects. The key to providing consistent and accurate information is the maintenance of an easily accessible database on green buildings linked to various professional bodies' websites. The system will ensure that stakeholders have accurate access to easily accessible information, which helps to promote enhanced collaboration among stakeholders.

4.4.1.3 Persuasion Step

To reduce the difficulties encountered by stakeholders in incorporating a green rating system into building construction, it was determined that educating stakeholders on the future benefits of green buildings and a sustainable rating system could facilitate the implementation of the concept despite its high initial cost (Opoku et al., 2019a). Simpeh and Smallwood (2015) concur that a lack of information regarding the total benefits sustainable practices can provide, especially in developing countries, was identified as a barrier to implementing sustainable practices. Experts gave this variable a high rating because it is conceivable that owners' knowledge of the sustainable building process could positively affect the initial designs agreed upon by project stakeholders. Wu et al. (2019) believed that educating and training stakeholders would facilitate their persuasion to implement a sustainable rating system in building construction.

When the benefits of having a building certified as meeting green building standards are readily apparent, individuals are persuaded to adopt it. If the benefits of using this certification system on a few green buildings are visible to potential adopters, then the SRS of the building can be appreciated by the building's stakeholders. Darko and Chan (2016) concur that clients and customers are unaware of the potential benefits of green building certification systems, it will be difficult for these individuals to demonstrate interest and, as a result, place demands on such certified buildings. Rapid urbanization in developing nations has created unprecedented opportunities to adopt sustainable building practices (SC). As a key driver of urbanization, property owners are crucial in persuading other stakeholders to adopt SC practices. However, the absence of owner demands, and requirements was regarded as the greatest barrier to implementing sustainable rating systems. Creating stakeholder demand for SRS would make it easier to persuade building owners and stakeholders to implement SRS in building construction for sustainable development.

4.4.2 Implementation phase

The implementation phase is comprised of the decision and implementation steps.

4.4.2.1 Decision Step

Subsidies are necessary to encourage the implementation of SRS in buildings. In building construction, the absence of SRS is frequently attributed to higher up-front costs, potential risks, and a lack of knowledge and training. To combat this, the government should exempt the purchase, installation, production, and construction of new green technologies from taxation to encourage stakeholders to adopt environmentally friendly practices. Additionally, loans, expedited permits, assistance with research and development, technical assistance, marketing assistance, and dedicated staff for green development in building and planning departments can accelerate the adoption of SRS in buildings. It can be helpful to access low-interest loans, grants, or other financial tools to bridge the cost gap between conventional buildings and certified green building projects.

4.4.2.2 Implementation Step

When a decision is made to adopt the SRS in building construction, there is a decision to put it in use. Involve personnel with SRS and technology backgrounds, which helps enhance the design process and encourage resource sharing. The experts concurred that stakeholders would face fewer obstacles if they collaborated with a team of the sustainable rating system and green building-trained experts. Such a team of experts could bring their peerless skills to the project and improve the reduction of rework and end up wasting while also providing exceptional recommendations regarding material selection, energy consumption, and the effectiveness of construction activities (Hwang et al., 2016).

Proper planning is essential to make the project successful, which reduces the rework and increases accountability, leading to reducing the wastage of materials and saving the project cost.

4.4.3 Evaluation phase

This phase consists of only one step called the evaluation step

4.4.3.1 Evaluation Step

Monitoring and evaluation are necessary to assess the project's conformance with the building's SRS requirements. It should be done by the GBC of their respective countries. Conduct inspection regularly by the approved bodies to reduce waste and ensure human health safety issues, ultimately reducing complications and saving project costs. If the building is not according to the standard of green certification and if it needs to be demolished, then deconstruction is the best approach to reduce wastage, save money and save materials.

Chapter 5

CONCLUSION AND RECOMMENDATION

5.1. Conclusion

In a nutshell, managing sustainability in construction is not a one-step process. Several aspects should be considered to ensure sustainable construction; even after using the Sustainable Rating System, an effective implementation plan must be followed. This study aimed to develop a framework for implementing the sustainable rating system in the construction industry, which leads to improved project performance in construction. System dynamic was used to reflect systems thinking and subsequently develop a framework to address the complexity resulting from managing the existing practices of resources. The framework, designed as a research outcome in this study, comprises several aspects that should be followed to ensure a reduction in complications and enhance collaboration.

Data were collected in two stages named preliminary survey and a detailed survey. A preliminary survey was carried out to shortlist significant drivers of the sustainable rating system, and a detailed survey was carried out to shortlist the most significant interrelationships between the drivers and their polarities. Expert opinions were also carried out to make the causal loop diagram meaningful.

The study started by identifying significant drivers of SRS from the literature. A total of 32 drivers of SRS were identified from the literature. A preliminary questionnaire was developed based upon these 32 significant drivers of SRS in which respondents were asked to rank significant drivers of SRS on a Likert scale ranging from 1 to 5. The normalized score for literature and respondents was developed for drivers of SRS and then merged using a 50/50 ratio. A total of 13 significant SRS drivers were shortlisted, with cumulative normalized scores ranging up to 50 per cent.

A detailed questionnaire was conducted from the respondents to rate the causal strength (low, medium, or high) and causal link (direct or indirect) of each contributing driver of the SRS on the other. This was done to develop systems thinking and causal loop diagrams (CLD). A causal loop diagram was created based on relationships with mean influence values of 4=m=5. In order to make the causal loop diagram intelligible and ensure its relevance to the building industry, it was changed based on the professional opinions of construction experts. Four reinforcing loops and two balancing loops make up the causal loop diagram. The framework was designed in accordance with these loops to show the flow of different aspects and factors to achieve the competitive advantage.

The author considered maximum possible factors that create complications in sustainable construction projects. Obviously, there could be several other factors and processes in construction, but the author mentioned the major ones that should be managed to ensure collaboration between the stakeholders.

5.2. Recommendations

i. The proposed framework could be extended further by analyzing and considering more drivers.
ii. The strategies and ways to implement the framework are limited that could be extended by investigating more relevant strategies. The future research could consider the factors, mentioned in other sustainable rating system like LEEDS.

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Appendices

Appendix 1: Preliminary Questionnaire

This questionnaire survey is a part of my MS thesis research titled ***"Developing a Framework for Implementation of Sustainable Rating System in the Building Construction Using Systems Thinking Approach"***. The main objective of this survey is to assess the perception of stakeholders about sustainable rating system in building construction. This survey will help us to shortlist the drivers od sustainable rating system and would also help in determining the importance, interconnectivity, and functionality of drivers using causal loop diagram in the research. The main part of this study relies on questionnaire survey.

Email * ____

Demographic Data

Please be assured that data will only be used for the study purpose and no personal information will be disclosed at any forum/level

Name * __________________________

Highest Academic Qualification *

- ☐ Bachelor
- ☐ B. Tech
- ☐ Masters
- ☐ Doctorate
- ☐ Other: ________________________

Your field of work *

- ☐ Architectural
- ☐ Building Design
- ☐ Infrastructure Management
- ☐ Construction Management
- ☐ Project Management
- ☐ Other:

Organization Type *

☐ Client

☐ Consultant

☐ Contractor

☐ Educational Institute

☐ Supplier

☐ Other: ____________________

Your country of working experience *

____

Please indicate your years of professional experience *

☐ 0-1

☐ 2-5

☐ 6-10

☐ 11-15

☐ 16-20

☐ 21 & above

Drivers influencing Stakeholder Perception on the Sustainable Rating System in the Building Construction

A total of 32 drivers have been identified from a thorough literature review

Rank the Possible drivers that influencing the stake holder Perception on the Sustainable Rating System in the Building Construction

1: Very Low 2: Low 3: Medium 4: High 5: Very High

Mark one per row *

S. No		Very Low	Low	Medium	High	Very High
1	Sustainable rating system provides a competitive advantage to the construction firm in terms of efficiency, performance, and pricing.	☐	☐	☐	☐	☐
2	Sustainable rating system helps in getting feedbacks from all the involved stakeholders with ease.	☐	☐	☐	☐	☐
3	Sustainable rating system helps the stakeholder to do proper scheduling of the task and the involved activities.	☐	☐	☐	☐	☐
4	Sustainable rating system is helpful in performing reinforcement by conducting performance evaluation of the involved stakeholders about the overall sustainable construction activities.	☐	☐	☐	☐	☐
5	Sustainable rating system is helpful in performing sustainable construction activities smoothly and efficiently that helps in avoid extra labor to complete the tasks.	☐	☐	☐	☐	☐
6	Sustainable rating system helps in reducing overall cost of the project in term of labor, material, scheduling and wastage.	☐	☐	☐	☐	☐
7	Stakeholders can take right decisions by using Sustainable Rating System.	☐	☐	☐	☐	☐
8	Stakeholders can avoid delays in completing the tasks by using a Sustainable rating system as it helps in scheduling the task perfectly.	☐	☐	☐	☐	☐
9	Sustainable rating systems develop a good communication level between the involved stakeholders that enhance collaboration between the stakeholders.	☐	☐	☐	☐	☐
10	Sustainable rating systems integrate overall functions of sustainable constructions that provide uniformity in the operation.	☐	☐	☐	☐	☐
11	Sustainable rating system simplifies the needs of all stakeholders and make it easier to carry out the sustainable construction operations.	☐	☐	☐	☐	☐
12	Sustainable rating system reduces the overall efforts of every stakeholder that speeds up the whole sustainable construction process.	☐	☐	☐	☐	☐
13	Complications come when collaboration and integration do not exist, and this issue is resolved by the Sustainable rating system.	☐	☐	☐	☐	☐
14	Sustainable rating system provides right information to every stakeholder on time.	☐	☐	☐	☐	☐
15	Collaboration and integration due to the use of Sustainable rating system makes easier for stakeholders to predict estimates of the cost, time, and efforts.	☐	☐	☐	☐	☐

16	Performance reporting about the stakeholders has become easier due to the Sustainable rating system in the construction field.	☐	☐	☐	☐	☐
17	Continuous support to the stakeholders at every stage is easy in a Sustainable rating system.	☐	☐	☐	☐	☐
18	Integrate of new ideas during the construction phases becomes easier for the stakeholders due to the Sustainable rating system.	☐	☐	☐	☐	☐
19	Performance evaluation of the overall construction project becomes easier by using the Sustainable rating system.	☐	☐	☐	☐	☐
20	Wastage could be avoided easily by using Sustainable rating system.	☐	☐	☐	☐	☐
21	Sustainable rating System ensures trust in safety.	☐	☐	☐	☐	☐
22	Credibility of process could be enhanced by using Sustainable Rating System.	☐	☐	☐	☐	☐
23	Sustainable Rating System helps in energy audit of buildings.	☐	☐	☐	☐	☐
24	Sustainable Rating System helps in enhancing productivity of occupants.	☐	☐	☐	☐	☐
25	Sustainable Rating System helps in maintaining indoor environment quality.	☐	☐	☐	☐	☐
26	Elimination of toxic material could become easier by using Sustainable Rating System.	☐	☐	☐	☐	☐
27	Protection of nature become easier by using Sustainable Rating System.	☐	☐	☐	☐	☐
28	We could create awareness about global warming by practicing Sustainable Rating System.	☐	☐	☐	☐	☐
29	Sustainable Rating System provides comforts, health, and wellbeing to occupants.	☐	☐	☐	☐	☐
30	Outdoor environmental quality could be improved by using Sustainable Rating System.	☐	☐	☐	☐	☐
31	Maintenance cost could be decreased by using Sustainable Rating System.	☐	☐	☐	☐	☐
32	Water conservation could be ensured by using Sustainable Rating System.	☐	☐	☐	☐	☐

Any other driver in your opinion not mentioned in the list above *

____

Thanks for the participation

Appendix 2: Detailed Questionnaire

This questionnaire survey is a part of my MS thesis research titled ***"Developing a Framework for Implementation of Sustainable Rating System in the Building Construction Using Systems Thinking Approach"***. The main objective of this survey is to determine the level of influence (causal strength) and relationship (polarity) among drivers of sustainable rating system which helps us in developing of influence matrix diagram and system thinking/causal loop diagram.

Email *

____

Demographic Data

Please be assured that data will only be used for the study purpose and no personal information will be disclosed at any forum/level

Name *

____

Highest Academic Qualification *

- ☐ Bachelor
- ☐ B. Tech
- ☐ Masters
- ☐ Doctorate
- ☐ Other: ____________________

Your field of work *

- ☐ Architectural
- ☐ Building Design
- ☐ Infrastructure Management
- ☐ Construction Management
- ☐ Project Management
- ☐ Other:

Organization Type *

☐ Client

☐ Consultant

☐ Contractor

☐ Sub-Contractor

☐ Academia

☐ Supplier

☐ Other: ____________________

Organization name *

____

Your country of working experience *

____

Please indicate your years of professional experience *

☐ 0-1

☐ 2-5

☐ 6-10

☐ 11-15

☐ 16-20

☐ 21 & above

Introduction to Sustainable Rating System

A sustainable rating system is basically a reference tool that assesses a building's performance and its impact on the environment. It includes a stipulated set of criteria that pertain to the design, construction, and operations of green buildings.

Drivers influencing Stakeholder perception on the Sustainable rating System In Building Construction

A total of 32 drivers of sustainable rating system have been identified from a thorough literature review that help to understand the role of the Sustainable Rating System in the construction field. After a preliminary survey 13 drivers of sustainable rating system have been shortlisted.

Purpose: This questionnaire survey will help to understand the relationship among the drivers of sustainable rating systems

Methodology: The relationship / interconnectivity between the 13 sustainable rating system will be observed through which causal loop diagram will be developed to address complexity in terms of implementation of sustainable rating system.

***Note*:** Please check two boxes per row. One from Low/Medium/High for severity and one from Direct/Indirect Polarity of relationship.

To What extent the "Competitive Advantage" influence over the following sustainable rating system and what is the polarity of this relationship? *

	Low	Medium	High	Direct Relation	Indirect Relation
Save Cost	☐	☐	☐	☐	☐
Avoid Extra Labor	☐	☐	☐	☐	☐
Collaboration between Stakeholders	☐	☐	☐	☐	☐
Simplify the Needs	☐	☐	☐	☐	☐
Proper Scheduling	☐	☐	☐	☐	☐
Integration of new Ideas	☐	☐	☐	☐	☐
Wastage	☐	☐	☐	☐	☐
Feedback	☐	☐	☐	☐	☐
Right Information	☐	☐	☐	☐	☐
Right Decision	☐	☐	☐	☐	☐
Reinforcing Process	☐	☐	☐	☐	☐
Complications	☐	☐	☐	☐	☐

To What extent the "Save Project Cost" influence over the following sustainable rating system and what is the polarity of this relationship? *

	Low	Medium	High	Direct Relation	Indirect Relation
Competitive Advantage	☐	☐	☐	☐	☐
Avoid Extra Labor	☐	☐	☐	☐	☐
Collaboration between Stakeholders	☐	☐	☐	☐	☐
Simplify the Needs	☐	☐	☐	☐	☐
Proper Scheduling	☐	☐	☐	☐	☐
Integration of new Ideas	☐	☐	☐	☐	☐
Wastage	☐	☐	☐	☐	☐
Feedback	☐	☐	☐	☐	☐
Right Information	☐	☐	☐	☐	☐
Right Decision	☐	☐	☐	☐	☐
Reinforcing Process	☐	☐	☐	☐	☐
Complications	☐	☐	☐	☐	☐

To What extent the "Avoid extra Labor" influence over the following sustainable rating system and what is the polarity of this relationship? *

	Low	Medium	High	Direct Relation	Indirect Relation
Competitive Advantage	☐	☐	☐	☐	☐
Save Cost	☐	☐	☐	☐	☐
Collaboration between Stakeholders	☐	☐	☐	☐	☐
Simplify the Needs	☐	☐	☐	☐	☐
Proper Scheduling	☐	☐	☐	☐	☐
Integration of new Ideas	☐	☐	☐	☐	☐
Wastage	☐	☐	☐	☐	☐
Feedback	☐	☐	☐	☐	☐
Right Information	☐	☐	☐	☐	☐
Right Decision	☐	☐	☐	☐	☐
Reinforcing Process	☐	☐	☐	☐	☐
Complications	☐	☐	☐	☐	☐

To What extent the "Collaboration between Stakeholders" influence over the following sustainable rating system and what is the polarity of this relationship? *

	Low	Medium	High	Direct Relation	Indirect Relation
Competitive Advantage	☐	☐	☐	☐	☐
Save Cost	☐	☐	☐	☐	☐
Avoid Extra Labor	☐	☐	☐	☐	☐
Simplify the Needs	☐	☐	☐	☐	☐
Proper Scheduling	☐	☐	☐	☐	☐
Integration of new Ideas	☐	☐	☐	☐	☐
Wastage	☐	☐	☐	☐	☐
Feedback	☐	☐	☐	☐	☐
Right Information	☐	☐	☐	☐	☐
Right Decision	☐	☐	☐	☐	☐
Reinforcing Process	☐	☐	☐	☐	☐
Complications	☐	☐	☐	☐	☐

To What extent the "Simplify the Needs" influence over the following sustainable rating system and what is the polarity of this relationship? *

	Low	Medium	High	Direct Relation	Indirect Relation
Competitive Advantage	☐	☐	☐	☐	☐
Save Cost	☐	☐	☐	☐	☐
Avoid Extra Labor	☐	☐	☐	☐	☐
Collaboration between stakeholders	☐	☐	☐	☐	☐
Proper Scheduling	☐	☐	☐	☐	☐
Integration of new Ideas	☐	☐	☐	☐	☐
Wastage	☐	☐	☐	☐	☐
Feedback	☐	☐	☐	☐	☐
Right Information	☐	☐	☐	☐	☐
Right Decision	☐	☐	☐	☐	☐
Reinforcing Process	☐	☐	☐	☐	☐
Complications	☐	☐	☐	☐	☐

To What extent the "Proper Scheduling" influence over the following sustainable rating system and what is the polarity of this relationship? *

	Low	Medium	High	Direct Relation	Indirect Relation
Competitive Advantage	☐	☐	☐	☐	☐
Save Cost	☐	☐	☐	☐	☐
Avoid Extra Labor	☐	☐	☐	☐	☐
Collaboration between stakeholders	☐	☐	☐	☐	☐
Simplify the Needs	☐	☐	☐	☐	☐
Integration of new Ideas	☐	☐	☐	☐	☐
Wastage	☐	☐	☐	☐	☐
Feedback	☐	☐	☐	☐	☐
Right Information	☐	☐	☐	☐	☐
Right Decision	☐	☐	☐	☐	☐
Reinforcing Process	☐	☐	☐	☐	☐
Complications	☐	☐	☐	☐	☐

To What extent the "Integration of new Ideas" influence over the following sustainable rating system and what is the polarity of this relationship? *

	Low	Medium	High	Direct Relation	Indirect Relation
Competitive Advantage	☐	☐	☐	☐	☐
Save Cost	☐	☐	☐	☐	☐
Avoid Extra Labor	☐	☐	☐	☐	☐
Collaboration between stakeholders	☐	☐	☐	☐	☐
Simplify the Needs	☐	☐	☐	☐	☐
Proper Scheduling	☐	☐	☐	☐	☐
Wastage	☐	☐	☐	☐	☐
Feedback	☐	☐	☐	☐	☐
Right Information	☐	☐	☐	☐	☐
Right Decision	☐	☐	☐	☐	☐
Reinforcing Process	☐	☐	☐	☐	☐
Complications	☐	☐	☐	☐	☐

To What extent the “Reduce wastages” influence over the following sustainable rating system and what is the polarity of this relationship? *

	Low	Medium	High	Direct Relation	Indirect Relation
Competitive Advantage	☐	☐	☐	☐	☐
Save Cost	☐	☐	☐	☐	☐
Avoid Extra Labor	☐	☐	☐	☐	☐
Collaboration between stakeholders	☐	☐	☐	☐	☐
Simplify the Needs	☐	☐	☐	☐	☐
Proper Scheduling	☐	☐	☐	☐	☐
Integration of new Ideas	☐	☐	☐	☐	☐
Feedback	☐	☐	☐	☐	☐
Right Information	☐	☐	☐	☐	☐
Right Decision	☐	☐	☐	☐	☐
Reinforcing Process	☐	☐	☐	☐	☐
Complications	☐	☐	☐	☐	☐

To What extent the “Feedback” influence over the following sustainable rating system and what is the polarity of this relationship? *

	Low	Medium	High	Direct Relation	Indirect Relation
Competitive Advantage	☐	☐	☐	☐	☐
Save Cost	☐	☐	☐	☐	☐
Avoid Extra Labor	☐	☐	☐	☐	☐
Collaboration between stakeholders	☐	☐	☐	☐	☐
Simplify the Needs	☐	☐	☐	☐	☐
Proper Scheduling	☐	☐	☐	☐	☐
Integration of new Ideas	☐	☐	☐	☐	☐
Wastage	☐	☐	☐	☐	☐
Right Information	☐	☐	☐	☐	☐
Right Decision	☐	☐	☐	☐	☐
Reinforcing Process	☐	☐	☐	☐	☐
Complications	☐	☐	☐	☐	☐

To What extent the "Right Information" influence over the following sustainable rating system and what is the polarity of this relationship? *

	Low	Medium	High	Direct Relation	Indirect Relation
Competitive Advantage	☐	☐	☐	☐	☐
Save Cost	☐	☐	☐	☐	☐
Avoid Extra Labor	☐	☐	☐	☐	☐
Collaboration between stakeholders	☐	☐	☐	☐	☐
Simplify the Needs	☐	☐	☐	☐	☐
Proper Scheduling	☐	☐	☐	☐	☐
Integration of new Ideas	☐	☐	☐	☐	☐
Wastage	☐	☐	☐	☐	☐
Feedback	☐	☐	☐	☐	☐
Right Decision	☐	☐	☐	☐	☐
Reinforcing Process	☐	☐	☐	☐	☐
Complications	☐	☐	☐	☐	☐

To What extent the “Right Decision” influence over the following sustainable rating system and what is the polarity of this relationship? *

	Low	Medium	High	Direct Relation	Indirect Relation
Competitive Advantage	☐	☐	☐	☐	☐
Save Cost	☐	☐	☐	☐	☐
Avoid Extra Labor	☐	☐	☐	☐	☐
Collaboration between stakeholders	☐	☐	☐	☐	☐
Simplify the Needs	☐	☐	☐	☐	☐
Proper Scheduling	☐	☐	☐	☐	☐
Integration of new Ideas	☐	☐	☐	☐	☐
Wastage	☐	☐	☐	☐	☐
Feedback	☐	☐	☐	☐	☐
Right Information	☐	☐	☐	☐	☐
Reinforcing Process	☐	☐	☐	☐	☐
Complications	☐	☐	☐	☐	☐

To What extent the "Reinforce Process" influence over the following sustainable rating system and what is the polarity of this relationship? *

	Low	Medium	High	Direct Relation	Indirect Relation
Competitive Advantage	☐	☐	☐	☐	☐
Save Cost	☐	☐	☐	☐	☐
Avoid Extra Labor	☐	☐	☐	☐	☐
Collaboration between stakeholders	☐	☐	☐	☐	☐
Simplify the Needs	☐	☐	☐	☐	☐
Proper Scheduling	☐	☐	☐	☐	☐
Integration of new Ideas	☐	☐	☐	☐	☐
Wastage	☐	☐	☐	☐	☐
Feedback	☐	☐	☐	☐	☐
Right Information	☐	☐	☐	☐	☐
Right Decision	☐	☐	☐	☐	☐
Complications	☐	☐	☐	☐	☐

To What extent the "Complications" influence over the following sustainable rating system and what is the polarity of this relationship? *

	Low	Medium	High	Direct Relation	Indirect Relation
Competitive Advantage	☐	☐	☐	☐	☐
Save Cost	☐	☐	☐	☐	☐
Avoid Extra Labor	☐	☐	☐	☐	☐
Collaboration between stakeholders	☐	☐	☐	☐	☐
Simplify the Needs	☐	☐	☐	☐	☐
Proper Scheduling	☐	☐	☐	☐	☐
Integration of new Ideas	☐	☐	☐	☐	☐
Wastage	☐	☐	☐	☐	☐
Feedback	☐	☐	☐	☐	☐
Right Information	☐	☐	☐	☐	☐
Right Decision	☐	☐	☐	☐	☐
Reinforce Process	☐	☐	☐	☐	☐

Thanks For Your participation