

**STAKEHOLDERS ASSESSMENT FOR A
RESIDENTIAL CONSTRUCTION USING SOCIAL
LIFE CYCLE ASSESSMENT APPROACH: A CASE
STUDY OF MUZAFFARABAD, AJK**



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

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in

Urban and Regional Planning

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Thesis titled

**STAKEHOLDERS ASSESSMENT FOR A RESIDENTIAL
CONSTRUCTION USING SOCIAL LIFE CYCLE ASSESSMENT
APPROACH: A CASE STUDY OF MUZAFFARABAD, AJK**

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has been accepted towards the partial fulfillment

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(Hamza Muzaffar)

TABLE OF CONTENTS

TABLE OF CONTENTS.....	v
LIST OF ABBREVIATIONS AND TERMS.....	viii
LIST OF FIGURES	ix
LIST OF TABLES	x
ABSTRACT.....	1
Chapter 1	3
INTRODUCTION	3
1.1 BACKGROUND OF RESEARCH	3
1.2 SOCIAL LIFE CYCLE ASSESSMENT	5
1.3 IMPORTANCE OF UTILIZING SLCA	8
1.4 AIM AND OBJECTIVE OF STUDY	11
1.5 RESEARCH QUESTION.....	12
1.6 SIGNIFICANCE AND RATIONALE OF STUDY.....	13
1.7 STRUCTURE OF STUDY	13
Chapter 2.....	14
LITERATURE REVIEW	14
2.1 INSTRIDUCTION.....	14
2.2 LITERATURE REVIEW	14
2.2.1 Concept of SLCA	14
2.2 SOCIAL LIFE CYCLE ASSESMENT	16
2.3 DIMENSIONS/STAKEHOLDERS	20
2.4 CREATING A SUSTAINABLE FUTURE USING A “LIFE CYCLE ANALYSIS”	24
2.5 BENEFITS OF USING SLCA FOR CONDUCTING STAKEHOLDER ASSESSMENT.....	26
2.6 SUMMARY.....	27

Chapter 3.....	29
METHODOLOGY	29
3.1 INTRODUCTION	29
3.2 RESEARCH METHOD.....	29
3.3 RESEARCH PHILOSOPHY	30
3.4 RESEARCH APPROACH	30
3.5 DATA COLLECTION METHODS	31
3.6 POPULATION AND SAMPLING STRATEGY	31
3.7 DATA ANALYSIS.....	32
3.8 DATA COLLECTION TOOL.....	32
3.9 RESEARCH DESIGN	33
3.10 ETHICAL CONSIDERATION	33
3.11 LIMITATION AND POSSIBLE INNOVATIONS	34
Chapter 4.....	35
WORKERS SOCIAL DEVELOPMENT INDEX.....	35
4.1 INTRODUCTION	35
4.2 THE CONCEPT OF SLCA AND SDI.....	38
4.3 METHODOLOGY	42
4.3.1 Study Area Selection	42
4.3.2 Sampling and Data Collection.....	43
4.3.3 Index Construction and Data Analysis	45
4.4 RESULTS AND DISCUSSION	46
4.4.1 Health and Safety.....	48
4.4.2 Fair Working Conditions	49
4.4.3 Extreme Weather Condition/Heat Wave	50

Chapter 5.....	53
SOCIAL LIFE CYCLE ASSESSMENT OF RESIDENTIAL CONSTRUCTION FROM RESIDENTS PERSPECTIVE.....	53
5.1 INTRODUCTION	53
5.2 THE CONCEPT OF SLCA	55
5.3 METHODOLOGY	60
5.3.1 Study Area Selection	60
5.3.2 Sampling and Data Collection.....	61
5.3.3 Index Construction and Data Analysis	65
5.4 RESULTS AND DISCUSSION.....	66
5.4.1 WORKERS.....	67
5.4.1.1 Health and Safety.....	67
5.4.1.2 Fair Working Conditions	68
5.4.1.3 Extreme Weather Condition/Heat Wave	69
5.4.1.3 Risk Perception.....	69
5.4.2 LOCAL COMMUNITY	70
5.4.3 CONSUMERS.....	71
5.4.4 VALUE CHAIN ACTORS	72
Chapter 6.....	73
CONCLUSION.....	73
ANNEXURE	

LIST OF ABBREVIATIONS AND TERMS

BIM	Building Information Modelling
DLCA	Dynamic Life Cycle Assessment
ESL	Estimated Service Life
GHG	Green House Gas
ILCA	Industry Life Cycle Assessment
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
LCI	Life Cycle Inventory
SLCA	Social Life Cycle Assessment
SETAC	Society of Environmental Toxicology and Chemistry
SLCIA	Social Life Cycle Impact Assessment
SMoC	Social-impact Model of Construction
SHDB	Social Hotspot Database
TBL	Triple Bottom Line
UN	United Nations

LIST OF FIGURES

Chapter 2

Figure 2. 1 Four steps of Life Cycle Assessment.....	16
Figure 2. 2 Typical Life Cycle of a Product	18
Figure 2. 3 Annual Publication on SLCA (2010-2021).....	20
Figure 2. 4 Dimensions/Stakeholders for SLCA	21

Chapter 4

Figure 4. 1 Dimensions of SDI	40
Figure 4. 2 A Map of Muzaffarabad	42
Figure 4. 3 A Methodological Framework for development of Workers SDI.....	44
Figure 4. 4 SDI Value vs. Health & Safety factors.....	48
Figure 4. 5 SDI Value vs. Fair Working Condition factors	49
Figure 4. 6 SDI Value vs. Extreme Condition/Heat wave factors	50
Figure 4. 7 Social Development Index	51

Chapter 5

Figure 5. 1 Typical Hierarchy of SLCA	58
Figure 5. 2 A Map of Muzaffarabad	60
Figure 5. 3 Methodological Framework	62
Figure 5. 4 Results of Health & Safety Indicators in Percentage	67
Figure 5. 5 Results of Fair Working Conditions Indicators in Percentage	68
Figure 5. 6 Results of Extreme Weather Conditions Indicators in Percentage.....	69
Figure 5. 7 Results of Risk Perception Indicators in Percentage.....	69
Figure 5. 8 Results of Local Community Indicators of in Percentage.....	70
Figure 5. 9 Results of Consumers Indicators of in Percentage	71
Figure 5. 10 Results of Value Chain Actors Indicators of in Percentage	72
Figure 5. 11 Social Life Cycle Assessment	73

LIST OF TABLES

Chapter 4

Table 4. 1 Indicators for Workers Health & Safety, Fair Working Condition, Extreme Heat Wave.....	45
Table 4. 2 Workers Socio-Economic Profile	47

Chapter 5

Table 5. 1 Indicators for Workers	63
Table 5. 2 Indicators for Local Community.....	63
Table 5. 3 Indicators for Consumers.....	64
Table 5.4 Indicators for Value Chain Actors	64
Table 5.5 Indicators for Consumers.....	64
Table 5.6 Indicators for Value Chain Actors	64
Table 5.6 Residents Socio Economic Profile.....	66

ABSTRACT

Social Life Cycle Assessment (SLCA) is a method for evaluating the social impacts of a product or process. It aims to identify and assess the positive and negative impacts of a project on various stakeholder groups, including workers, local communities, consumers, and value chain actors. The research aims to assess and evaluate results obtained from the survey of workers and residents who are directly involved in the whole construction process. Social Development Index (SDI) was developed which measures the social well-being of society by observing the social and environmental aspects. The research aimed to identify the influence of social life cycle assessment focusing on its critical stakeholder 'Workers' during construction activities followed in Pakistan. From the results obtained through the survey, it can be concluded that Social Development Index is low in certain aspects and high in some. Workers claimed that safety equipment is not used by them in organizations and construction activities because they are not provided with those basic lifesaving health and safety equipment's. Due to this reason, the risk of health and safety problems is high. Additionally, the workers claimed that they do not use safety gloves, helmets, and other safety equipment while carrying out their construction activities. Due to this reason, organizations face issues in carrying out their responsibilities proactively. When it comes to fair working conditions and extreme weather conditions situation is relatively better, mainly due to the culture of the country labors are usually hard workers, willing to work in any extreme conditions. This method can help construction professionals to make informed decisions about the social impact of their projects and to prioritize initiatives that will contribute to a more sustainable future. Also from residents perspective it was seen that workers were the key and most critical stakeholders as their safety during construction activity come first. It was seen that construction material supplier relation with consumers was much better although when it comes to the local community the constructed house residents don't bother much about formal ethics. SLCA was done on the results of these results. Although SLCA is in its emerging phase and much research and analysis needs to be done to make a criterion that is universally accepted.

Keywords: Social Life Cycle Assessment (SLCA); Life Cycle Assessment; Stakeholders assessment; Social Sustainability; Social Development Index (SDI); Worker Development Index; Extreme Working Conditions

INTRODUCTION

The first section of the study is concerned with the ‘introduction’ where it highlights the interest, scope, motivation and rationale behind undertaking the study. The major focus that is specifically made in the first chapter is regarding the explanation of social life cycle assessment (SLCA). The aim and objective of the study are also defined in the section that can provide the main purpose to the readers. Lastly, the structure of the study is also defined in this section where the information for each chapter is provided. Hence, this chapter provides the fundamental aim and scope of conducting the entire research.

1.1 Background of the research

The contemporary level of environmental degradation along with the noticeable climate change has led to the importance for sustainable development through the globe. The social impact on the globalized economic structure is emerging through different methods. The common example of the social factors includes the child labor, poor working environment condition, unfair wages, and unfavorable living condition along with other social factors (Lobsiger-Kägi et al., 2018; Herrera Almanza and Corona, 2020). Due to consequence on the social aspects, the debates on sustainable developments and social aspects is drastically increasing by the scholars especially the need for measuring and comparing sustainability performance. In this regard, it has led to the development of life cycle assessment (LCA) approach that was developed and proven to be important. The LCA was further evolved where the environmental factor was integrated which was used for assessing the environmental impact on the product or service (Janjua, Sarker and Biswas, 2019; Hoque et al., 2019).

With the increasing issues on social aspects, it has led to the importance and need to integrate the LCA with the social aspects which caused the emergence of social life cycle assessment which was developed in the 1990s. There is a significant increase on the social impacts of the products along with promoting sustainability

(Petti, Serreli and Di Cesare, 2018). Similarly, the studies of Lobsiger-Kägi et al. (2018); Grubert (2018) has indicated that the integration of social and socio-economic aspects within the LCA were made in the early 1990s that led to an emergence of a new methodology which focused on addressing the social dimension within the sustainability and deal with the variety of social issues which reflects to population growth, poverty, income inequality and others. The basic purpose of SLCA is to present with the information on the social issues for decision making and further helping in informing the suggestions for improvement. The SLCA is not a widely recognized tool as LCA but its approach is gaining significant interview that can be reflected to the number of academic researches and case studies. The first attempt for using the framework was published in 2019 by the United Nations Environment Program /Society and has presented with the extensive guidelines for Social Life Cycle Assessment.

In respect to the construction industry, the research undertaken by Rani et al. (2022) has highlighted that there are several social and environmental issues that are involved within its lifecycle of the business. The initial operations of residential properties leads to concern on the work environment as is characterized to be dangerous and hazardous where much work-related death occurs in the industry. In an assessment by previous studies, it was reported that 73% of the construction employees has the belief that the employer does not have much concern for their mental health. Therefore, the mental health issues exist among the employees of construction industry where the workers receive little help to their mental health. Moreover, the study of Tijani, Osei-Kyei and Feng (2020) has demonstrated that social issues are commonly observed among the workers which include depression, anxiety and strategy. It is vital that the employers not only focuses on the physical aspects but also on the psychological elements such as securing workplaces can help in assisting workers while also providing a good work-life balance. Therefore, it is critical to assess the stakeholders of the residential property through using effective framework such as SLCA that can support in determining the social issues that are faced in the company.

1.2 Social Life Cycle Assessment

In the contemporary environment, there are different methods and techniques that are being developed or developing to evaluate the social and sociological aspects of product, service or others. The discussion and debates has drastically increased on the social and sociological aspects since 29 years ago where the publication made by the Society of Environment Toxicology and Chemistry (SETAC) in the period 1993 has drastically added to the importance of addressing social aspects (Mebane et al., 2020). On this regard, SLCA has become a significant area for undertaking research that can contribute to its effectiveness for measuring the social aspects (Martucci et al., 2019). Before proceeding with explaining the concept of SLCA, it is critical to discuss the LCA where the factor of social was later integrated in the assessment. According to the study undertaken by Lu et al. (2021), LCA is method that is specifically used for evaluating the environmental impact among the products based on the lifecycle. In most of the cases, LCA is utilized for evaluating the environment impact assessment of the business in respect to the energy and carbon emission. Therefore, several studies have adopted the measures of LCA in respect to reducing the environmental impact of buildings and other aspects. However, the major issue with the LCA is that it only concentrated on the environmental factors based on the life cycle of the product. With the increasing debate on social aspects and a framework for measuring social elements, it has led to the evolving of the LCA by integrating the social factor. This has led to the introduction of SLCA which is method and technique for evaluating the social and socio-economic aspects of the products in respect to its positive and negative impact throughout its life cycle which is from the extraction of raw material, manufacturing, distribution, use, reuse, maintenance, recycling and financial disclosure (Pollok et al., 2021). In general terms, the SLCA is mainly focusing on the assessment of the people's life-cycle activities by incorporating the social side of the sustainability among the LCA methodology.

In order to achieve sustainable development, the environment, the economy, and society must all work together. Tools such as ELCA and LCC came into being as a result of an increased focus on the environmental impact of individual products

(Pagnon et al., 2020). These models may investigate the repercussions a product has on the environment and the economy from its beginning to its end of life. Despite this, the social aspect of sustainable development gets a very little amount of attention, which is problematic given the absence of social performance measurements. At the moment, SLCA is still in its infant stages of development. The Guidelines for Social Life Cycle Assessment of Products define social life cycle assessment (Vilaboa Diaz et al., 2022), or SLCA, as a social impact assessment technique that aims to assess the social and socioeconomic aspects of products as well as their potential positive and negative impacts along their life cycle. This life cycle includes the extraction and processing of raw materials, manufacturing, distribution, use, re-use, maintenance, recycling, and final disposal of the product. SLCA assesses a product's environmental effect.

The SLCA is a descendant of the ELCA and maintains the ELCA's four-phase framework (ISO 2006a, b): defining the aim and scope of the analysis, inventory analysis, conducting an impact assessment, and drawing conclusions from the results (da Silva et al., 2021). The initial phase of an SLCA research is determining the functional unit, as well as the aim, the audience, and the system boundary. The second part of inventory analysis consists of data collection, the building of SLCA models, and the outcomes of LCI. The findings of the life cycle impact assessment are then broken down into many subcategories of effect indicators (SLCIA). The next step is to assess the findings of the LCI and SLCIA tests and search for hotspots. The Guidelines provide an explanation of research standards (Wang and Sinha, 2021). These stages involve general research as well as S-four Life Cycle Assessments. Since case studies that contain methodological debates have the potential to improve SLCA understanding and practical application, including them as one of the general research criteria ought to be a priority.

Numerous stakeholders attach a great deal of importance to the building life cycle, particularly those working in the construction industry. Construction projects must take into consideration issues of public health and safety, as well as noise pollution and cultural heritage. Particularly in Hong Kong, which has a high population density as well as a high construction intensity (Almeirida et al., 2020), it is essential to

investigate the social repercussions of the expansion of the building industry. In order to assist construction employees in better comprehending the social effect of the projects they work on, this research presents a case study of SLCA. A tool for SLCA modelling, the Social-impact Model of Construction (SMoC) is used in the building construction industry in Hong Kong. This is the more important piece of news. The model was developed using responses to a survey as well as data collected at the national level (Najjar et al., 2022). A social impact assessment of a proposed residential development in Hong Kong may be carried out with the help of SMoC. This locates the various hotspots. The findings of this study should be taken into consideration in any future SLCA research.

During the last 10 years, there has been an increase in the usage of SLCA, a method that could be helpful. Among the industries that are being investigated are those pertaining to electronics, food, waste treatment, tourism, building materials, and biofuel. The Social Hotspots Database (SHDB) was established the same year, in 2009. This compilation has 150 different social indicators that span 22 different topics (Backes et al., 2022). Because SLCA is still in its developmental stages as a method, both LCI and SLCIA contain problems that have not yet been overcome. Case studies illuminate a variety of approaches to the data collecting process. In order to gather data on the whole life cycle chain of building materials, a research team conducted interviews with industry professionals. The SLCA grading system was developed using the information obtained from the interviews (Ersan et al., 2022). In one of the studies, an SLCA model was created, however national data rather than project data were used, and no project data were collected. It is possible for you to request both national and project data in many different scenarios; however, you will need to mix them in an inventive manner.

LCI presents a number of challenges, one of which is the quantification of data, or how to link data to a functional unit. This is an important component of the LCI. A research contrasted two different methodologies: type 1, which weighted the findings of the SLCIA by semi-quantity, and type 2 (Ingrao et al., 2018), which formed a quantitative relationship between the inventory indicator and the functional unit. The study was conducted in the United Kingdom. They came to the conclusion that type

1 links are the most realistic, despite the fact that they do not portray the societal costs associated with a certain quantity of a commodity. This research employs a hybrid quantitative and semi-quantitative methodology (Asdrubali and Grazieschi, 2020). There is no one method that is universally accepted for classifying effects into categories and evaluating indicators in SLCIA (Jrgensen et al. 2008). The SLCIA Guidelines provide a top-down method with a total of 31 subcategories and five different stakeholders. In a different piece of research, the method for discovering indicators was a combination of top-down and bottom-up approaches. Even though workers are the primary focus of the vast majority of SLCA study, it is essential to engage other stakeholders. They suggested including the participatory approach into the SLCA methodology since it could be used to gather the perspectives of many stakeholders and to produce relevant indicators.

1.3 Importance of utilizing SLCA

When the organizations use LCA, they are able to achieve many benefits which profit them for a longer time period. This heading provides the assessment of importance of LCA in construction activities and the reason it should be used. One of the most important benefits of using LCA is that it helps in designing life cycle inventory, which is important for designing a sustainable construction program (Naypyitaw, 2020). Basically, LCA is segmented into 2 main categories which helps in development of a more robust construction plan. Due to this reason, the management of the organization is able to complete their construction project in time. LCA helps in collecting primary and secondary data which is helpful.

Life cycle assessment experts collect primary data, while secondary data comes from general databases or works that have already been written. Silva et al. say that establishing LCIs requires a large amount of data (Thwe et al., 2021). The authors said that getting first-hand information about processes should be a higher priority, since most of the environmental effects of building goods are caused by processes. Background programmes could use databases that are already there. Parameters that have already been calculated from different databases are used to figure out how building materials and consumer goods affect the environment (Marson et al., 2021). Because these datasets aren't correct and are missing important information, it's

necessary to use coefficients that have already been calculated. As part of a research project, a method that combines process-based and economic input-output data was made to get a more accurate level of cost intensity (LCI). This strategy is explained in more detail in the next section.

The life cycle assessment (LCA) may help reduce the negative effects that buildings have on the environment and give information about trade-offs between environmental pressures, health and welfare, and the use of natural resources, both upstream and downstream. ILC came up with LCA (ILCA). Life cycle assessment has the potential to change policy by giving information about how well buildings are for the environment (Rey-Alvarez et al., 2022). The LCA methods and technologies that are currently used have a lot of problems and drawbacks. In building assessments, it's important to think about things like the microclimate and how they affect the building (Song et al., 2020). Buildings are also made up of many different materials and products that work together as a complex assembly or system. Lastly, scenario uncertainty must be taken into account. This is because buildings are used for a long time and may be renovated in the future, which makes things hard to predict.

Life cycle assessment, also known as LCA, is being used more and more during the building design process to look at how building affects the environment. During the design phase, LCA must think about many different things. Some of these challenges include a lack of information during the early stages of design, the need to quickly evaluate design choices, and the economic and social effects of sustainability. The results of this study show that there are three different types of LCA designs. Frameworks, comparing LCA research, and putting LCA together with other modelling methods are all things that will be talked about (Emami et al., 2019). The first type of study is made up of those that built frameworks to make the LCA design process easier. In this category is research that suggests a simpler screening method to be used in the early stages of design when choosing materials and structural systems (Zhang et al., 2019). The computational approach looks at how different building designs would affect the environment around them. This helps architects and designers make better decisions. This is helpful when the design criteria and the

specifics of the material are not clear. When it was time to choose solutions for the structure and the envelope, design, cost-effectiveness, and embodied impacts were all taken into account early on (Ceacero et al., 2021). Their research led to the creation of a way to make decisions that takes into account several factors and combines structural resilience with assessments of the environment and the economy. Using life cycle analysis, life cycle cost analysis, energy modelling, and seismic loss analysis, they built a framework. The goal was to find out what happened when materials were used, as well as when energy and water were used.

Comparative LCA studies look at environmental, economic, and social factors to figure out which design option is the least harmful to the environment (Lopez-Garcia et al., 2021). When the window-to-wall ratio (WWR) and environmental performance of different slab systems, as well as the greenhouse gas emissions and energy needs of five structural systems, were looked at, it was found that a higher WWR has more negative effects on the environment and costs more money.

A DLCA framework is made up of data on consumption, basic inventory information, factors for characterization, and weighting components. Researchers used dynamic life cycle assessment to find out how climate change will affect a building made of bamboo and concrete (DLCA). The research took into account the rise in temperature, as well as changes in the grid mix and factors that show how the environment is changing over time (Feehan et al., 2021). A dynamic weighting mechanism helps put into place environmental and planning requirements that change over time. They compared the results of static LCA with those of dynamic LCA by taking into account how GHGs change over time. When added to other factors, a static life cycle assessment could lead to wrong conclusions about bio-based products. The dynamic life cycle assessment (DLCA), which takes both GHG emissions and uptakes into account, is more accurate (Vazquez-Rowe et al., 2021). In a similar way, the results may be a little different when static models are used instead of dynamic ones, especially when bio-based materials are involved. They looked into "the need to apply temporally resolved building-level data while capturing the effects of a changing electrical grid on building life cycle impacts," and

they found that a "normal" life cycle assessment (LCA) understates the effects of the consumption phase.

BIM makes life cycle assessment (LCA) in the building industry easier and gives integrated solutions to frameworks that would otherwise be hard to work with and complicated. Building Information Modeling, or BIM, is a way to model and simulate in three dimensions (Uceda-Rodriguez et al., 2022). Since it is possible to look into many different design options while doing LCA calculations at the same time, the integrated BIM-LCA approach is often used as a decision-making tool during the design stage. This is where it happens most of the time. By combining BIM and LCA, one of the main things that can be done is to get information and quantities about materials. However, data interoperability is still a problem. Integration of BIM and LCA happens on three levels to make it easier to share and get feedback on data (Backes and Traverso, 2022). First, BIM is used to make the LCI (for example, bill of quantities and material information). Second, BIM tools contain environmental data. The third level is in charge of making the software processes run automatically.

A study found that most BIM-based LCA studies used manual and semi-automatic methods to make the process easier and reduce the amount of human input that was needed. Automated data exchange is a new trend that is becoming more popular. After that, they came up with three different ways to integrate. Before starting the LCA calculation with a spreadsheet, the BIM and environmental data from the model must be extracted by hand (Najjar et al., 2022). The second method is to use a semi-automated process to merge and change data. Because of how this method works, changes to models cannot be sent in real time. Dynamic integration takes into account the fact that the BIM model and the inventory data don't match up in terms of time (the data collection and mapping process are nevertheless still manually performed).

1.4 Aim and objectives of the study

The aim of the research is to conduct an assessment among the stakeholders of the residential construction in Pakistan through utilizing the social life cycle

assessment. Based on the aim of the study, there are several objectives are designed that are aimed to guiding the researcher in effectively carrying out the study that can aid in addressing the fundamental aim. The following are the objective of the study:

- To understand the concept and guidelines of SLCA for sustainable development with the support of literature review
- To understand the importance of the SLCA for carrying out assessment for stakeholders and others
- To carry out an assessment among the stakeholders of the residential construction in Pakistan through utilizing the social life cycle assessment.
- To provide recommendation to the construction sector of Pakistan addressing the needs of social and sociological aspects especially in case of workers.

1.5 Research Questions

The research questions of the study are categorized into two groups where the first group refers to the main research question which is particularly focused on the fundamental aim and is:

“What can be concluded from the stakeholder analysis of the residential construction in Pakistan with the support of SLCA?”

The sub-research questions of the research are the following:

- What is the concept of SLCA and how does the guideline of SLCA show about sustainable development?
- What is the benefit of using SLCA approach in conducting the assessment of stakeholders?
- What recommendation can be provided to the construction sector of Pakistan for addressing the needs of social and sociological aspects?

1.6 Significance and Rationale of the study

The findings of the research on the challenges posed by modern sustainable world lead to Social Life Cycle Assessment (SLCA) that is more precise and grounded in reality. Building economics in the modern era place a significant emphasis on economic viability. The ever-increasing need for technologically advanced building processes calls for the development of a technique that is less complicated and more user-friendly in order to determine the economic sustainability of an organization. This study has shown the significance of life cycle assessment (LCA) in the building and construction industry as well as the reasons why organizations should use it.

1.7 Structure of the study

Before proceeding with the other sections, it is critical for the researcher to determine the entire structure of the study that can be useful for the readers in gaining an understanding for each of the segments. In total, there are five chapters that are covered in the entire study where each of the segments provides with the different view on the study. The first segment is concentrated on the introduction where it provides a brief review on the background of the study while explaining the SLCA in-depth. Furthermore, the aim and objectives are also defined in this study. The second segment is the literature review in which the previous studies that helps in exploring the concept of SLCA along with its connection for improving the social aspects among the construction companies are analyzed along with defining the theories. The third chapter is the methodology which refers to defining the process and technique in carrying out the research. The fourth segment in research is concerned with the results and findings based on the gathering the data. The last chapter is concerned with the conclusion and recommendation which reflects to concluding the study.

LITERATURE REVIEW

2.1. Introduction

This chapter presents the assessment of the arguments presented on the topic by different scholars in the last 5 years. The purpose of this chapter is to critically review the concepts and arguments of the scholars and how they compare and contrast on the topic and their relevant arguments. The chapter is segmented into heading and subheadings.

2.2. Literature review

2.2.1. Concept of SLCA

LCA has transformed from its origins in energy analysis in the 1960s and 1970s into a broad tool used to assess the environmental and resource impacts of products or systems. This approach has gained a foothold in research, industry, and politics. Its application is expanding to include diverse impacts such as resource accounting and social welfare. (McManus & Taylor, 2015). Due to consequence on the social aspects, the debates on sustainable developments and social aspects is drastically increasing by the scholars especially the need for measuring and comparing sustainability performance. Since its original conception, the use of LCA has grown rapidly, and it is now a well-known and widely used tool in the industry, academia, and policy. The least established of the three complementary life cycle assessment strands that provide analytical frameworks for lifecycle-based sustainability measurement and management is the Social Life Cycle Assessment (SLCA) (Pelletier, 2018). By comprehending and identifying ways to lessen the social consequences connected to product life cycles, SLCA aims to improve decision support and environmental LCA and life cycle costing. More focus has been given to "Life Cycle Sustainability Assessment (LCSA)," which blends environmental, economic, and social performance since sustainable development has risen to the top of the global agenda. (Roh et al., 2018). With the increasing issues on social aspects, it has led to the importance and need to integrate the LCA with the social aspects which caused the emergence of social life cycle assessment which was developed in the 1990s. There is a significant increase on the social impacts of the products along with promoting sustainability (Luigia Petti, 2018).

Through the course of a process's entire life cycle, SLCA takes into account the existing and potential (both positive and negative) socioeconomic repercussions. Similar to the environmental life cycle assessment (ELCA), the social life cycle assessment (SLCA) focuses on the social implications of products, processes, services, or systems (hence referred to as "products") in general throughout their life cycle (Jørgensen et al., 2010). SLCA assists decision-makers in selecting the alternatives with the best social consequences (Huertas-Valdivia et al., 2020). Usually, there are four steps/ stages for life cycle assessment (Figure 1).

1. *Goal and scope of work*

The first question for practitioners and researchers before implementing a method consider whether the purpose, approach and representation of social issues will be appropriate for their examined system. Similarly, before developing a framework and associated method, SLCA developers must first understand the available frameworks/methods (Wu et al., 2014). The goal and scope of work are defined based on the purpose of the study. It is defined well before data is collected at the start of the study. It is the first step in defining what will be the direction of study and what will be the goals to be achieved.

2. *Inventory Analysis*

The purpose of inventory analysis is to collect and analyze relevant information determined when determining the range. Depending on the type of SLCA, a social life cycle inventory is carried out, which may comprise some or all of the following: choose what information to acquire; data collection method for specific and/or relevant stakeholders and subcategories, and additional data for impact evaluation (if needed) (Sehlin MacNeil et al., 2021). The literature points to some disagreement among researchers about what information should be collected for the SLCA. Some researchers debate that a method similar to ELCA, in which input and output data are generated for many commonly used processes, cannot be applied in the case of SLCA. According to the researchers, the effects in the Social Life Cycle Assessment (SLCA) scenario are related to business conduct rather than the characteristics of the industrial processes. The SLCA methods demonstrate how widely people's perceptions of social repercussions vary. A study that concentrates on social consequences that are produced close to the operations of the product system could not always point in the

same direction as a study that focuses on broader societal aspects. (Jørgensen et al., 2007).



Figure 2.1: Four steps of Life Cycle Assessment

3. *Impact Assessment*

Knowing and evaluating the potential social effects of the organization, product, or service under consideration are part of a life cycle impact assessment. Inventory data are translated into impacts through four steps: classification, characterization, normalization, and impact valuation.

4. *Results Interpretation*

Life cycle interpretation is a systematic technique for locating, quantifying, checking, and assessing information from the Life Cycle Impact Assessment results. The process of evaluating results and analyzing results, drawing conclusions, explaining the limitations of the study, and giving recommendations and complete reports. The results of the inventory analysis and effect assessment are summarized at the interpretation stage. This interpretation process concludes with a set of study conclusions, suggestions, and recommendations (Cao, 2017).

2.2 Social Life Cycle Assessment

The work on sustainability evaluation is always evolving, as are the methods that are currently available. Environmental, social, and economic consequences and benefits are usually considered when assessing sustainability. Before proceeding with explaining the concept of SCLA, it is critical to discuss the LCA where the factor of social was later integrated in the assessment. According to the study undertaken by Lu et al. (2021), LCA is method that is specifically used for evaluating the environmental

impact among the products based on the lifecycle. In most of the cases, LCA is utilized for evaluating the environment impact assessment of the business in respect to the energy and carbon emission. Therefore, several studies have adopted the measures of LCA in respect to reducing the environmental impact of buildings and other aspects. To achieve a complete triple bottom line life cycle assessment (LCA), the development of social life cycle assessment (SLCA) has been a significant methodological contribution focusing on environmental, social, and economic factors is growing rapidly (Grubert, 2016). The main goal of SLCA is to assess and analyze the social consequences of diverse products throughout their life cycles. Traditional life cycle evaluation is combined with social components in social life cycle assessment (SLCA). Social life cycle assessment (SLCA) combines traditional life cycle evaluation with social components. Objective analysis of SLCA will be difficult because impacts might be perceived differently by different stakeholders, communities, and countries. Researchers employed an integrated tool termed life cycle sustainability assessment (LCSA) to measure sustainability across the life cycle. LCSA aligns the three pillars of sustainability by including the LCA tools (environmental, economic, and social). SLCA is, although a new concept, it has contributed significantly to social (like human health and safety), environmental and ecological concerns. Thus, understanding the concept can help us integrate social, economic, and environmental development into the broader sustainability concept and sustainable development framework.

The major purpose of SLCA is to evaluate and compare the social implications of various products throughout their life cycle. One of the key development goals of modern civilization is well-being. Assessing what can increase well-being and harm is an important part of public policy, especially when considering social benefits and impacts. The way social issues are perceived is influenced by cultural factors, values, and lifestyles. Furthermore, many parties, such as government, business, and non-governmental organizations, are increasingly assessing social implications along supply chains. Using lifecycle-based methodologies, the environmental effects have been evaluated throughout supply chains, from the extraction of raw materials through the end of product life, as shown in figure 2 below.

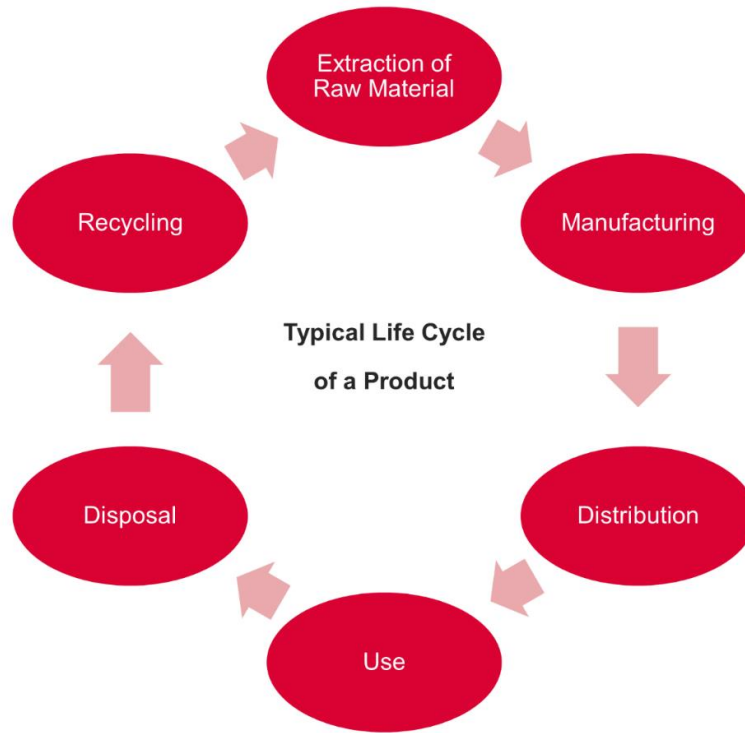


Figure 2.2 Typical Life Cycle of a Product

Social Life Cycle Assessment (SLCA) can be viewed as a technique for the tactical planning of a product's social sustainability and takes on the role of analysis to enable the business to gauge the product's social impact through sustainability assessment over the course of its life cycle. To increase organizational performance and stakeholder well-being, SLCA delivers information on social elements important for decision-making. The framework for applying SLCA in research investigations is unique. It provides a generic, comprehensive, simple-to-understand, and practical decision-making approach that incorporates several aspects. It offers a general, thorough, understandable, and useful approach to making decisions that characterizes the comparison task by utilizing various tools and strategies.

There has been a need to integrate social factors into life cycle assessments (LCAs), which gave rise to social life cycle assessments (SLCAs). SLCA has a young history that has evolved significantly in the last decade due to several groundbreaking documents published by UNEP that provide a framework and guidance on conducting SLCA (Du et al., 2014). Since then, there has undoubtedly been a significant increase in interest in the social impacts of products to promote sustainability (Petti et al., 2018). An evaluation of social impact is called a social life cycle assessment method that

focuses on people's life cycle activities. It was created as an add-on to the LCA technique to incorporate the social side of sustainability into the LCA methodology. A methodology with constant improvements called SLCA can be used at several scales, including those of goods, economic sectors, and systems at the meso- and macro levels. While SLCA has historically evaluated harmful social externalities, human actions may also have beneficial social benefits (Di Cesare et al., 2016).

SLCA research has grown significantly in the last three years. However, the method is still in its infancy (Chang et al., 2015). From the extraction and processing of raw materials to production, distribution, consumption, reuse, maintenance, recycling, and final disposal, SLCA may analyze the social and socioeconomic elements of products as well as their both positive and negative effects (Adami Mattioda et al., 2017). The questions raised are whether including social impacts in a study has implications for system boundary definition, whether issues arise when translating criteria into implications, and whether an LCA should confine itself to social and socioeconomic consequences impacting other environmental parameters directly or indirectly.

SLCA is also used to assess socioecological aspects along the life cycle. It is a systematic process from product extraction to final disposal, or one can call it from 'cradle to grave.' It assesses both potentially negative and favorable effects on stakeholders over the course of a lifetime. In order to enhance social circumstances during the life cycle of products, assessment of the social life cycle can be used to boost knowledge, make decisions clearer, and encourage these improvements. For competitiveness and integration, sustainability is an important factor within the local community for all stakeholders (Arcese et al., 2013). The most valuable and significant guidelines while performing social life cycle assessment is the "Guidelines for social life cycle assessment of products" (Andrews et al., 2010).

From the finalized research papers used for this literature review, the graph for annual publications on SLCA is shown in figure 3 below.

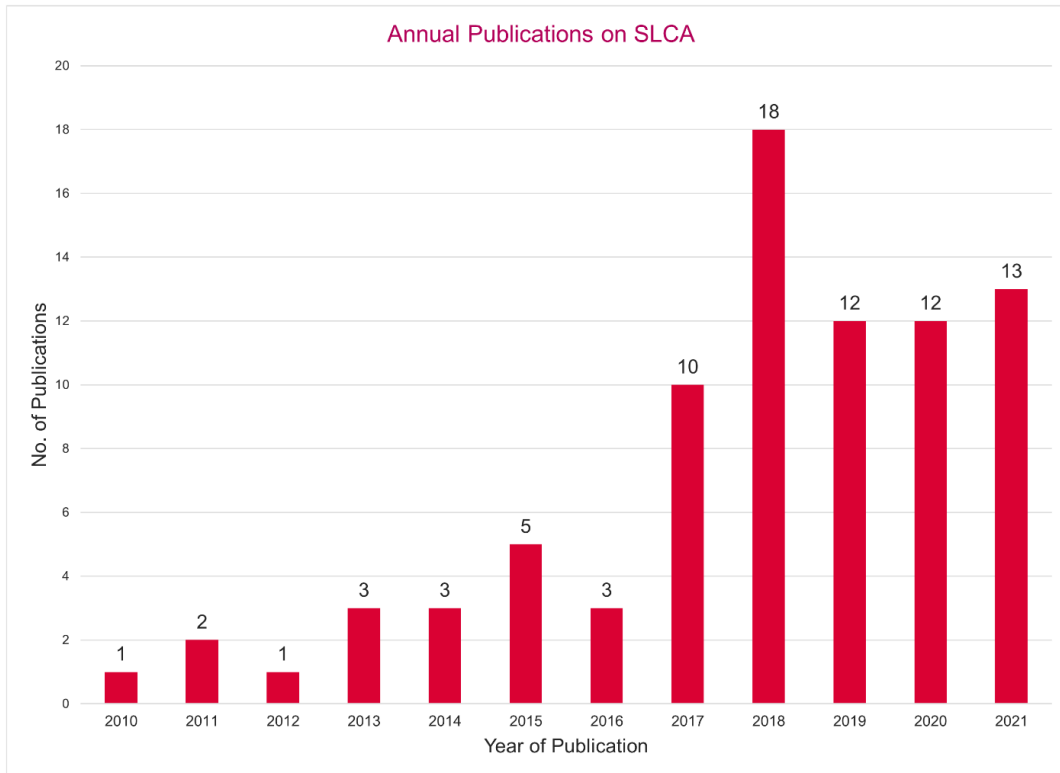


Figure 2.3 Annual Publication on SLCA (2010-2021)

2.3. Dimensions/Stakeholders

Social Life Cycle Assessment majorly depends on the stakeholder involved in it. For many years, the LCA community has debated social life cycle assessment (SLCA). The discussion of social impacts from a life cycle perspective has a long history, dating back to attempts to include impacts on stakeholders in the Life Cycle Assessment process (Baumann et al., 2013). As a social assessment, stakeholders are those related to the product or industry whose social life cycle assessment is being performed (Figure 4). Stakeholder categories are commonly used in the Social Life Cycle Assessment (SLCA) to organize the numerous groups of persons who may be affected by the organization's operations (Siebert et al., 2018).

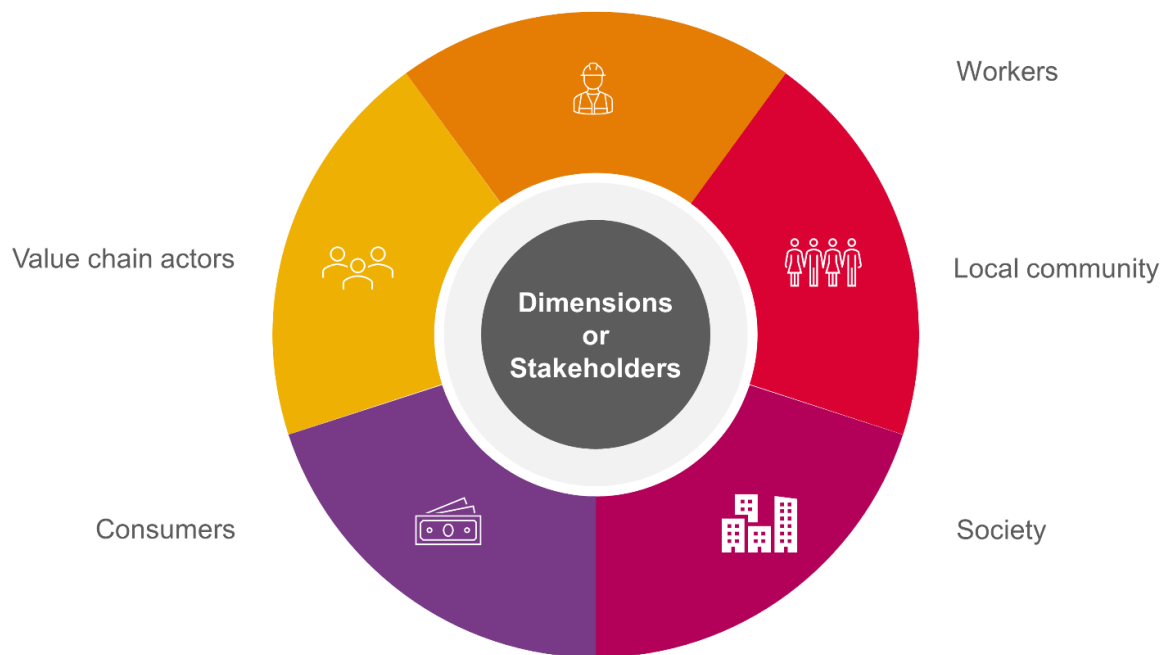


Figure 2.4 Dimensions/Stakeholders for SLCA

2.3.1 Workers and Employees

A person who contributes their talents to the company in exchange for payment is known as an employee or worker. In particular, the International Labor Organization (ILO) highlighted the necessity for stable contracts in 1993, in which workers have explicit or implicit employment contracts, on paper or verbally, with the same employer continuingly. Workers are the basic social factor of production in all sectors, yet they are frequently not recognized by contract, as in some underdeveloped nations. Workers, as significant stakeholders, have quantitative impacts and more distinct social impact indicators and categories than other groups.

Workers are the most effective stakeholder in all the processes, whether it is in the case of child labor or forced labor. Their working hours are also a core issue related to human rights. Also, their health and safety should not be neglected, and they should be given fair salaries, which is their right (Roh et al., 2018). Not only this, but the past research has shown that freedom of association, gender equality, child labor, fair salary, working hours, and social benefits are the key indicators that are mostly used to assess the

workers' SLCA. Studies have shown that child labor is considered to be discouraging, has an extremely negative effect on society and social norms, and is against the human rights of children. Moreover, a fair salary and fair working hours is the human and social right of every worker and employee. In the category of social security and benefits, some of the inventory indicators are employee insurance policies for health care, retirement, paid maternity leave, and legal contracts that are incorporated and considered their social right.

2.3.2 Local Community

The Local Community plays a vital role when it comes to community engagement. As per the ethics, local employment should be considered for local community people, and Indigenous rights should be respected. The potential of the cultural heritage service to improve the local area's quality of life that enable its residents to reach higher levels of social, economic, and cultural development position is of primary concern to this community (Arcese et al., 2015). It can be extremely difficult to comprehend the demands of the surrounding populations. Another difficult task is figuring out what local communities' needs are. Simple requirements like business taxes or intangible assets like information access or volunteer work in the community can be considered basic needs. A percentage of personnel from the town itself may be required for affiliation needs. Additionally, this stakeholder group is viewed as an indirect one with very qualitative outcomes.

2.3.2 Society

Society is the main stakeholder in economic development (Hannouf et al., 2020), a public commitment to sustainability issues. A morally strong society is corruption free and on high ethical grounds. Outside of the already-mentioned social groups, all additional social groups come into the notion of a global society. This category includes state, national, and worldwide government entities and network linkages. Research has shown that in the case of public commitment to the sustainable issue, the basic requirements can be evidence of any sustainability-related agreement, which is spread through organizational websites, promotional materials, and other means of spreading sustainability awareness. Similarly, the basic requirements remain the same in society,

such as economic progress, armed conflict prevention and mitigation, technological advancement, and corruption.

2.3.4 Consumers

Consumers are the users of a service and represent a diverse group of stakeholders. It is assumed that the customers come first in the business. However, this stakeholder is not in the actual use of the product and is only considered part of the purchase-related issue. This stakeholder is considered the end consumer of the process, item, or service. This is not just for people, but from a lifecycle perspective, it includes the following downstream links in the supply chain. Their feedback, privacy, and transparency are the key aspects that cannot be neglected. Also, consumers' health and safety should be under consideration (Hosseinijou et al., 2013).

2.3.5 Value Chain Actors

For the application of SLCA, it is also essential to review a company's relationship considering that this group of stakeholders is actively engaged in the value creation process. (Arcese et al., 2015). The categories such as respect for intellectual property rights, social responsibility, supplier relationships, and fair competition are highly relevant in social life cycle assessment. This group of actors captures potential social impacts between producer (buyer) and supplier (seller). Stakeholders who supply the firm with goods or services are known as suppliers or value chain participants. An individual firm can have multiple suppliers across multiple product lines at any time. Suppliers can be viewed as the next link in the supply chain when examined from a life cycle perspective. In addition to instant tier-one relationships, manufacturers must consider the entire supply chain, which adds significant complexity to lifecycle sustainability analysis. The common characteristics of value chain actors include fair competition, supplier relationships, and the enforcement of the intellectual property system. Fair competition generally requires that the company or organization compete fairly. In the case of relationships with suppliers, the organization has a code of conduct with ethical requirements and norms. At the same time, in the subcategory of the intellectual property system, it requires evidence that the company upholds the concept of intellectual property

2.4 Creating a Sustainable Future Using a "Life-Cycle Analysis,"

ELCA, LCC, and SLA have been used to solve the environmental, social, and economic problems that have been plaguing the construction industry. The life cycle assessment looks at all of these methods. When figuring out how a building affected the environment around it, either its carbon footprint or how much energy it used were taken into account (Janjua et al., 2019). LCC in residential construction has gotten a lot of attention because it is good for the economy. However, the economic effects on developers and end-users have not been looked into. A lot of attention has been paid to LCC for residential buildings lately. There is a chance that the SLCA study on residential buildings looked at both social equality within and between generations as factors that contribute to sustainability. Even though three different approaches to sustainability (ELCA, SLCA, and LCA) are enough to manage a single sustainability target throughout the building's life cycle, it would be good to combine these approaches to figure out the building's overall sustainability score (Navarro et al., 2018). The ELCA, LCC, and SLCA are all used to reach social, economic, and environmental sustainability goals at the same time. This paradigm chooses indicators to measure large-scale effects after looking at them from different points of view. In addition, it stops double counting, connects social indicators to a functional unit, includes stakeholders in indicator weighting to reduce assessment uncertainties, looks at both positive (benefit) and negative (carbon footprint) indicators, and applies to real-world situations.

The Sustainable Landscape Certification Act (SLCA), which would look at how buildings affect the environment, society, and economy, is being made right now. According to the review done by the authors, very few studies on SLCA for residential buildings took into account regional differences in sustainability indicator selection, supply chain stakeholder participation, TBL objectives (Balasbaneh et al., 2021), and the service life of all building components and the building itself when trying to make a comprehensive SLCA framework. Not much research on SLCA in homes has shown this to be true. The TBL's environmental, social, and economic sustainability goals and key performance indicators (KPIs) vary from one building site to the next because of things like climate, location, and social and economic conditions (e.g., child labor, temperate zone, water scarcity, etc.) (Dunwila et al., 2022). Acceptability of KPIs also

depends a lot on the people who are chosen for the supply chain and how much they are involved in making KPIs.

Taking into account how long a building is in use, the performance of buildings in terms of how sustainable they are is either overestimated or underestimated. But the research on the performance of sustainable buildings has used numbers from 30 to 100 years, with 50 being the most common choice. The Australian building code says that residential buildings should last for 50 years, but this number can range from 30 to 100 years (Wang et al., 2019). This doesn't take into account how long a lot of the building's architectural parts will last. Recent research done by one of the authors showed that the difference in the actual service life of a structure due to the durability of its parts affects the conclusions and results of the environmental LCA. Without service life integration, the early end of life of the structure makes it likely that the results of a sustainability assessment will be wrong. When there is no maintenance or repair work done on a building while it is in use, the durability of the building materials isn't taken into account (Santos et al., 2019). This makes it hard to figure out how the building affects the environment.

So, a full SLCA framework needs to include TBL objectives in order to measure the life cycle sustainability of residential buildings. This framework needs to take into account the estimated service life (ESL) of building parts and of the whole building. It also needs to take into account regional sustainability indicators from multiple points of view (developers, users, society, and generations), quantitative social KPIs related to functional units, and the involvement of stakeholders in the selection process (Dunmade et al., 2018). An SLCA framework will be built on the basis of these qualities. Key performance indicators (KPIs) will be used in this framework to find gaps in sustainability performance and suggest ways to fix them. In order to evaluate and improve the sustainability of TBL residential buildings, the authors set up a life cycle sustainability framework. So that the evaluation would be fair (Fufa et al., 2019), open, and honest, the authors chose and gave weights to a number of important performance measures based on scientific criteria (KPIs).

The SLCA framework that the authors created needs to be tested with real-world data to see if it is original and scalable. This paper uses the authors' SLCA approach to look at residential buildings in Western Australia to see how sustainable they are. The results

of this analysis will show how many ways there are to make the building more environmentally friendly.

2.5 Benefit of using SLCA for conducting stakeholders assessment

The SLCA, which stands for "social life cycle assessment," is used to figure out what goals society wants to reach with a product. During a building's life cycle, it gives the needs of the end-user, the community, the supplier, the builder, and the designer the most importance. In a way similar to the ELCA, the SLCA sets goals and a scope, makes an inventory, evaluates the effects, and looks at the results. A study that made ELCA more useful looked at environmental concerns from both a political and a social point of view (Nubi et al., 2021). In 1999, SETAC thought about whether or not to combine SLCA with LCC and LCA. This session was about social welfare because it was a part of the ELCA study that looked at the effects on society. Because of this, it was suggested that LCC and LCA be added to SLCA (Wei et al., 2022). In 2009, UNEP/SETAC released a number of methodology sheets and guidelines for SLCA. By interviewing stakeholders for cradle-to-grave life cycle studies of specific products, such as laptop computers (e.g., workers' benefits, health and safety, and healthy living conditions for the local community), vehicle fuels (e.g., child labour, health and safety, and fair salary) (Wei et al., 2022), palm oil biodiesel products (e.g., exploitative labor relations, the wellbeing of the local community), and papyrus, this tool was able to find social hotspots. Other products that were looked at are: (e.g., labor laws, occupational hazards and accidents, and local community deaths due to air pollution).

The SLCA tool is not used very often in construction. Only a small number of SLCA studies have been done on residential buildings. Most of the studies have been about social welfare issues like employment and health. These things were taken into account. The Social Life Cycle Assessment (SLCA) looked at the social effects of concrete and steel (Balasbaneh et al., 2018). It did this by analyzing the flow of materials and using a participatory approach to find social hotspots. The biggest effect on society, according to the results of this study, was management, not methods or materials. The European Standard EN 16309:2014 health and comfort methodology was used to analyze the building's thermal, acoustic, indoor air quality, visual comfort, and spatial characteristics. In this study, three experimental Portuguese buildings with different floor plans, designs, and total area coverage were used to look at how these five building

features affect how people behave in society (Jiang et al., 2022). The volumetric structure of a fully prefabricated, a partially prefabricated, and a fully prefabricated building was looked at in a study. In the study, a framework for building social sustainability was made. This framework gave more weight to workers, tenants, the community, and society than to other things. According to the analysis, option one is better than option two because of how it protects workers and how it uses modern technology (Jiang et al., 2022). The results of an SLCA on the precast building construction industry show that precast constructions hurt local employment. This happened because the facade, the floor, and the stairs were all made of precast concrete that was shipped from another country. Together with other studies, this one found that eco-efficiency can make buildings better in terms of how they affect people and the environment.

The SLCA is a new method that is hard to use because it is hard to put together and evaluate life cycle inventories (LCI). Most SLCA research was based on broad data collected from all over the country, not site-specific data. There is no one way to choose indicators of impact. Even though the UNEP/SETAC standards call for a "top-down" approach to social LCI (Safarpour et al., 2022), some research suggests that a "bottom-up" approach, where everyone is involved in choosing the impact indicators, would be better. There is no one way to choose indicators of impact. Stakeholders in the SLCA depend on the study's goals, how stakeholders act, and confidentiality agreements that are legally binding.

2.6 Summary

This study shows that life cycle assessment (LCA), a way to measure the environmental, social, and economic performance of the building industry, is becoming more and more popular. LCA has only been used in a small number of studies to meet all three TBL objectives and evaluate how sustainable buildings are. The frameworks that are available now were not meant to be used to compare the structural sustainability. Each of these three sustainability criteria must be looked at in a single process in order for buildings to get points. Second, this framework needs to find any problems with the project's long-term viability so that useful steps can be taken to fix them. Third, because TBL indicators are affected by things like location and socioeconomic status, it is very important to choose which ones to use. So, a vote by

agreement is needed to choose the criteria that are specific to a region and can help evaluate how sustainable a building is. Building SL has an effect on the viability of structures made of more than one material, and it may be the most important one. With the current evaluation method, the indicators, TBL indicators, and building sustainability performance targets can all be made better. When figuring out if a building is sustainable, it's important to think about how flexible and hard the three sustainability goals for the building sector are.

METHODOLOGY

3.1. Introduction

This chapter is considered one of the most important ones in the thesis because it explains the methods used for conducting investigation and the way they should be designed.

3.2. Research method

Quantitative research usually involves survey research, which looks at how people answered the questions. The research strategy is flexible enough to work with both qualitative and quantitative survey formats. For this study, closed- and open-ended questionnaires are made using a 5-point Likert scale-based questionnaire. The quantitative method of descriptive analysis is used in a lot of studies to figure out what kind of relationship there is between the research objectives which is based on SLCA and its impact on sustainability. In this piece of work, mathematical values are used to explore and show quantitative information. During experimental research, researchers used methods of investigation and came out with the frequency analysis for the questionnaires.

The study has put a lot of focus on quantitative analysis and use a wide range of techniques for evaluating quantitative data. Quantitative research is used to narrow in on a sample that is a good representation of a larger population (Rutberg and Bouikidis., 2018). The main goal of quantitative analysis is to gather statistical data for examination. To come up with a strong hypothesis or plan, the research had to look at accurate data. A sample of the whole population was used to get these numbers. Analysis is a must if you want to come up with a good theory or plan. There is a place for primary and secondary research in the field. For this quantitative analysis, primary research was done to get the information that is needed (Najafi et al., 2022). One example of primary research is talking to the people being studied one-on-one or being in direct contact with them. The research method in this study involved conducting surveys with the residents and workers of the construction sector. For this purpose, a close-ended questionnaire was the best option of which frequency analysis was done.

3.3. Research philosophy

When an investigation is carried out, it becomes important that an important method is deployed and used by the researcher because it directly contributes to the validity and reliability of the findings. The philosophies are available in many forms segmented into quantitative and qualitative research philosophies. Due to this reason, this investigation makes use of best methods.

During this quantitative research analysis, the idea of pragmatism was taken into account. The goal of pragmatist research is to figure out which philosophical idea best explains the problem being looked into. When it comes to marketing baby products, the researcher aimed to analyze the benefits of using SLCA for conducting research. To find the best answer, the researchers have to go through a series of logical steps (Ekanem, 2021). So, the best way to figure out SLCA techniques is to look at the answers from the participants and analyse the data. Pragmatism, which puts more weight on logical reasons than on theories, can help get to these conclusions because it puts more weight on logical reasons hence presenting detailed values.

3.4. Research approach

The research approaches are available in two different forms namely quantitative and qualitative, also categorized as deductive and inductive approach. Interviews are one example of a qualitative research method. Interviews are a common tool for investigators to use. This is as a result of the fact that during this kind of investigation, an investigator will conduct interviews with the persons who have replied to the survey either in-person or online. The reason for this is as follows: Open-ended or closed-ended questions decide this. A researcher questions a group of participants while conducting a focus group. The field of study known as ethnography investigates culture across time. Case study research, on the other hand, zeroes in on a single case study and the particular effects that it has. The identification of prior records and the drawing of inferences based on those records are essential components of qualitative record keeping.

However, this research made use of quantitative method. In this quantitative study, the research placed place a strong emphasis on deductive reasoning. The deductive approach

places more of an emphasis on the underlying theory that is being built in relation to the topic that is the focus of the research, which results in the generation of hypotheses (Pandey, 2019). Research in the scientific community is putting an associated theory to the test. The close-ended questionnaire is put to the test through the use of environmental observations. The testing of that question involves employing logical reasoning and evidence from the surrounding environment. Data are used to examine and provide results related to SLCA approach. The comparison of the responses received from both residents and workers was done to show how they support SLCA.

3.5. Data collection methods

Primary data collection was used to gather the sample responses for the current quantitative study. In order to do this study, the researcher used questionnaires. For this purpose, the researcher first took consent form from the respondents and then carried out surveys (Gillespie et al., 2021). Respondents will give feedback by answering questions that are on point. When researcher talk to respondents in person, they can learn more about their personalities, their points of view on the issue, and their perceptions. This is the reason, this research inquired the close-ended questionnaire for finding the role of SLCA in construction sector. Primary survey data about the role of SLCA in stakeholder assessment and construction building was done to find how it is used and their strengths and weaknesses. Questions and answers were read out loud on papers for the workers and similarly residents' questions were distributed to them, and the results obtained were saved for further analysis.

3.6. Population and sampling strategy

There are many methods of selecting the population and sample size and then conduct the research. The sampling methods are normally segmented into probability and non-probability sampling methods which are considered important for the results generation. In this investigation, both a random sample and purposive sampling methods were used. The researcher went to a number of residents and workers who were related to ongoing and already done construction and carried out survey from them, all of the responses were collected from them by hand to insure more accuracy and facts in results. The researcher put more emphasis on finding the purposeful people who are aware of the SLCA approach

and its benefits in construction. The sample is made up of 120 people from both the residents and workers (240 in total) who participated and presented their respective questionnaires either online or in hand. By using the purposive sampling method, the researcher can get information as quickly as possible. It is because purposive sampling method is used when data is being collected from the respondents who are well aware of the topic being investigated. This was most important because not all the people have knowledge of SLCA.

3.7. Data analysis

The data analysis can be carried out using both the quantitative and qualitative methods of investigation. When a research is being carried out, it is important that both the quantitative and qualitative methods should be assessed and the best one should be selected. In this investigation, data analysis was done using quantitative method. The information given by respondents was analyzed numerically using frequency analysis for this purpose, the SPSS software was used which is famous for carrying out quantitative analysis. In frequency analysis, the responses collected through each question were separately analyzed (Sen., 2021). In Chapter 4, we'll look at the results generated from frequency analysis carried out on the SPSS in the form of tables. On top of that, the data will be looked by comparing the results from other studies to check what they reported.

3.8. Data collection tool

Choosing the right research tool is important because it requires coming up with original ideas and gives research benefits. After the goal analysis is done, the researcher can then choose from a number of study instruments. Snyder (2019) suggests looking at the selection criteria to get the most out of the qualitative and quantitative methods that will be used in this study. There are many different kinds of equipment for research, and each one is made for a certain size of sample.

Quantitative and qualitative research methods are thought to be the two most important ways to gather information (Snyder, 2019). In statistics, math relationships are used to figure out what's going on. In this investigation, data collection tool that was used, was based on finding the numerical results hence close ended questionnaire was used for

reporting the results. The results were generated using SPSS and they were presented in the form of different values for which the conclusion became easy to draw. Data collection tool was based on Yes and No, Likert scale options out of which the respondents were required to mark any one of them. Also there were open ended questions as well.

3.9. Research Design

This study used a number of different ways to do research. In data analysis, both qualitative and quantitative methods are used. This investigation adopted quantitative research design for carrying out the research. The researcher used a quantitative questionnaire, which was segmented into two different forms. One was distributed among the residents and one was distributed among the workers of the construction sector.

Usually, the inquiry method is part of the planning for the research project. In this investigation, quantitative methods was used. The researcher adopted quantitative method for investigation and then compared results with other studies. During survey, people completed out questionnaires with answers that were related to the SLCA approach in building. Hence, this was the main method used for carrying out the research and presenting the results.

3.10. Ethical consideration

Protecting the personal information of the people who take part in a study should be the top priority. This is a very important thing to think about when studying. In order to protect the respondents' privacy and get their verbal permission (Barnard et al., 2021). They gave their verbal permission to take part in the survey. Respondents must give their informed consent for their answers to be evaluated. While filling out the questionnaire, respondents' ages' gender were written down. However, respondents' names will not be asked for in order to protect their privacy. Also, we will keep their comments secret and only use them for research (Akologo et al., 2019). For research to be ethical, human subjects must be protected. This has to be done in order to protect human subjects from possible harm that could come from their personal information getting out.

The researcher owes it to the people who took the survey to protect their privacy by keeping their information secret and destroying it when the research is done. The data will be saved in sealed files in a protected place (Kapiszewski and Wood, 2021). Only the researcher and supervisor will be able to access data files, which is sealed and protect both the data and the personal information of the respondents. Respondents can always get rid of their personal information and stop taking part in the research. If the respondent doesn't want to give information, the researcher cannot force him to do so. So that information doesn't get out, it's the researcher's job to keep the answers of the respondents secret. This makes sure that their privacy is kept even when research partners are around.

3.11. Limitation and Possible Innovations

One of the limitations of this study is that it made use of quantitative method only. This was done to ensure that results obtained are quantified in best possible manner. Furthermore, this research only used the quantitative method of using close ended questionnaire when option of conducting interviews was also available. The researcher did not used respondents from any country except for the home nation. The role of SLCA was only analyzed, when many other sociological methods of assessing are also available.

Lack of money makes it hard to do this research. Still, there has been some national research done on the subject. The budget is kept in mind while everything is done. But there is a chance that due to less concept and research being done on SLCA it will be new for us and might have some errors for future consideration.

Worker Social Development Index (SDI)

4.1. Introduction

In the contemporary environment, there are different methods and techniques that are being developed or developing to evaluate the social and sociological aspects of product, service or others. The discussion and debates has drastically increased on the social and sociological aspects since 29 years ago where the publication made by the Society of Environment Toxicology and Chemistry (SETAC) in the period 1993 has drastically added to the importance of addressing social aspects (Mebane et al., 2020). On this regard, SLCA has become a significant area for undertaking research that can contribute to its effectiveness for measuring the social aspects (Martucci et al., 2019). SLCA is a methodology developed to assess the positive and negative social impacts of products and services throughout their life cycle. SLCA aims to assist decision-makers in making with the increasing debate on social aspects and a framework for measuring social elements, it has led to the evolving of the LCA by integrating the social factor. This has led to the introduction of SLCA which is method and technique for evaluating the social and socio-economic aspects of the products in respect to its positive and negative impact throughout its life cycle which is from the extraction of raw material, manufacturing, distribution, use, reuse, maintenance, recycling and financial disclosure (Pollok et al., 2021). In general terms, the SLCA is mainly focusing on the assessment of the people's life-cycle activities by incorporating the social side of the sustainability among the LCA methodology. In order to achieve sustainable development, the environment, the economy, and society must all work together. Tools such as ELCA and LCC came into being as a result of an increased focus on the environmental impact of individual products (Pagnon et al., 2020). These models may investigate the repercussions a product has on the environment and the economy from its beginning to its end of life. Despite this, the social aspect of sustainable development gets a very little amount of attention, which is problematic given the absence of social performance measurements. At the moment, SLCA is still in its infant stages of

development. The Guidelines for Social Life Cycle Assessment of Products define social life cycle assessment (Vilaboa Diaz et al., 2022), or SLCA, as a social impact assessment technique that aims to assess the social and socioeconomic aspects of products as well as their potential positive and negative impacts along their life cycle. The SLCA is a descendant of the ELCA and maintains the ELCA's four-phase framework (ISO 2006a, b): defining the aim and scope of the analysis, inventory analysis, conducting an impact assessment, and drawing conclusions from the results (da Silva et al., 2021). The initial phase of an SLCA research is determining the functional unit, as well as the aim, the audience, and the system boundary. The second part of inventory analysis consists of data collection, the building of SLCA models, and the outcomes of LCI.

The findings of the life cycle impact assessment are then broken down into many subcategories of effect indicators. The next step is to assess the findings of the Life Cycle Impact and Social life cycle impact assessment tests and search for hotspots. The Guidelines provide an explanation of research standards (Wang and Sinha, 2021). Since case studies that contain methodological debates have the potential to improve SLCA understanding and practical application, including them as one of the general research criteria ought to be a priority.

Social Development Index (SDI) measures the social wellbeing of society observing the social and environmental aspects. Workplace wellbeing includes all dimensions of working life, including the standard and security of the physical workplace as well as how employees feel about their positions, work settings, work climate, and work structure. Workplace well-being initiatives aim to maintain employees' safety, health, satisfaction, and engagement. The long-term effectiveness of a business is significantly influenced by its employees' well-being. Numerous studies demonstrate a clear link between worker health and well-being and production levels.

Climate change is causing a variety of extreme weather events to occur more frequently and with greater intensity. These events include heat waves, droughts, floods, and storms. The impacts of these events can be devastating for communities and ecosystems. Heat waves can lead to heat stress and illnesses, droughts can cause crop failures and water shortages, floods can damage homes and infrastructure, and storms

can cause widespread power outages and property damage. Climate change can also exacerbate existing problems such as air pollution, spread of disease, and wildfires. It is important to take action to reduce greenhouse gas emissions and adapt to the impacts of climate change that are already happening. Similarly these extreme weather conditions impacts are experienced mostly by people working in open atmosphere.

The social impact on the globalized economic structure is emerging through different methods. The common example of the social factors includes the child labor, poor working environment condition, unfair wages, and unfavorable living condition along with other social factors (Lobsiger-Kägi et al., 2018; Herrera Almanza and Corona, 2020). Construction businesses, like any other, should follow certain regulations to ensure the health and safety of their workers. Enterprises and organizations are increasingly recognizing the need to take the well-being of their workers seriously. The more progressive organizations are doing so because they recognize that their most valuable resources are their people. Other organizations are starting to address well-being issues because it is becoming clear that many workplace problems stem from a lack of commitment to their workers' needs. A lack of recognition on the need to promote workers well-being may give rise to workplace problems, such as fair working conditions, working hours, fair salary etc. Potential solutions, such as leadership, communication and a focus on learning and development are essential for anyone committed to making the workplace a more decent and satisfying place.

With the passage of time, it has been observed that SLCA is beneficial for the construction activities, but in Pakistan this adoption is too low and extreme working condition and extreme climate is one of main reasons. The performance of the organizations in the construction sector has been in middle with some companies performing too well and some below average. So due to this reason, the performance of the organizations is declining and their reviews have gone below average. The need to adopt the SLCA is increasing and the management of organizations need to be aware of the consequences they are facing, and how the SLCA adoption can resolve them. The organizations in the construction sector of Pakistan are not well aware of the SLCA approaches that must be adopted to keep the workers safe, and also elevate efficiency of the construction activities. Before moving on to the other sections, the researcher must first determine the overall

structure of the study so that the readers can gain an understanding of each segment. In total, four sections are covered in the entire study, with each segment providing a unique perspective on the subject. The first segment focuses on the introduction, which provides a brief overview of the study's background while explaining the SLCA and SDI in general. In addition, the study defines the goal and objectives. The second segment is a literature review, which analyses previous studies that aid in exploring the concept of SLCA as well as its connection to improving social aspects among construction companies, as well as defining theories. The methodology refers to defining the process and technique for carrying out the research in the third section. The fourth segment of research is concerned with the results and findings derived from data collection. The final segment is concerned with the conclusion, discussion and recommendations that relate to the study's conclusion.

4.2. The Concept of SLCA and SDI

The four steps of ELCA are followed by SLCA because it was developed after ELCA: defining the objective and scope of the analysis, inventory analysis, effect assessment, and drawing conclusions from the findings (ISO 2006a, b). The first step in using SLCA for research is identifying the objective, target population, system boundary, and functional unit. During the inventory analyses second stage (Tsalidis and Korevaar, 2019), data is collected, SLCA models are made, and LCI results are evaluated. The people who work in the building construction industry care about how long a building lasts. When planning a project, safety precautions for construction workers, reducing noise, and protecting cultural sites must be at the top of the list. Because of this, it is very important to study the social effects of building development (Medyna et al., 2018). It is essential to determine the optimal number of key indicators related to sustainability goals and standards. An AHP-based SLCA was used to evaluate modular home structures in the Canadian province of British Columbia. The study included 24 different indicators. There were twelve environmental, nine economic, and twelve social. The study's indicators were chosen through a group decision-making process. The LCA stages were used to divide the indicators into multiple indicators, such as operational cost, maintenance cost, end-of-life cost, design and build cost, and so on. There is no standard way to choose the effects categories for the SLCA or to measure the indicators. The

Guidelines suggested a top-down SLCIA plan with 31 subcategories and five stakeholder groups. A study that looked for indicators used methods from both the top and the bottom. Hybrid technique (Zhou et al., 2019). According to the review done by the authors, very few studies on SLCA for residential buildings took into account regional differences in sustainability indicator selection, supply chain stakeholder participation, TBL objectives (Balasbaneh et al., 2021). SLCI life cycle assessments and SLCIA stages have some problems that haven't been solved yet because the approach is still new. The case studies showed many different ways to gather information. In one piece of research, experts in the field were asked a series of questions to get information for a project that looked at the whole life cycle of the supply chain for building materials (Mesa Alvarez and Ligthart, 2021). Even though most of the research has been on employees, SLCA studies on stakeholders should not be ignored. They suggested using a participatory method in the SLCA to find out what stakeholders thought and to find the most important metrics. They also supported the use of this method. When planning a project, safety precautions for construction workers, reducing noise, and protecting cultural sites must be at the top of the list. Because of this, it is very important to study the social effects of building development (Medyna et al., 2018), especially in Hong Kong, which has a lot of people and a lot of construction going on at the same time. Social life cycle assessments and Social Life Cycle Impact Assessment stages have some problems that haven't been solved yet because the approach is still new. The SLCA scores were based on these responses. They made an SLCA model without first getting any project data. They also used national data instead of data from the projects themselves. In different situations, you can ask for both national and project data. However, putting them together takes some creativity. Quantification, or connecting data to the functional unit, is another problem with LCI. SLCA has become a significant area for undertaking research that can contribute to its effectiveness for measuring the social aspects (Martucci et al., 2019).

Social Development Index majorly depends on the dimensions involved in it. For many years, the LCA community has debated social life cycle assessment (SLCA). The discussion of social impacts from a life cycle perspective has a long history, dating back to attempts to include impacts on stakeholders in the Life Cycle Assessment process

(Baumann, 2013). The three parameters making up the social development index are shown in figure below.

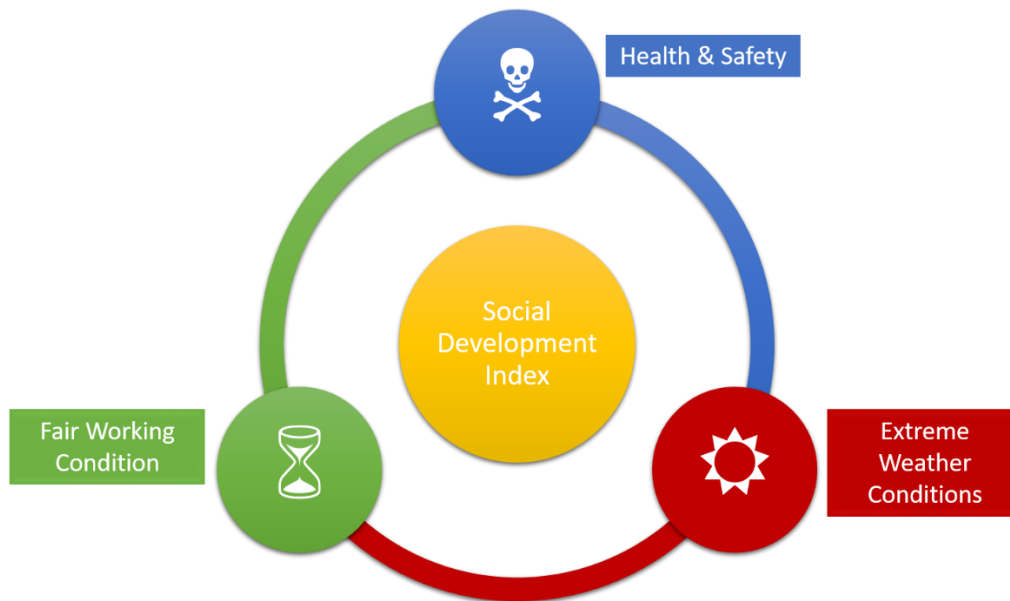


Figure 4.1: Dimensions of SDI

ELCA, LCC, and SLA have been used to solve the environmental, social, and economic problems that have been plaguing the construction industry. The life cycle assessment looks at all of these methods (SLCA). When figuring out how a building affected the environment around it, either its carbon footprint or how much energy it used were taken into account (Janjua et al., 2019). LCC in residential construction has gotten a lot of attention because it is good for the economy. However, the economic effects on developers and end-users have not been looked into. A lot of attention has been paid to LCC for residential buildings lately. There is a chance that the SLCA study on residential buildings looked at both social equality within and between generations as factors that contribute to sustainability. Even though three different approaches to sustainability (ELCA, SLCA, and LCA) are enough to manage a single sustainability target throughout the building's life cycle, it would be good to combine these approaches to figure out the building's overall sustainability score (Navarro et al., 2018). A study that made ELCA more useful looked at environmental concerns from both a political and a social point of view (Nubi et al., 2021). In 1999, SETAC thought about whether or not to combine SLCA with LCC and LCA. This session was about social welfare because it was a part of the

ELCA study that looked at the effects on society. Because of this, it was suggested that LCC and LCA be added to SLCA (Wei et al., 2022). UNEP/SETAC published a number of methodology sheets and guidelines for SLCA in 2009. By conducting stakeholder interviews for cradle-to-grave life cycle studies of specific products such as laptop computers (e.g., workers' benefits, health and safety, and healthy living conditions for the local community), vehicle fuels, and so on (e.g., child labor, health and safety, and fair salary) (Wei et al., 2022). The SLCA tool is not used very often in construction. Only a small number of SLCA studies have been done on residential buildings. Most of the studies have been about social welfare issues like employment and health. These things were taken into account. The Social Life Cycle Assessment (SLCA) looked at the social effects of concrete and steel (Balasbaneh et al., 2018). The Social Development Index is a new approach for social indexes extracted from Social Life Cycle Assessment Approach that is difficult to implement because life cycle inventories are difficult to create and evaluate (LCI). The majority of SLCA research was based on broad data collected from across the country, rather than site-specific data. There is no single way to select impact indicators. Despite the fact that the UNEP/SETAC standards call for a "top-down" approach to social LCI (Safarpour et al., 2022), some research suggests that a "bottom-up" approach, in which everyone is involved in selecting impact indicators, would be preferable. There is no single way to select impact indicators. Stakeholders in the SLCA rely on the study's goals, how stakeholders act, and legally binding confidentiality agreements. SLCA studies are used to determine the boundaries of systems based on their scope. However, the same system constraints must be used in every study that relates to the SLCA's three goals—environmental, social, and economic (Mesa Alvarez and Ligthart, 2021). The importance and necessity of integrating the life cycle assessment (LCA) with social aspects has grown as a result of the escalating social issues, giving rise to the development of social life cycle assessment in the 1990s. Along with promoting sustainability, the social impacts of products have significantly increased (Petti, Serreli and Di Cesare, 2018).

4.3. Methodology

4.3.1. Study Area Selection

Muzaffarabad is the capital of Pakistan's Azad Kashmir. It is situated on the banks of the rivers Jhelum and Neelum. The district is bounded in the west by the North-West Frontier Province, in the east by the districts of Kupwara and Baramulla on the Indian side of the Line of Control, and in the north by the Neelum District of Azad Kashmir. The 13,297-square-kilometer AJK region is divided into 10 districts and 1,771 villages. Muzaffarabad is one of ten districts. Approximately 88% of the population lives in rural areas, while 12% lives in cities.



Figure 4.2: Map of Muzaffarabad

The area's literacy and primary enrollment rates are both astoundingly high, at 74% and 94%, respectively. The elevation is 737 meters, and the population is approximately 150,000 people. Muzaffarabad was officially established in 1646 by Sultan Muzaffar Khan, who ruled Kashmir at the time. He built a red fort in the city to protect it from the Mughals. The October 2005 earthquake that killed over 75,000 people struck

Muzaffarabad. The city was devastated, and it was overrun with tent camps and non-governmental organizations. Reconstruction has been slow.

Muzaffarabad was one of the city that was hardly hit by 2005 Earthquake, The has poorly constructed structures and can experience considerable damage as compared to other less populated sites in the surroundings(MonaLisa 2008). With this study the readers can also get to know that after such a disastrous earth quake where construction practices improved and implemented on construction sites.

SLCA aims to assist decision makers the well-being social decisions in order to improve the organization's social performance and the well-being of stakeholders throughout the life cycle.

The SDI, or "social development index," is used to determine what goals society wants to achieve with a product. It emphasizes the needs of the end-user, the community, the supplier, the builder, and the designer throughout the life cycle of a building. The SDI, like the SLCA and ELCA, establishes goals and a scope, creates an inventory, evaluates the effects, and examines the outcomes. Similar to the Human Development Index, our indicator, the Workers' Social Development Index (W-SDI), measures 3 aspects of worker development, these are as follow:

1. Health and Safety
2. Fair Working Conditions
3. Extreme Weather Conditions

4.3.2. Sampling and Data Collection

The Survey based study was conducted in Muzaffarabad Azad Jammu & Kashmir, Two questionnaires' were made covering the aspects of stakeholders of social lifecycle assessment (SLCA). The stakeholders were:

1. Workers
2. Local Community
3. Consumers
4. Value Chain Actors

The questionnaire asked from workers against which their social development index was development and analyzed had an assortment of close-ended questions mainly pertaining to the indicators Workers Health and Safety, Fair Working Condition and Extreme Heat Waves. A Total number of 120 samples were collected from workers

working in different construction projects. Prior to the survey, the respondents were briefed about the purpose of the study, and their consent was sought. Additionally, the questions were translated into the local language for a better understanding of the respondents as most of them were uneducated.

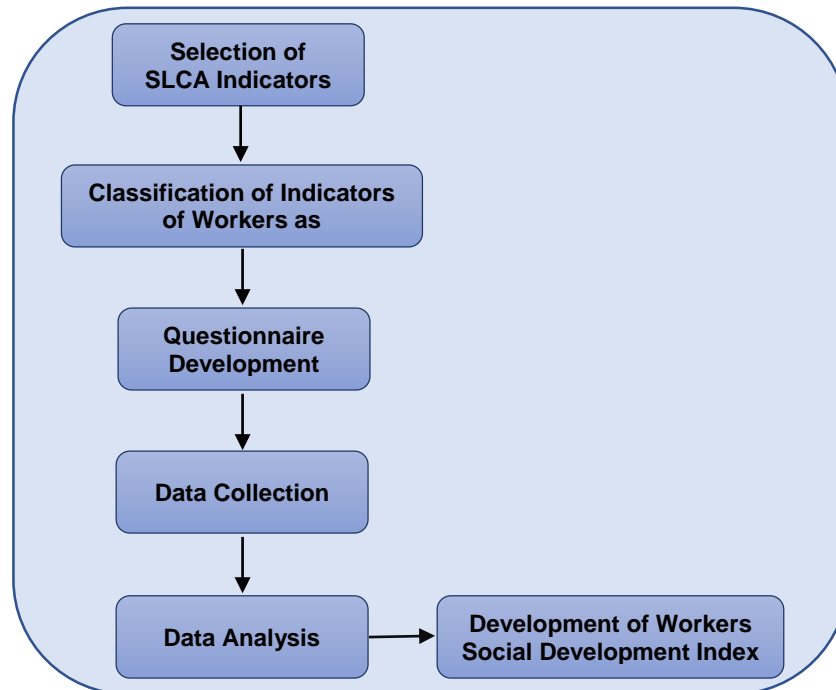


Figure 4.3: A Methodological Framework for development of Workers SDI

Indicators for Workers Health & Safety, Fair Working Condition, Extreme Heat Wave.

Sr. no.	Indicators	Unit of measurement	Weights	Explanation
Health & Safety				
1	Safety Helmet	Yes	1	It will add positive impact on Workers SDI
		No	0	
2	Safety Glasses	Yes	1	"
		No	0	
3	Safety Gloves	Yes	1	"
		No	0	
4	Safety Shoes	Yes	1	"
		No	0	
5	Safety Belt	Yes	1	"
		No	0	
6	Safety Sign	Yes	1	"
		No	0	
7	Hearing Protection	Yes	1	"
		No	0	

8	Green Sheet	Yes	1	"
		No	0	
9	Near Miss	Yes	1	Less Near miss will add positive impact on Workers SDI
		No	0	
10	Injuries	Yes	1	Less Injuries will add positive impact on Workers SDI
		No	0	
11	Deaths	Yes	1	Less Deaths will add positive impact on Workers SDI
		No	0	
12	First Aid Kit	Yes	1	Having First aid kit will add positive impact on Workers SDI
		No	0	
Fair Working Condition				
1	Uncompleted Tasks	Yes	1	Less Uncompleted tasks will add positive impact on Workers SDI
		No	0	
2	Day-off	Yes	1	It will add positive impact on Workers SDI
		No	0	
3	Overtime Wage	Yes	1	"
		No	0	
4	Delay in Payments	Yes	1	Less Payments Delay will add positive impact on Workers SDI
		No	0	
5	Child Labor	Yes	1	No Child labor will add positive impact on Workers SDI
		No	0	
6	Equal Wage	Yes	1	Equal Wages add positive impact on Workers SDI
		No	0	
7	Work Load	Yes	1	Volunteer work load on will add positive impact on Workers SDI
		No	0	
8	Hours per Day	≤8	1	≤8 hours will add positive impact on Workers SDI
		>8	0	
Extreme Working Conditions/ Heat Wave				
1	Faint	Yes	0	Less people faint will add positive impact on Workers SDI
		No	1	
2	Protection from HW	Yes	1	More people wearing hat on hot days add positive impact on Workers SDI
		No	0	
3	Water Consumption	Yes	1	More water consumption will add positive impact on Workers SDI
		No	0	
4	Light Clothes	Yes	1	Wearing light clothes will add positive impact on Workers SDI
		No	0	
5	Breaks on hot days	Yes	1	More breaks on hot days will add positive impact on Workers SDI
		No	0	

Table 4.1 Indicators for Workers Health & Safety, Fair Working Condition, And Extreme Heat Wave

4.3.3. Index Construction and Data Analysis

An indicator-based approach was adopted to quantify the three components of Social Development Index. Each indicator from all three components was classified and given equal weights, assuming that each indicator has a similar impact on overall SDI.

$$CI = (W1 + W2 + W3 + \dots + Wn)/n$$

$$= \sum_{i=1}^n W_i / n$$

Where,

CI is the composite index; W1 to Wn are the assigned transformed values; n is the total number of indicators

Indexes of respective three components of SDI were formulated as follow.

$$\text{Health \& Safety Index (H\&SI)} = \sum_{i=1}^{12} H\&SW_i / n \quad (n = 12)$$

$$\text{Fair Working Condition Index (FWCI)} = \sum_{i=1}^8 FWCW_i / n \quad (n = 8)$$

$$\text{Heat Wave (HWI)} = \sum_{i=1}^5 HW_i / n \quad (n = 5)$$

After respective index values which individually contribute towards Social Development Index and their cumulative SDI value can be obtained from equation formulated below. SDI value equals to 1 indicates positive impact and vice versa.

$$\sum SDI = (\sum H\&SI + \sum FWCI + \sum HWI) / 3$$

4.4. Results and Discussion

The most critical stakeholder came out to be ‘workers’ .After performing survey with 120 workers working in different residential projects of Muzaffarabad, AJK, results were documented using SPSS software

Workers Socio-Economic Profile:

Gender	Value	Frequency	Percent
		Male	120
Age	<=18	7	5.8
	19-24	23	19.2
	25-30	68	56.7
	31-36	16	13.3
	37+	6	5.0
Education	Uneducated	53	44.2
	Matric/O-Levels	65	54.2
	Fsc./A-Levels	2	1.7

Marital Status	Unmarried	10	8.3
	Married	110	91.7
Number Of Dependents	<= 2.00	10	8.3
	3.00 - 5.00	68	56.7
	6.00 - 8.00	40	33.3
	9.00 - 11.00	2	1.7

Table 4.2 Workers Socio-Economic Profile

As indicated in the table all the workers were ‘male’ and most of them were of in age gap of 25-30 yrs. This shows that female participation in this area is nill due to job nature and cultural aspects as well. Addressing gender inequality requires a multifaceted approach that addresses both systemic and cultural factors, such as advocating for gender equality policies, challenging gender stereotypes, and promoting inclusive environments that value and respect all individuals, regardless of gender. Finally, achieving gender equality benefits society as a whole by promoting fairness, opportunity, and justice for all. Almost 44 percent of workers were uneducated and 54 percent of them have matric degree. The survey also shows that most of workers were married and have dependents for which they have to work in extreme conditions and hours keeping their health on stake. Workers' socioeconomic condition refers to their social and economic standing in society. Income, education, occupation, and access to resources and opportunities are all factors. The socioeconomic status of a worker can have a significant impact on their quality of life and overall well-being. Those in lower socioeconomic status may face challenges such as limited access to education and job opportunities, which can lead to a cycle of poverty and make it difficult to improve their situation. Workers in higher socioeconomic positions, on the other hand, have greater access to resources and opportunities and enjoy a higher standard of living. It is critical for society to address socioeconomic disparities and ensure that all workers have access to the resources and opportunities they require to thrive.

4.4.1. Health and Safety:

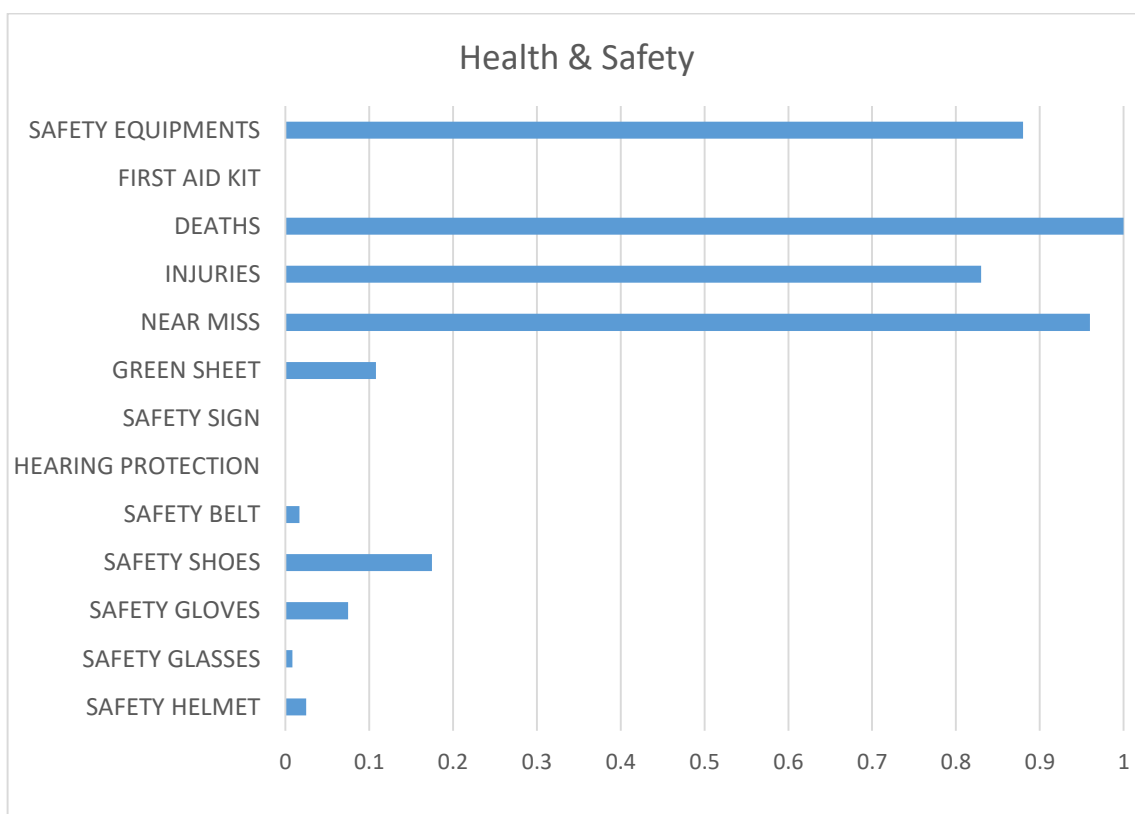


Figure 4.4 SDI Value vs. Health & Safety factors

From the above figure, it can be concluded that safety equipment is in good condition, first aid kits are in bad condition, and deaths and injuries are taking place because they are at high value. Near miss is also found at high value, while all the other variables are found in bad condition. This shows that greet sheet, safety sign, hearing protection, safety belt, safety shoes, safety gloves, safety glasses and safety helmet are not found in good condition. The results from the above table indicate that most of the workers do not wear safety helmet because the number of respondents found was 97.5% who marked no. The above table indicates that most of the workers do not wear safety glasses because 99.2% marked no against the asked question. The table above indicates that 92.5% of respondents do not wear safety gloves when asked about the question. The safety shoes are not worn by the respondents most of them because 82.5% marked

no when asked about it. From the above table, it can be summarized that workers do not use safety belts when working on heights because 98.3% marked “No”. The responses received show that all the respondents marked no when asked about wearing hearing equipment when working in a noisy environment. The results obtained show that all the respondents do not put safety signs or notes on the road outside under construction houses when they carry out critical construction activities. The respondents (89.2%) marked no which shows that construction site was not covered with green sheets. The results indicate that there did not happen any mishap during construction activity because 96.7% marked “No”. There were no injuries as per the results of 83.3% of respondents. There were no injuries as per the results of 83.3% of respondents. The results show that no deaths took place during the construction activities. The availability of first aid kits was not present per all the respondents. Most of the respondents claimed that safety equipment and overall safety measure is necessary because 82.5% marked yes in response to the question.

4.4.2. Fair Working Conditions:

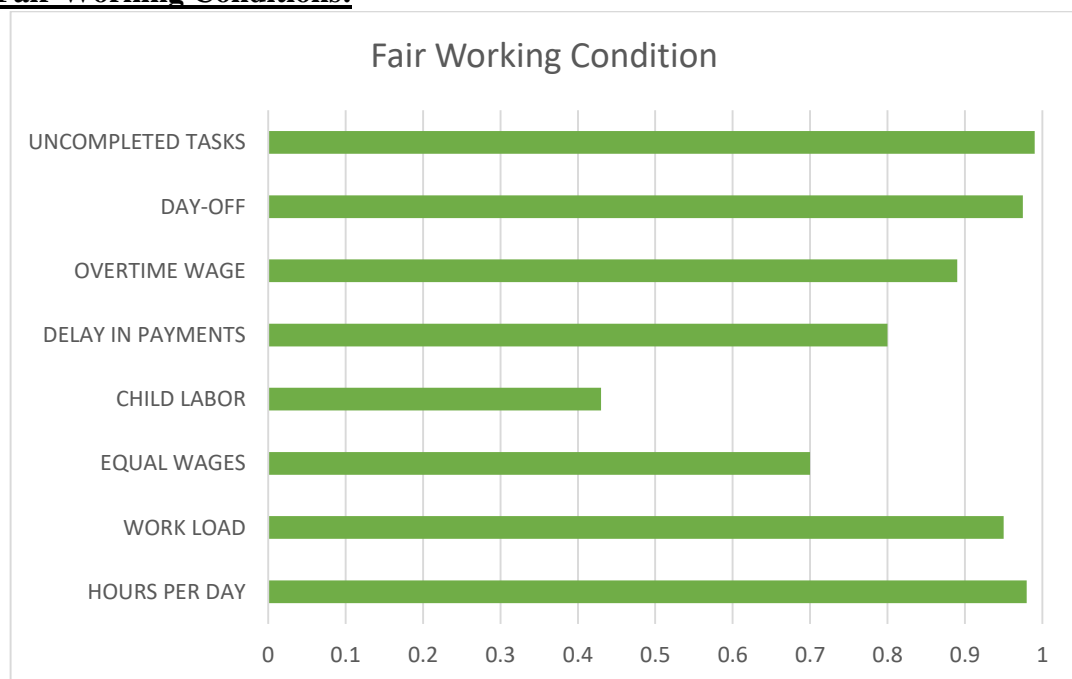


Figure 4.5 SDI Value vs. Fair Working Condition factors

On the basis of the above results obtained, it can be summarized that most of the working conditions are in good condition because uncompleted tasks also stand near

one, along with day-off, overtime wage, delay in payments, equal wages, workload and hours per day. Only child labor is found in bad conditions to some extent. Hence, there is a need to improve working conditions and make them fair in Pakistan.

4.4.3. Extreme Weather Condition/Heat Wave:

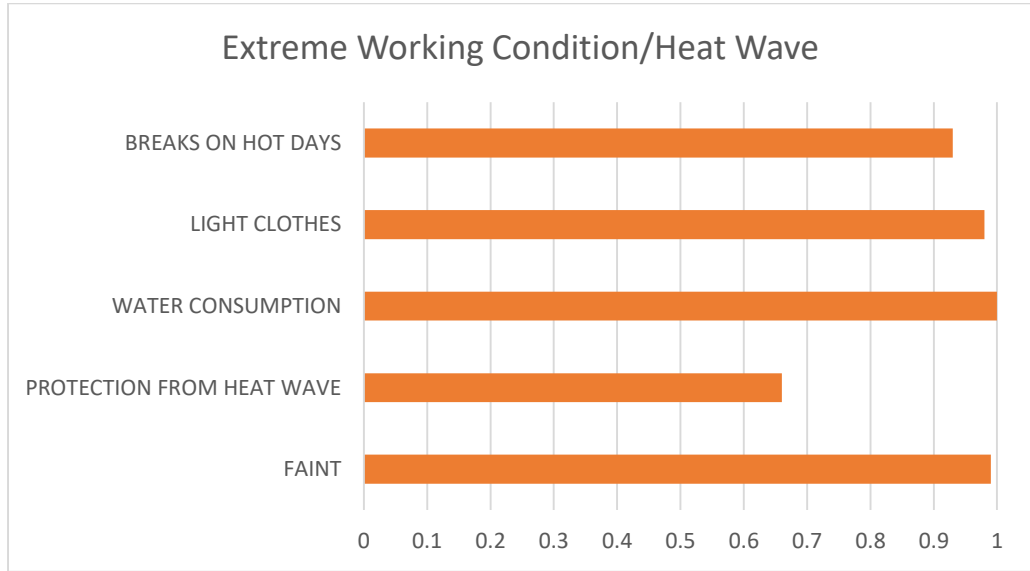


Figure 4.6 SDI Value vs. Extreme Condition/Heat wave factors

All the values obtained are high, which shows that people are working in extreme working conditions and heat waves. The value of all fainting, protection from heat waves, water consumption, light clothes and breaks on hot days are found with low value. Hence working conditions followed are extremely difficult.

These THREE “Health and Safety” “Fair Working Conditions” “Extreme Weather Condition/Heat Wave” indicators make Social development index SDI of Workers really difficult because most of them are found criticizing the activities and claiming that they are not satisfied with them. Furthermore, the results obtained show that working conditions are not fair and demand them to be more engaged in risky activities. The results obtained also indicate that most of the workers are found dissatisfied with the working environment and tools provided to them. This is because the organizations are not using the safety equipment as per the responses received from survey questions. The results also show that workers must be provided with the equipment because they are not involved in the responsibilities as per the requirements of the safety principles. The performance of the workers can be improved by providing them with safety equipment because in this way their working pattern would significantly improve. If the SLCA approach is needed to be improved, the three parameters analyzed above must be sorted by the management accurately.

So, the SDI value from results came out to be,

$$\sum SDI = (\sum H\&SI + \sum FWCI + \sum HWI)/3$$

$$\Sigma SDI = (0.3134 + 0.83 + 0.912)/3$$

$$\Sigma SDI = 0.685$$

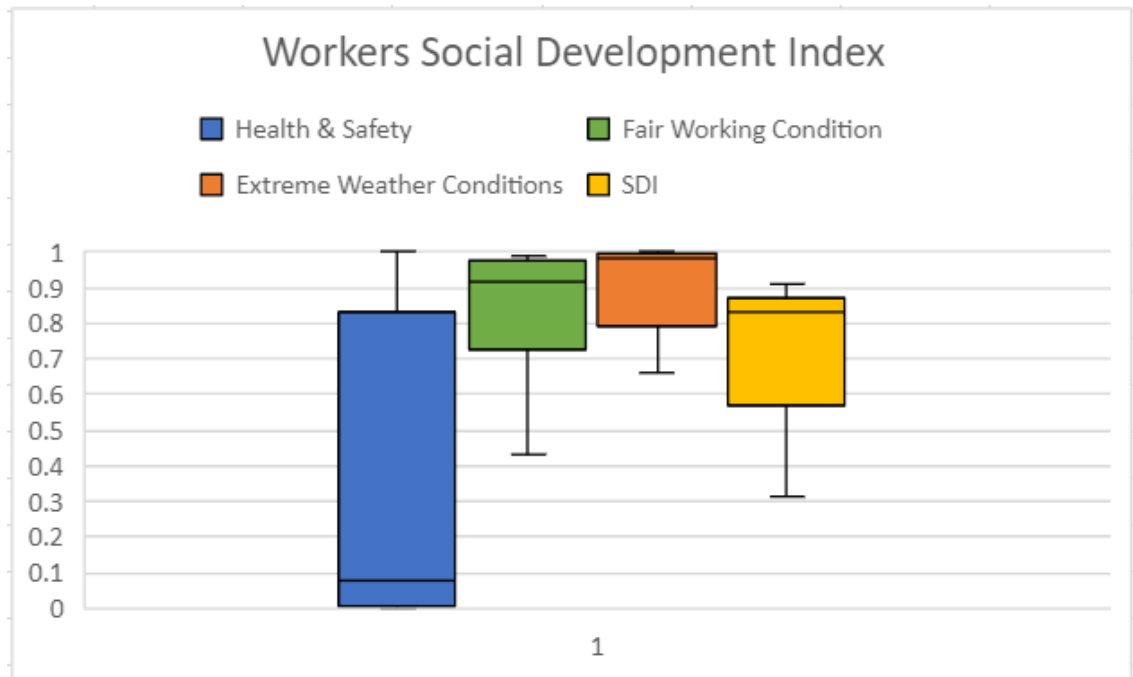


Figure 4.7 Social Development Index

As, SDI equals to 1 means that it has a positive impact, the value was low in Health & Safety but relatively high in other to parameters.

Mean of health & safety is 0.314

$$\text{Standard Deviation of health \& safety} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2}$$

Standard Deviation of health & safety = 0.423

the mean of health and safety comes out to be 0.314 which is very low and had negative impact on SDI where as standard deviation comes out to me 0.423.

Mean of fair working condition is 0.83

$$\text{Standard Deviation of fair working condition} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2}$$

Standard Deviation of fair working condition = 0.194

The mean fair working conditions comes out to be 0.83 which is high and had relatively positive impact on SDI where as standard deviation comes out to me 0.194.

Mean of extreme weather conditions is 0.912

$$\text{Standard Deviation of extreme weather conditions} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2}$$

$$\text{Standard Deviation of fair working condition} = 0.143$$

The mean extreme weather conditions comes out to be 0.912 which is very high and had positive impact on SDI where as standard deviation comes out to me 0.143.

SOCIAL LIFE CYCLE ASSESSMENT OF RESIDENTIAL CONSTRUCTION FROM RESIDENTS PERSPECTIVE

This chapter describes in brief the concept of SLCA, methods and their results.

5.1. Introduction

Social Life Cycle Assessment (SLCA) is a method used to evaluate the social impacts of a product or service throughout its entire life cycle. It is an extension of the traditional Life Cycle Assessment (LCA) method, which focuses on environmental impacts. The SLCA method involves identifying and assessing the social impacts of a product or service, from the extraction of raw materials to the disposal of waste. This includes evaluating the impacts on workers, communities, and other stakeholders throughout the supply chain. The assessment also considers the social impacts of the product's use, such as the effects on the health and well-being of the user.

One of the main objectives of SLCA is to identify and understand the social issues associated with a product or service, and to identify opportunities for improvement. It can also be used to compare the social impacts of different products or services, and to identify the most sustainable options. The backbone of an SLCA is the information and data describing the product life cycle, the processes therein, and the relations with different stakeholders in accordance with the goal and scope defined for the study (Benoît et al., 2010).

The construction of residential houses is one of the most important occasions in the lives of people. In this research, it has been assessed the social life cycle of a house construction, the way it is experienced and its significance on life of each person. With the increasing issues on social aspects, it has led to the importance and need to integrate the LCA with the social aspects which caused the emergence of social life cycle assessment which was developed in the 1990s. There is a significant increase on the social impacts of the products along with promoting sustainability (Petti et al., 2018). The basic purpose of SLCA is to present with the information on the social issues for decision making and further helping in informing the suggestions for improvement. The SLCA is not a widely recognized tool as LCA but its approach is gaining significant interview that can be reflected to the number of academic researches and case studies. The first attempt for using the framework was published in 2019 by the United Nations Environment Program/Society and has presented with the extensive guidelines for Social Life Cycle Assessment.

Therefore, several studies have adopted the measures of LCA in respect to reducing the environmental impact of buildings and other aspects. Although Methodologies for the implementation of SLCA are still under development (Hosseinijou et al., 2013). However, the major issue with the LCA is that it only concentrated on the environmental factors based on the life cycle of the product. With the increasing debate on social aspects and a framework for measuring social elements, it has led to the evolving of the LCA by integrating the social factor. This has led to the introduction of SLCA which is method and technique for evaluating the social and socio-economic aspects of the products in respect to its positive and negative impact throughout its life cycle which is from the extraction of raw material, manufacturing, distribution, use, reuse, maintenance, recycling and financial disclosure (Pollok et al., 2021). In general terms, the SLCA is mainly focusing on the assessment of the people's life-cycle activities by incorporating the social side of the sustainability among the LCA methodology.

In order to achieve sustainable development, the environment, the economy, and society must all work together. Tools such as ELCA and LCC came into being as a result of an increased focus on the environmental impact of individual products (Pagnon et al., 2020).

The SLCA is a descendant of the ELCA and maintains the ELCA's four-phase framework (ISO 2006a, b): defining the aim and scope of the analysis, inventory analysis, conducting an impact assessment, and drawing conclusions from the results (da Silva et al., 2021).

The need to integrate the life cycle assessment (LCA) with the social aspects that led to the social life cycle assessment (SLCA) dates back to 15 years ago (Petti et al., 2018). During the last 10 years, there has been an increase in the usage of SLCA, a method that could be helpful. Among the industries that are being investigated are those pertaining to electronics, food, waste treatment, tourism, building materials, and biofuel. The Guidelines for Social Life Cycle Assessment of Products define social life cycle assessment, or SLCA, as a social impact assessment technique that aims to assess the social and socioeconomic aspects of products as well as their potential positive and negative impacts along their life cycle (Vilaboa Díaz et al., 2022). This life cycle includes the extraction and processing of raw materials, manufacturing, distribution, use, re-use, maintenance, recycling, and final disposal of the product. The SLCA Guidelines use a top-down approach with 31 subcategories and five different stakeholders. In another study, the method for identifying indicators was a combination of top-down and bottom-up approaches. Even though workers are the primary focus of the vast majority of SLCA studies, other stakeholders must be involved. They proposed incorporating the participatory approach into the SLCA methodology because it could be used to collect the perspectives of numerous stakeholders and generate relevant indicators. The Guidelines provide an explanation of research standards (Wang & Sinha, 2021).

5.2. The Concept of SLCA

Numerous stakeholders attach a great deal of importance to the building life cycle, particularly those working in the construction industry. Construction projects must take into consideration issues of public health and safety, as well as noise pollution and cultural heritage. Particularly in Hong Kong, which has a high population density as well as a high construction intensity (Almeida, Charbuillet et al. 2020), it is essential to investigate the social repercussions of the expansion of the building industry. In order to assist construction employees in better comprehending the social effect of the projects they

work on, this research presents a case study of SLCA. A tool for SLCA modelling, the Social-impact Model of Construction (SMoC) is used in the building construction industry in Hong Kong. The model was developed using responses to a survey as well as data collected at the national level (Najjar, Figueiredo et al. 2022). A social impact assessment of a proposed residential development in Hong Kong may be carried out with the help of SMoC. This locates the various hotspots. The findings of this study should be taken into consideration in any future SLCA research. Because SLCA is still in its developmental stages as a method, both LCI and SLCA contain problems that have not yet been overcome. Case studies illuminate a variety of approaches to the data collecting process. In order to gather data on the whole life cycle chain of building materials, a research team conducted interviews with industry professionals. The SLCA grading system was developed using the information obtained from the interviews (Ersan, Gulcimen et al. 2022). In one of the studies, an SLCA model was created, however national data rather than project data were used, and no project data were collected. It is possible for you to request both national and project data in many different scenarios; however, you will need to mix them in an inventive manner.

When using SLCA to do research, the first step is to figure out the study's goal, target group, system boundary, and functional unit. In the second phase of inventory analysis (Tsalidis, Gallart et al. 2020) , data is collected, SLCA models are made, and LCI results are evaluated. The social life cycle impact assessment categorizes the LCI results into various types of effects. The final step is to examine the results to determine where any hotspots exist (Cadena, Rocca et al. 2019). The Guidelines give an overview of the research that needs to be done. These criteria are made up of both general research and steps from the SLCA. Case studies that include technique talks can help people learn more about SLCA and the different ways it can be used in the real world. For general research, this is a must.

Building construction workers are concerned with the longevity of a structure. When planning a project, safety precautions for construction workers, noise reduction, and cultural site protection must be prioritized. As a result, it is critical to investigate the social effects of building development (Biber-Freudenberger, Basukala et al. 2018) , particularly

in Pakistan, where there are a lot of people and a lot of construction going on at the same time. This article uses SLCA as a case study to help construction workers understand how their projects affect the community. Social life cycle assessments (SLCA) stages have some problems that haven't been solved yet because the approach is still new. The case studies showed many different ways to gather information. In one piece of research, experts in the field were asked a series of questions to get information for a project that looked at the whole life cycle of the supply chain for building materials (Mesa Alvarez and Ligthart 2021). The SLCA scores were based on these responses.

There is no standard way to choose the effects categories for the SLCA or to measure the indicators. The Guidelines suggested a top-down SLCA plan with 31 subcategories and five stakeholder groups. A study that looked for indicators used methods from both the top and the bottom. The calculation method of weight factors reduces man-made disturbances and the sensitivity analysis demonstrates strong robustness of the results and effectiveness of the modification for the mode (Zhaozhi Zhou 2019). Even though most of the research has been on employees, SLCA studies on stakeholders should not be ignored. They suggested using a participatory method in the SLCA to find out what stakeholders thought and to find the most important metrics. They also supported the use of this method.

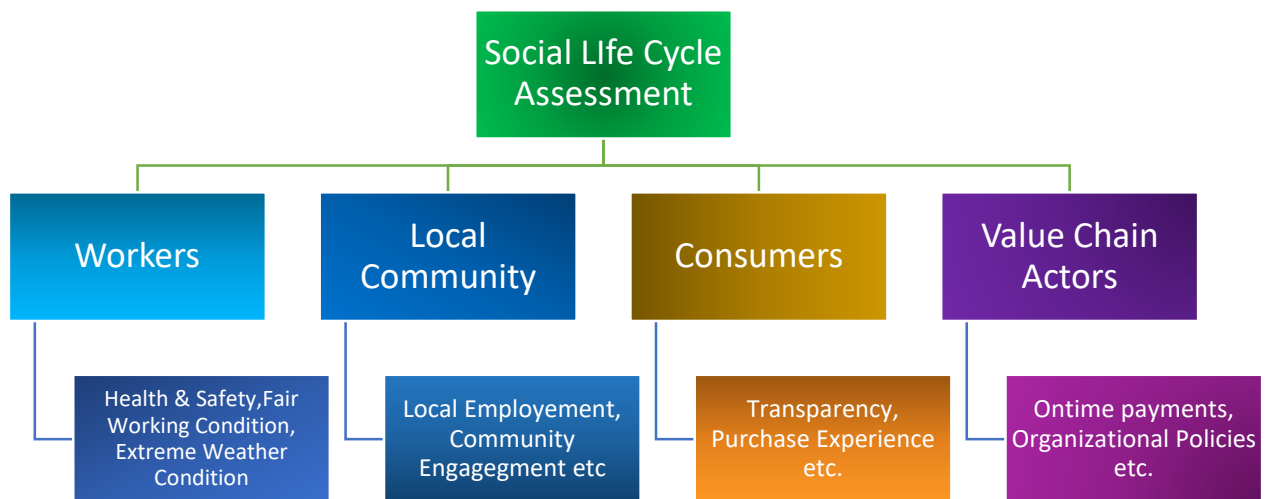


Figure 5.1: Typical Hierarchy of SLCA

There is a chance that the SLCA study on residential buildings looked at both social equality within and between generations as factors that contribute to sustainability. The SLCA approaches show that the perception of social impacts is very variable (Jørgensen, Le Bocq et al. 2007). Even though three different approaches to sustainability (ELCA, SLCA, and LCA) are enough to manage a single sustainability target throughout the building's life cycle, it would be good to combine these approaches to figure out the building's overall sustainability score (Navarro, Yepes et al. 2018). The ELCA, LCC, and SLCA are all used to reach social, economic, and environmental sustainability goals at the same time. This paradigm chooses indicators to measure large-scale effects after looking at them from different points of view. In addition, it stops double counting, connects social indicators to a functional unit, includes stakeholders in indicator weighting to reduce assessment uncertainties, looks at both positive (benefit) and negative (carbon footprint) indicators, and applies to real-world situations. According to the authors' review, very few studies on SLCA for residential buildings took regional differences in sustainability indicator selection and supply chain stakeholder participation

into account (Tighnavard Balasbaneh and Sher 2021). Recent research done by one of the authors showed that the difference in the actual service life of a structure due to the durability of its parts affects the conclusions and results of the environmental LCA. Without service life integration, the early end of life of the structure makes it likely that the results of a sustainability assessment will be wrong. When there is no maintenance or repair work done on a building while it is in use, the durability of the building materials isn't taken into account (Santos, Mendes et al. 2019). The authors' SLCA framework must be tested with real-world data to determine whether it is unique and scalable. Regarding technology implementation, it was examined which indicators are available in this SLCA approach and which could additionally be integrated and applied (Lehmann, Zschieschang et al. 2013).

During a building's life cycle, it gives the needs of the end-user, the community, the supplier, the builder, and the designer the most importance. In a way similar to the ELCA, the SLCA sets goals and a scope, makes an inventory, evaluates the effects, and looks at the results. A study that made ELCA more useful looked at environmental concerns from both a political and a social point of view (Nubi, Morse et al. 2021). In 1999, SETAC thought about whether or not to combine SLCA with LCC and LCA. This session was about social welfare because it was a part of the ELCA study that looked at the effects on society. Because of this, it was suggested that LCC and LCA be added to SLCA (Wei, Cui et al. 2022). In 2009, UNEP/SETAC released a number of methodology sheets and guidelines for SLCA. By interviewing stakeholders for cradle-to-grave life cycle studies of specific products, such as laptop computers (e.g., workers' benefits, health and safety, and healthy living conditions for the local community), vehicle fuels (e.g., child labor, health and safety, and fair salary, palm oil biodiesel products (e.g., exploitative labor relations, the wellbeing of the local community), and papyrus, this tool was able to find social hotspots. Other products that were looked at are: (e.g., labor laws, occupational hazards and accidents, and local community deaths due to air pollution) (Wei, Cui et al. 2022).

5.3. Methodology

5.3.1. Study Area Selection

Muzaffarabad is the capital of Pakistan's Azad Kashmir. It is situated on the banks of the rivers Jhelum and Neelum. The district is bounded in the west by the North-West Frontier Province, in the east by the districts of Kupwara and Baramulla on the Indian side of the Line of Control, and in the north by the Neelum District of Azad Kashmir. The 13,297-square-kilometer AJK region is divided into 10 districts and 1,771 villages. Muzaffarabad is one of ten districts. Approximately 88% of the population lives in rural areas, while 12% lives in cities.



Figure 5.2 Map of Muzaffarabad AJK

The area's literacy and primary enrollment rates are both astoundingly high, at 74% and 94%, respectively. The elevation is 737 meters, and the population is approximately 150,000 people. Muzaffarabad was officially established in 1646 by Sultan Muzaffar Khan, who ruled Kashmir at the time. He built a red fort in the city to protect it from the Mughals. The October 2005 earthquake that killed over 75,000 people struck Muzaffarabad. The city was devastated, and it was overrun with tent camps and non-governmental organizations. Reconstruction has been slow. Muzaffarabad was one of the city that was hardly hit by 2005 Earthquake, The has poorly constructed structures and can experience considerable damage as compared to other less populated sites in the surroundings (Monalisa, Khwaja et al. 2008). With this study the readers can also get to know that after such a disastrous earth quake where construction practices improved and implemented on construction sites.

SLCA aims to assist decision makers the well-being social decisions in order to improve the organization's social performance and the well-being of stakeholders throughout the life cycle. The aim of the research is to conduct an assessment among the stakeholders of the residential construction in Pakistan through utilizing the social life cycle assessment. Based on the aim of the study, there are several objectives are designed that are aimed to guiding the researcher in effectively carrying out the study that can aid in addressing the fundamental aim. The main aim is to understand the concept and guidelines of SLCA for sustainable development with the support of literature review and to know the importance of the SLCA for carrying out assessment for stakeholders and others and in the end provide recommendation while addressing the needs of social and sociological aspects.

5.3.2. Sampling and Data Collection

The Survey based study was conducted in Muzaffarabad Azad Jammu & Kashmir. Questionnaire was made covering the aspects of stakeholders of social lifecycle assessment (SLCA). The stakeholders were:

1. Workers
2. Local Community
3. Consumers

4. Value Chain Actors

The questionnaire was asked from residents about regarding all the stakeholders as they are direct involved in their home construction and can address and answer the questions more effectively against which their social life cycle can be assessed and analyzed that had an assortment of close-ended questions mainly pertaining to the indicators Workers (Health and Safety, Fair Working Condition and Extreme Heat Waves), Local Community, Consumers and Value chain actors. A Total number of 120 samples were collected from residents residing in different residential construction projects. Participation is one of the nonmarket mechanisms that facilitate stakeholder coordination (Mathe 2014). Prior to the survey, the respondents were briefed about the purpose of the study, and their consent was sought. Additionally, the questions were translated into the local language for a better understanding of the respondents.

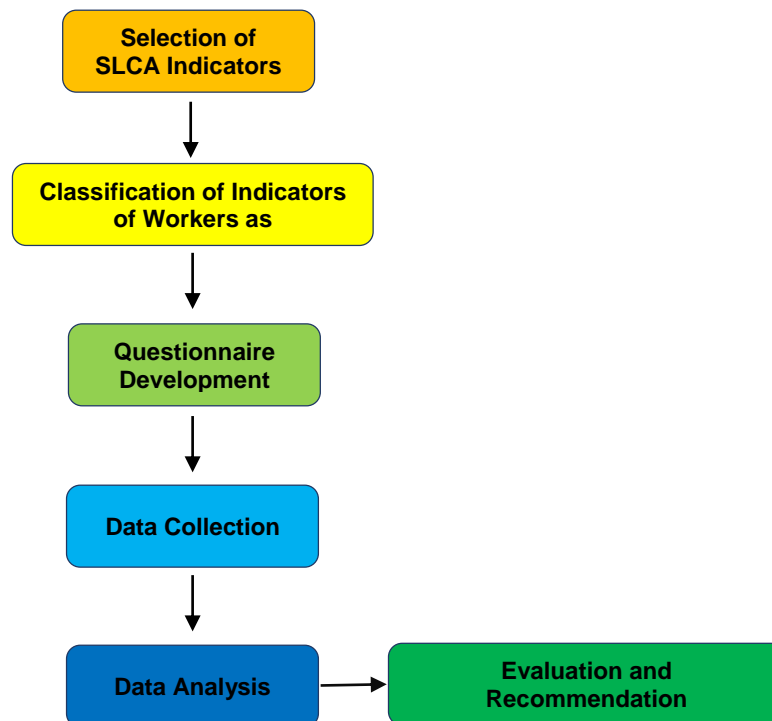


Figure 5.3: Methodological Framework

Indicators for Workers

Sr. no.	Indicators	Unit of measurement	Weights	Explanation
Health & Safety				
1	Use of Safety Equipment	Yes	1	It will add positive impact on SLCA
		No	0	
2	Use of Protective Green Sheet	Yes	1	"
		No	0	
3	Near Miss	Yes	1	Less Near miss will add positive impact on SLCA
		No	0	
4	Injuries	Yes	1	Less Injuries will add positive impact on SLCA
		No	0	
5	Deaths	Yes	1	Less Deaths will add positive impact on SLCA
		No	0	
6	Availability of First Aid Kit	Yes	1	Having First aid kit will add positive impact on SLCA
		No	0	
Fair Working Condition				
1	Uncompleted Tasks	Yes	1	Less Uncompleted tasks will add positive impact on SLCA
		No	0	
2	Day-off	Yes	1	It will add positive impact on SLCA
		No	0	
3	Overtime Wage	Yes	1	"
		No	0	
4	Delay in Payments	Yes	1	Less Payments Delay will add positive impact on SLCA
		No	0	
5	Child Labor	Yes	1	No Child labor will add positive impact on SLCA
		No	0	
6	Equal Wage	Yes	1	Equal Wages add positive impact on SLCA
		No	0	
7	Work Load	Yes	1	Volunteer work load on will add positive impact on SLCA
		No	0	
8	Hours per Day	≤8	1	≤8 hours will add positive impact on SLCA
		>8	0	
Extreme Working Conditions				
1	Climate Change	Yes	1	Construction Practices due to Climate Change
		No	0	
2	Leave due to Heat Wave	Yes	1	Less people leaving on hot days add positive impact on SLCA
		No	0	
3	Hydrated	Yes	1	More water consumption will add positive impact on SLCA
		No	0	
4	Hot Days	Yes	1	More people working on hot days shows extreme working conditions
		No	0	

Table 4.1 Indicators for Workers

Indicators for Local Community

Sr. no.	Indicators	Unit of measurement	Weights	Explanation
---------	------------	---------------------	---------	-------------

1	Local Employment	Yes No	1 0	It will add positive impact on SLCA
2	Community Engagement	Yes No	1 0	"
3	Formal Notice	Yes No	1 0	"
4	Cultural Heritage	Yes No	1 0	Protecting Cultural Heritage adds positive impact
5	Noise Pollution	Yes No	1 0	Low noise will adds positive impact
6	Waste Blockage			Not letting waste block sewerage adds positive impact
7	Construction Waste	Yes No	1 0	"

Table 4.2 Indicators for Local Community

Indicators for Consumers

Sr. no.	Indicators	Unit of measurement	Weights	Explanation
1	Exchange Policy	Yes No	1 0	Having this policy will add positive impact on SLCA and better relation with consumers
2	Purchase Experience	Yes No	1 0	Having better experience will add positive impact on SLCA and better relation with consumers
3	Transparency	Yes No	1 0	It will add positive impact on SLCA

Table 4.3 Indicators for Consumers

Indicators for Value Chain Actors

Sr. no.	Indicators	Unit of measurement	Weights	Explanation
1	On time delivery to Supplier	Yes No	1 0	It will add positive impact on SLCA
2	On time payment to Supplier	Yes No	1 0	"
3	Seismic Resistant	Yes No	1 0	Having Seismic resistant adds positive impact
4	Building Bye-Laws	Yes No	1 0	Following Bye-laws adds positive impact
5	Development of Organizational Policy	Yes No	1 0	Following Development Authority policies adds positive impact
6	Fair Competition and anticompetitive behavior	Yes No	1 0	Less Price difference in market means more completion

Table 4.4 Indicators for Value Chain Actors

5.3.3 Index Construction and Data Analysis

An indicator-based approach was adopted to quantify the three components of Social Development Index. Each indicator from all three components was classified and given equal weights, assuming that each indicator has a similar impact on overall SDI.

$$CI = (W1 + W2 + W3 + \dots + Wn)/n$$

$$= \sum_{i=1}^n Wi/n$$

Where,

CI is the composite index; W1 to Wn are the assigned transformed values; n is the total number of indicators

Indexes of respective components (Worker, Local Community, Consumers and Value chain Actors) of SLCA were formulated as follow.

For Workers,

$$\text{Health \& Safety Index (H\&SI)} = \sum_{i=1}^6 H\&SWi/n \quad (n = 6)$$

$$\text{Fair Working Condition Index (FWCI)} = \sum_{i=1}^8 FWCWi/n \quad (n = 8)$$

$$\text{Extreme Weather Condition (HWI)} = \sum_{i=1}^4 HWi/n \quad (n = 4)$$

For Local Community,

$$\text{Local Community (LCI)} = \sum_{i=1}^7 LCWi/n \quad (n = 7)$$

For Consumers,

$$\text{Consumers (CI)} = \sum_{i=1}^3 LCWi/n \quad (n = 3)$$

For Value Chain Actors,

$$\text{Value Chain Actors (VCAI)} = \sum_{i=1}^6 LCWi/n \quad (n = 6)$$

$$\Sigma SLCA = (\Sigma WI + \Sigma LCI + \Sigma CI + \Sigma VCAI)/4$$

5.4. Results and Discussion

SLCA aims to assist decision makers the well-being social decisions in order to improve the organization's social performance and the well-being of stakeholders throughout the life cycle. After performing survey with 120 residents of different residential projects of Muzaffarabad, AJK, results were documented using SPSS software. The most critical stakeholder came out to be workers, as by any means health and safety of humans comes first, later on questions regarding other stake holders were also analyzed.

Residents Socio-Economic Profile:

Gender	Value	Frequency	Percent
	Male	86	71.67
	Female	34	28.3
Age	<=25	6	5
	26-33	42	35
	34-41	59	49.2
	42-49	12	10
	51-58	1	0.8
Education	Uneducated	2	1.7
	Matric/O-Levels	1	0.8
	Fsc./A-Levels	4	3.3
	Graduate	77	64.2
	Post-Graduate	36	30
Marital Status	Unmarried	35	29.2
	Married	85	70.8
Number Of Dependents	<= 2.00	42	35
	3.00 - 5.00	75	62.5
	6.00 - 8.00	3	2.5

Table 4.5: Residents Socio Economic Profile

As indicated in the table all the residents were more male and almost 28% female and most of them were of in age gap of 26-41 yrs. Almost 64 percent of residents were graduated and 30 percent of them have post-graduate degree. The survey also shows that most of residents were married and have dependents.

Residents were asked questions regarding following aspects:

1. Workers: Health and Safety, Fair Working Conditions, Extreme Weather Condition/Heat wave.
2. Local Community: Safe and Healthy Living Condition, Cultural Heritage, Community Engagement, Local Employment.
3. Consumer

4. Value Chain Actors

5.4.1. Workers

5.4.1.1. Health and Safety:

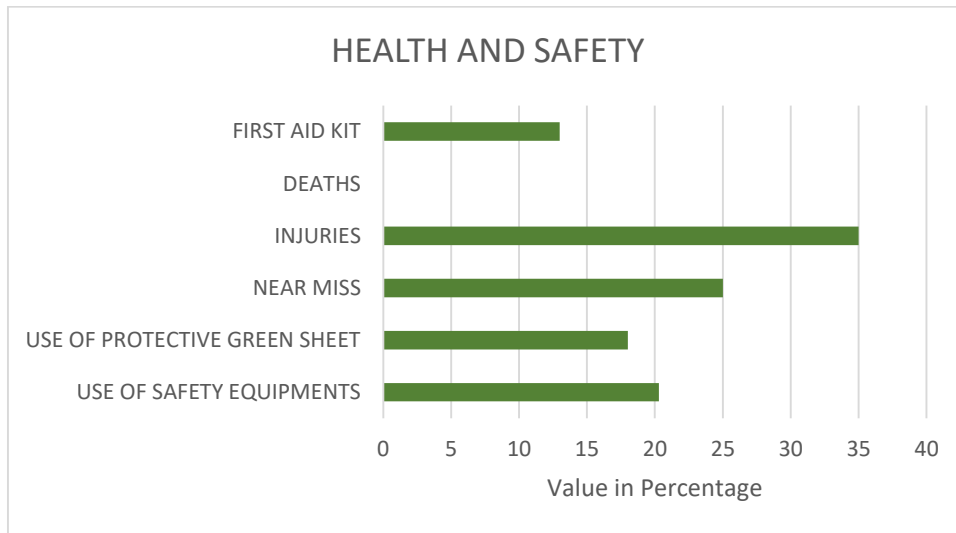


Figure 5.4: Results of Health & Safety Indicators in Percentage

From the above figure, it can be concluded that when we asked residents an open question that do they think safety equipment and overall safety measure is necessary safety equipment all of them agrees and say yes. Availability of first aid kits are in bad condition, and no deaths take place but there were injuries taking place. Near miss is also found at relatively high value, while all the other variables are found in bad condition. This shows that greet sheet, safety sign, hearing protection, safety belt, safety shoes, safety gloves, safety glasses and safety helmet are not found in good condition. The results from the above table indicate that most of the workers do not wear safety helmet according to residents of that particular project because the number of respondents found was more than 80% who marked no. The above table indicates that most of the workers according to residents do not wear safety glasses because almost 84% marked no against the asked question. The table above indicates that 82.5% of respondents do not wear safety gloves when asked about the question. The safety shoes are not worn by the respondents most of

them because 82.5% marked no when asked about it. From the above table, it can be summarized that workers do not use safety belts when working on heights because 90% marked “No”. The responses received show that 84% respondents marked no when asked about wearing hearing equipment when working in a noisy environment. The results obtained show that 70% respondents do not put safety signs or notes on the road outside under construction houses when they carry out critical construction activities. The respondents (82%) marked no which shows that construction site was not covered with green sheets. The results indicate that there did not happen any mishap during construction activity because 75% marked “No”. There were no injuries as per the results of 65% of respondents. The results show that no deaths took place during the construction activities. The availability of first aid kits was not present per all the respondents. All of the respondents claimed that safety equipment and overall safety measure is necessary because 100% marked yes in response to the question.

5.4.1.2. Fair Working Condition:

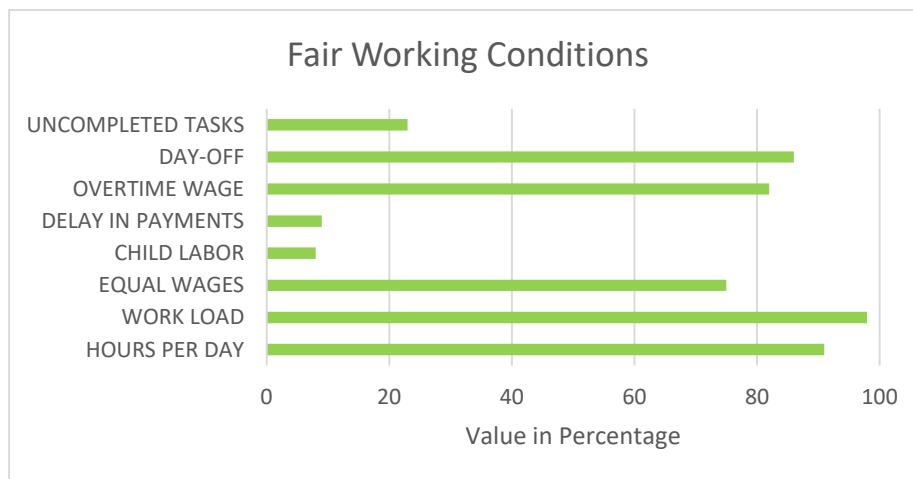


Figure 5.5: Results of Fair Working Conditions Indicators in Percentage

On the basis of the above results obtained, it can be summarized that only 23% workers according to residents left task uncompleted, Similarly 80+% says that workers get day-off and overtime wage, 91% residents claimed that there were no delay in payments, 75% residents say that they give equal wages to workers, 98% of residents said that workers voluntarily agreed on workload and hours per day. 92% residents claim that

there was no child labor is found. Hence, there is a need to improve working conditions and make them fair in Pakistan.

5.4.1.3. Extreme Weather Condition/Heat Wave:

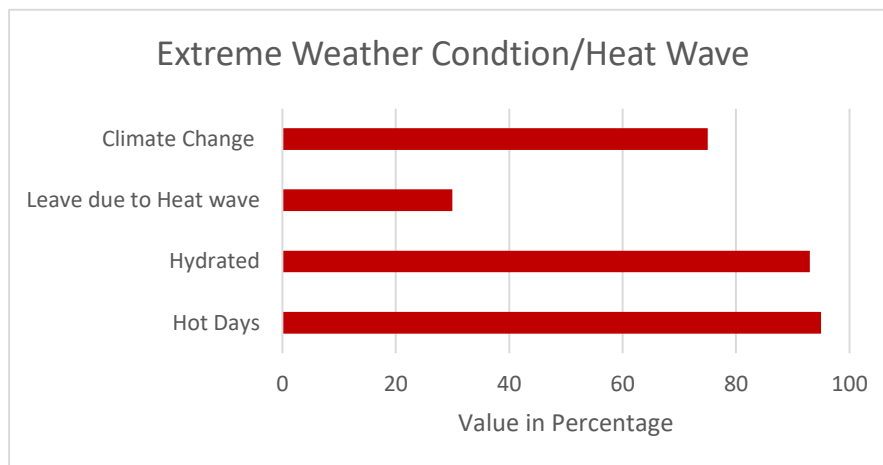


Figure 5.6 Results of Extreme Weather Conditions Indicators in Percentage

All the values obtained are high, which shows that people are working in extreme working conditions and heat waves. The value of all working in hot days, water consumption, and climate change impact on construction practices are found with high value but still workers leaving the job on hot days is still low according to residents. Hence working conditions followed are extremely difficult.

5.4.1.4. Risk Perception:

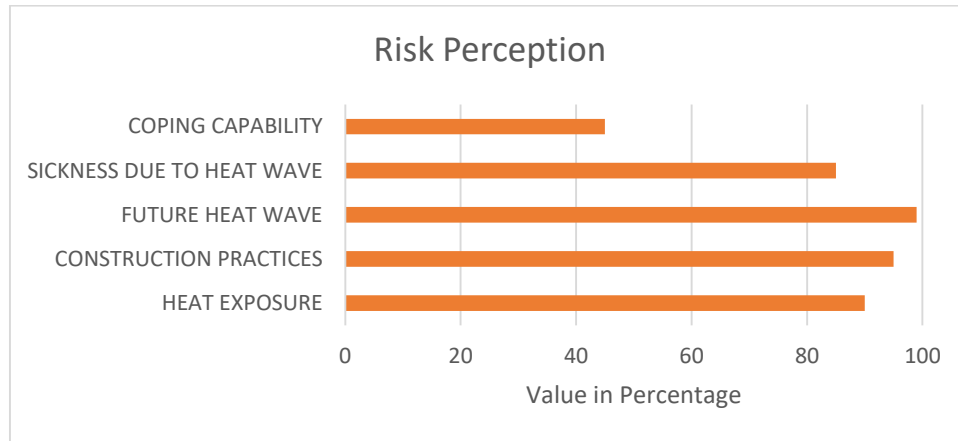


Figure 5.7 Results of Risk Perception Indicators in Percentage

The highest risk found is heat exposure, followed by decreasing work productivity, future heat wave problems, coping capability, construction practices, sickness due to heat waves and fear of heat waves according to the respondents. All these risks contribute to low performance of the workers and their performance significantly declines. On the basis of these findings, it can be summarized that organizations must be proactively engaging in activities that are related to the safety of their workers from these risks otherwise the chances of mortality and heat wave exposure would significantly increase.

5.4.2 Local Community

The local community plays a crucial role in the social life cycle assessment (SLCA) of a product or service. This may involve engaging with community members, conducting community-based assessments, and incorporating community feedback into the SLCA process. By considering the local community's perspectives, the SLCA can provide a more comprehensive and accurate assessment of a product or service's social impacts.

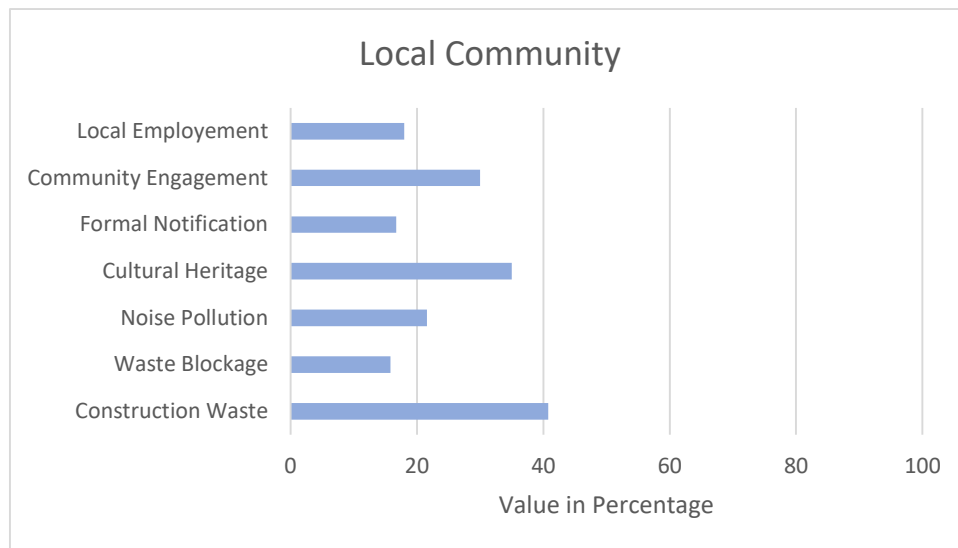


Figure 5.8 Results of Local Community Indicators of in Percentage

In the graph above we can extract that in case local employment only 18% of residents said that they hire local people which discourages local employment. Another setback was shown in community engagement and formal notice to neighborhood during construction activities as majority don't follow this formal procedure. Almost 35% of residents said that there were cultural importance sites near there project and all of them claim that that site was protected during any critical construction activity. Only 21.6% residents said that neighbors complain about noise of machines during construction. Only 40.8% of residents claim that they requested municipal for removal of construction waste and 15.8% of residents said that there construction block the main sewerage line.

5.4.3. Consumers

Consumers play a vital role in the social life cycle assessment (SLCA) of a product or service. The consumer's behavior, preferences, and purchasing habits have a direct impact on the social impacts of a product or service. For example, consumer's demand for a product may lead to increased production, which can have a negative impact on the local community and the environment. Similarly, consumer's disposal habits can have a direct impact on the environmental impacts of a product or service. Therefore, it is important to consider consumer's perspectives when conducting an SLCA.

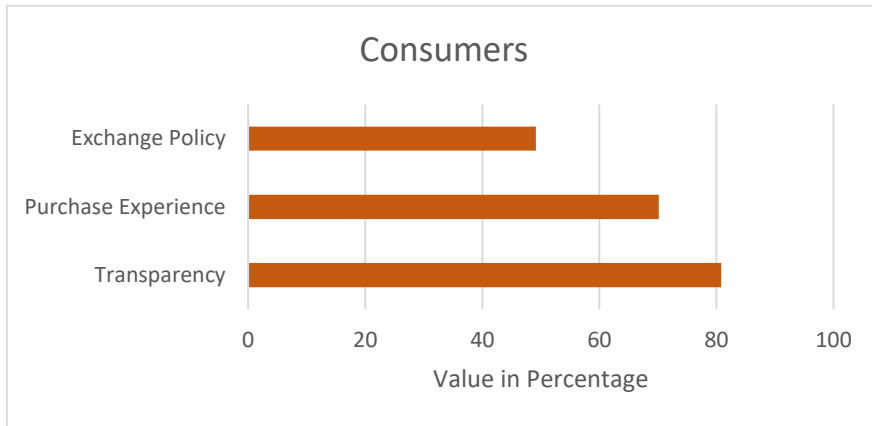


Figure 5.9 Results of Consumers Indicators of in Percentage

In the graph above we can extract that in case of consumers transparency 80.83% of residents said that they were provided complete information whereas almost 49% of residents said that they were offered exchange policy in case of wrong delivery material and 70% said that there purchase experience was good.

5.4.4. Value Chain Actors

Value chain actors play a crucial role in the Social Life Cycle Assessment (SLCA) process. They are responsible for ensuring the ethical and sustainable production of goods and services, from raw materials to final consumption. These actors include suppliers, manufacturers, distributors and retailers, each of whom has a unique impact on the social and environmental impact of the process.

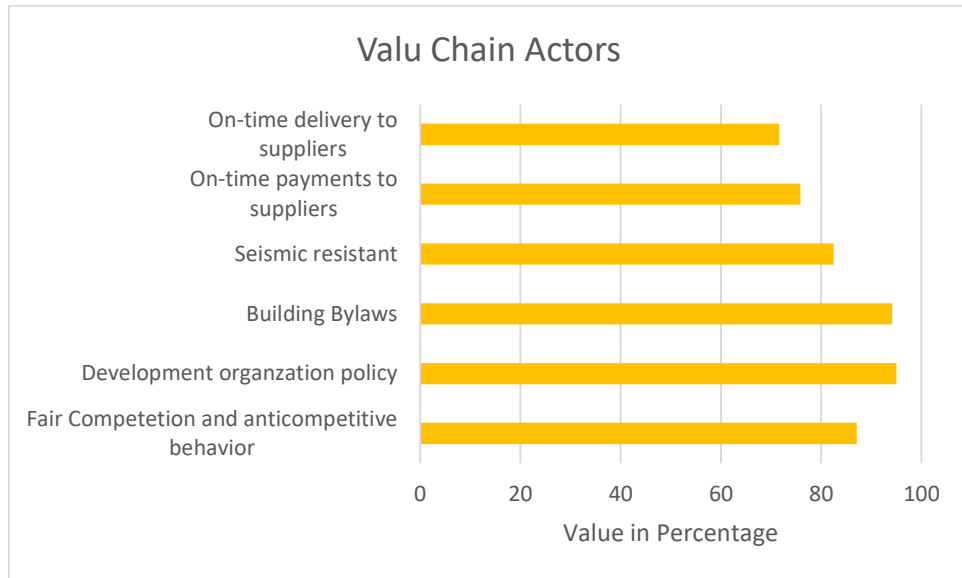


Figure 5.10 Results of Value Chain Actors Indicators of in Percentage

In the graph above we can extract that 87% of respondents said that they found price and quality difference in purchasing construction material for their residential project. Residents said that on time delivery and on time payments are above 70% which indicates a good relationship with the supplier as per residents of constructed houses. As Muzaffarabad is an earthquake zone and had experienced a massive earthquake in 2005 which dismantled most of the house hence the post earth-quake construction is seismic resistant as 82.5% of resident said so. This also prevails a sense of responsibility after experiencing a nightmare earthquake. As the city has its own development authority so the construction is approved by the authority and people have to follow the bye-laws as indicated in the graph.

$$\Sigma SLCA = (\Sigma WI + \Sigma LCI + \Sigma CI + \Sigma VCAI)/4$$

$$\Sigma SLCA = (48.87 + 23.14 + 66.52 + 84.2)/4$$

$$\Sigma SLCA = 55.6 \text{ (Value in Percentage)}$$

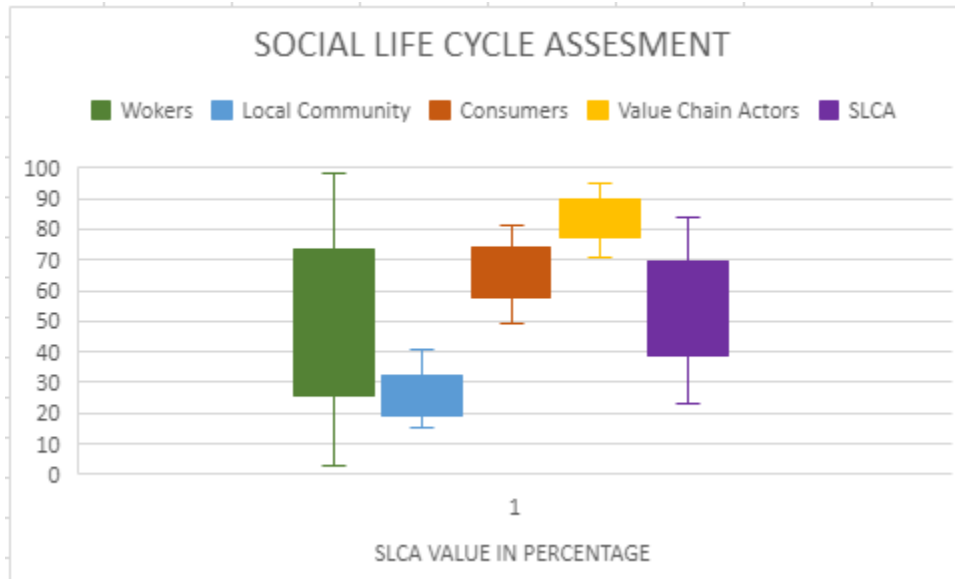


Figure 5.11 Social Life Cycle Assessment

Mean percentage of workers is 48.87% =0.48

$$\text{Standard Deviation of workers} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2}$$

Standard Deviation of workers = 0.39

The mean percentage of residents saying yes to question regarding workers health and safety, working conditions and fair working conditions comes out to be 48.87% where as standard deviation comes out to me 0.39.

Mean percentage of local community is 23.14%=0.23

$$\text{Standard Deviation of local community} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2}$$

Standard Deviation of local community =0.09

The mean percentage of residents saying yes to question regarding local community comes out to be 23.14 where as standard deviation comes out to me 0.09.

Mean percentage of consumers is 66.52%=0.665

$$\text{Standard Deviation of consumers} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2}$$

Standard Deviation of consumers =0.17

The mean percentage of residents saying yes to question regarding consumers comes out to be 66.52% where as standard deviation comes out to me 0.17.

Mean percentage of value chain actors is 84.2%=0.842

$$\text{Standard Deviation of value chain actors} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2}$$

Standard Deviation of value chain actors = 0.095

The mean percentage of residents saying yes to question regarding value chain actors comes out to be 84.2% where as standard deviation comes out to me 0.095

CONCLUSION

This chapter present the conclusion of this research. This chapter discussed the Social Life Cycle Assessment and stake holders' role and performance. In the last of this chapter, limitations of this study and suggestions for future research are presented.

The research aimed to identify the influence of social life cycle assessment on construction activities followed in Pakistan. From the results obtained through survey, it can be concluded that performance of the organizations is weak because most of them do not follow SLCA approach. Workers claimed that safety equipment is not used by them in the organizations and construction activities because they are not provided with the one by their construction managers. Due to this reason, the risk of health and safety problems is high. Additionally, the workers claimed that they do not use safety gloves, helmets and other safety equipment while carrying out their construction activities. Due to this reason, organizations face issues in carrying out their responsibilities proactively.

It is important that policies and government actively participate in the activities that are taking place in construction activities. Currently, the policies and government are not playing an active role in construction activities due to which their performance has significantly come down. The workers must be provided with governmental support through development of the policies and law enforcement agencies that take part in the construction activities. The organizations must be proactively engaged in ensuring that safety equipment is used and that working in heat waves is discouraged. If the government and policies go hand in hand the chances of performing construction activities would significantly increase. However, with current working patterns, organizations can never sustain their construction activities. One of the advantages of adopting LCA is that it facilitates the creation of a life cycle inventory, which is essential for developing a sustainable building program (Naypyitaw, 2020). LCA can be divided into two main groups, allowing for a more robust construction

strategy. Consequently, the organization's leaders can complete the construction project on schedule. LCA helps collect both primary and secondary data, which is beneficial. Therefore, the government should enforce LCA in construction activities so that construction activities can be improved and enhanced.

This study was based on different criteria and one of them was complying with all the requirements of the SLCA and the methods that make construction more effective and better. One of the most important things in construction is managing stakeholders which were main variable of this study because stakeholder management can be found in the topic as well. Additionally, this study had a major impact on construction activities because the importance of SLCA in construction sector was organized and presented. Furthermore, the requirements related to the SLCA were only kept on criteria in this investigation. The study only adopted criteria of performing survey because it helped in finding out the perceptions of the respondents and presenting them in detail as to how the construction activities should be improved. The performance of the organizations can be improved by focusing on the SLCA recommendations given in the previous heading because it was criteria of this study. Hence, organizational performance can be improved by focusing on it.

SLCA can be used in a variety of industries, including manufacturing, construction, and consumer goods. It is particularly useful for companies that want to understand and improve their social sustainability performance. The approach can also be used by governments, non-governmental organizations, and other stakeholders to evaluate the social impacts of different policies and initiatives. As workers were they key and most critical stakeholders as their safety during construction activity comes first the safety equipment were not used by them according to respondents. Due to this reason, the risk of health and safety problems is high. As SLCA is relatively new and can also bring uncertainty, instability, and conflicts as people navigate new norms and practices. The outcome of the emerging phase will depend on the decisions and actions of the individuals and groups involved, and will shape the future trajectory of the social life cycle. . This study was based on different criteria and one of them was complying with all the requirements of the SLCA and the methods that make construction more effective and better. One of the most important things in

construction is managing stakeholders which were main variable of this study because stakeholder management can be found in the topic as well. Additionally, this study had a major impact on construction activities because the importance of SLCA in construction sector was organized and presented. This study was based on different criteria and one of them was complying with all the requirements of the SLCA and the methods that make construction more effective and better. One of the most important things in construction is managing stakeholders which were main variable of this study because stakeholder management can be found in the topic as well. Additionally, this study had a major impact on construction activities because the importance of SLCA in construction sector was organized and presented. Furthermore, the requirements related to the SLCA were only kept on criteria in this investigation. The study only adopted criteria of performing survey because it helped in finding out the perceptions of the respondents and presenting them in detail as to how the construction activities should be improved. The government should enforce SLCA in construction activities so that construction activities can be improved and enhanced upon the evaluation and assessment of process. The performance of the organizations can be improved by focusing on the SLCA recommendations given in the previous heading because it was criteria of this study. Hence, organizational performance can be improved by focusing on it. As SLCA is in its emerging phase and much research and analysis needs to be done to make a criteria which is universally accepted.

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