LIVEABILITY DEFINED: THE CASE OF COLOMBO, SRI LANKA

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Degree of Master of Science

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Thesis submitted in partial fulfilment of the requirements for the degree Master of Science

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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate has carried out research for the Masters thesis under my supervision.

Signature of the supervisor Date

DEDICATION

to my beloved family

ACKNOWLEDGEMENT

The accomplishment of the research would not be possible solely due to my commitment. The achievement has always been encouraged and assisted by number of individual. Therefore, I embrace this opportunity to convey my heartiest gratefulness to all of them.

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ABSTRACT

LIVEABILITY DEFINED: THE CASE OF COLOMBO, SRI LANKA

The rapid increment in the population in the cities has manifested number of challenges in terms of unauthorized developments, underutilized housing, limitations in infrastructure and services, energy consumption and waste management. The quality of lives of the inhabitants have diminished and cities are becoming less liveable.

Hence, the need of a planning approach to address these issues with a sensitivity to the requirements of the inhabitants has been felt for some time. The concept of liveability which is a subset of the concept of sustainability is perceived as a philosophy to face the urban conundrum. Liveability has been assessed using liveability indexes which have marketability purpose. The representation of liveability through the existing indexes is unlike to address the issues of urbanization. Thus, this study advocates to define and characterize liveability to enhance the quality of lives of inhabitants in Sri Lanka.

Based on a pragmatist research philosophy, an abductive research approach is used for the study. Firstly, an extensive literature review is conducted, followed by a case study strategy to contextualize the literature findings. Data collection is done via expert interviews, document review to define liveability for the case. Six liveability characteristics, twenty-five attributes and seventy-one indicators were distinguished prioritized using Analytical Hierarchy Process.

Challenging the existing vague definitions, liveability was defined as the satisfactory quality of lives of inhabitants achieved through its balanced socio-economic environment reflected through the character of the city of Colombo with quality and proximate services, connectivity to amenities through proper infrastructure and preserved natural environment. Balanced socio-economic environment was prioritized over other characteristics. A global weight was assigned to these elements which was utilized as the weighting factor of the developed liveability index to enhance the quality of lives of the inhabitants of cities. Unlike current liveability indexes with marketability purposes, the developed liveability indexes adapt a participatory approach to address the issues in the cities with a liveability perspective.

Keywords: Liveability, Liveable City, Liveability Index and Urbanisation.

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LIST OF ABBREVIATIONS

AHP	-	Analytical Hierarchy Process
CBSL	-	Central Bank of Sri Lanka
CCC	-	Colombo Commercial City
CI	-	Consistency Index
CMRSP	-	Colombo Metropolitan Regional Structure Plan
CR	-	Consistency Ratio
DMMC	-	Dehiwala Mount-Lavinia Municipal Council
EIU	-	Economic Intelligence Unit
GDP	-	Gross Domestic Product
GoSL	-	Government of Sri Lanka
ICT	-	Information Communication Technology
IIED	-	International Institute for Environment and Development
MC	-	Municipal Council
MMWDSL	-	Ministry of Megapolis and Western Development Sri Lanka
MOF	-	Ministry of Finance Sri Lanka
OECD	-	Organisation for Economic Co-operation and Development
PRISMA	-	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PS	-	Pradeshiya Sabha
RI	-	Randomized Index
UC	-	Urban Council
UDA	-	Urban Development Authority

UN	-	United Nation's
UNDESA	-	United Nations Department of Economic and Social Affairs
UNFPA	-	United Nations Population Fund
USD	-	United State Dollar

1.0 INTRODUCTION

The projections of population growth indicate that human population is likely to keep growing and from 2050, urbanized population will increase by 3 billion (United Nations Department of Economic and Social Affairs [UNDESA], 2018). 54% of world population lives in cities and there are 34 cities which have a population over 10 million United Nations Department of Economic and Social Affairs [UNDESA], 2014). Majority of these cities are in developing countries (International Institute for Environment and Development [IIED], 2012). Furthermore, as stated by the Organisation for Economic Co-operation and Development [OECD], (2014), mega cities are cities which have a population above 10 million inhabitants and in1990 there were 10 cities which reached 28 by 2014. Presuming the perpetuation of the trend, 41 cities will become mega cities with a population above 10 million by 2030.

As a result of the rapid increment of population in cities, increased human activities in social, political and economic grounds over the physical boundaries of communities have been observed. Cities have become hubs of power consumption consuming nearly 60-80% of the energy products (Ramachandra, Bharath & Sowmyashree, 2014). Mori and Christodoulou (2012) explicated that carbon footprints of cities have protracted far beyond the physical boundaries. Furthermore, cities are associated with issues related to resources assimilation, greenhouse gas production, waste management and traffic congestion (Peris-Ortiz, Bennett, & Yábar, 2018). The unauthorised and uncontrolled development of housing, infrastructure and shops have increased at the expense of large area of land which is the scarcest resource in the cities (Poumanyvong, Kaneko & Dhakal, 2012; Madlener & Sunak, 2011). The spatial – temporal increment of the crimes in city communities is evident in the unauthorised and underutilized areas (Stevenson et al., 2016; Chi Jackie, 2013). Together, these factors reduce the quality of life of the inhabitants exposing them to economic and security risks, health issues and undesirable living conditions.

Hence, there is an urgent need to rethink the approaches to plan, develop and operate the cities to cater the increased requirement of proper infrastructure, services and balanced socio economic conditions. Some of these planning approaches are blueprint

planning, synoptic planning, participatory planning, and advocacy planning (Hall,2008). Both blueprint planning and synoptic planning employ rational paradigm of planning with the contribution of group of experts (Vajjarapu, Verma & Allirani, 2020). It is challenging to apply these urban planning approaches for urban renewal because it affects the existing inhabitants of the city (Bulkeley & Castán Broto, 2012). The currently deployed approaches have been insufficient in considering complex interdependencies and interactions between various social, economic, physical and natural sub-systems (McArthur & Robin, 2019). Therefore, a novel approach is required which harmonizes even the view of marginalized public with an emphasis on making cities more liveable to all.

In these design approaches, cities need to be considered as complex systems which combine and integrate social, economic, physical and natural infrastructures to create vast networks of interdependencies and connections (Powell, Kusumo, & Srirangam, 2019). However, the implementation of such holistic approach requires the breaking down of the silos which exist between various city administrative authorities, dismantling information silos to support decisions which are evidence-based, promoting the use of multi-simulation models, and collaborative stakeholder approach.

Alderton et al. (2019), have underlined the concept of liveable cities in his study, multi-dimensional approach to address localized concerns of inhabitants which promotes collaborative stakeholder approach. As a participatory planning approach, liveability is discussed in number of contexts including in the field of planning, community development, transportation and resilience (Giap, Thye & Aw, 2014).

Liveability is the quality of life expected or felt by the inhabitants of a county or a region in terms of sustainability and resilience in an aspiring level of satisfaction (Elshater, Abusaada & Afifi, 2019; Nastar, Isoke, Kulabako & Silvestri, 2019). Authors have argued that ideologies of liveability incorporate enhanced competitiveness in the economy, provision of more transportation choices, promotion of reasonable and affordable housing and value communities (Allen, Haarhoff & Beattie,2018; Southworth, 2016,). Brilhante and Klaas, (2018) have demonstrated that the maximum use of concepts of sustainability or liveability, could be achieved through establishing a method to evaluate the cities based on that particular concept.

Globally, there are indexes and studies that have been issued to evaluate the relative situation of cities in terms of their liveability (Badland et al., 2014). Economic Intelligence Unit (EIU) liveability index and the Mercer Quality of Life liveability index are among the most prevalent liveability indexes (Economist Intelligence Unit [EIU], 2018; Mercer, 2018). These indexes comprise of indicators related to socio-economic aspects, infrastructure, environment and other aspects which characterises liveability (Kaal, 2011). Selection of indicators and the significance given to the indicators in these indexes depends on the applied context and purpose. Hence, the generalizability of the research on liveability indexes is difficult.

Moreover, these indexes might not be ideal to represent the issues that have arose from urbanization and population growth. These liveability indexes give less significance to publicly provided services, welfare of the poor, disabled, young or aged population, waste management issues, sanitary facilities in city level and underdeveloped housing which are prominent issues challenging liveability of cities. (Onnom, Tripathi, Nitivattananon & Ninsawat, 2018). Especially the cities in the developing region of Asia have issues brought by the development itself and behavioural setting, size of economic activities and cultural diversity in these cities requires context specific approaches (Powell, Kusumo, & Srirangam, 2019; Mittal & Sethi, 2018). Therefore, Tsenkova (2016) have emphasised that studying liveability in cities should be benchmarked against their own terms. Hence, a liveability index which could address the ground level issues of a city and benchmark the development of the city in successive years could be effectively contribute to urban renewal while ensuring the city is liveable.

Within the context of Sri Lanka, there are many challenges with regard to the frenzied urban construction, improper planning and other effects of urbanization (De Silva, 2009). Social polarization, environmental pollution, natural disasters such as floods and manmade disasters such as fire, road accidents and industrial accidents are commonly observed in the Sri Lankan context (Ariyawansha, 2010). The inability to develop and manage the required infrastructure to furnish the increasing urban population is major reasons for the concerns in urban built environment of Sri Lanka (Bandara & Hettiarachchi, 2010).

These issues have made the urban cities in Sri Lanka uncomplimentary to their inhabitants to live in. Therefore, it is vital to identify the perception of liveability to the inhabitants of Sri Lanka and assess the level of liveability of the cities.

1.1 Problem Statement

The inconsistencies in socio-economic standards, service providence, infrastructure facilities, land use and availability of housing, environment and character of the city have diminished the liveability of rapidly developing cities (Mulligun and Carruthers, 2011).

From the urban planning approaches available, participatory planning method acquires contribution of public to outline the requirements of urban development (Hall,2008). Such approach based on urban liveability would best reflect the issues in cities. There are liveability indexes which are used to assess the liveability of cities (EIU, 2018; Ellis and Roberts, 2015; Mercer,2018). Yet, the available liveability indexes are developed for various purposes without considering much on the challenges rose due to urbanization and population growth.

Hence, it is essential to define liveability to a particular context and specify the characteristics, attributes and indicators of it based on the challenges to liveability of the considered context. Moreover, these challenges of liveability could have different priorities from one context to another.

Therefore, this study is narrowed down to improve the quality of lives of the inhabitants of, Sri Lanka based in the priority given to elements of liveability. There is no significant research carried out on urban liveability, exposing the need to define liveability for Sri Lanka or developing a liveability index consisting of inherent liveability indicators.

1.2 Aim

The research is aimed at enhancing the quality of lives of the inhabitants in Sri Lanka by making cities more liveable.

1.3 Objectives

There are mainly three objectives to be fulfilled, to accomplish the aim of this research. These objectives are,

1. To investigate the concepts and definitions related to 'Liveability' and 'Liveable Cities'

2. To identify the attributes and indicators that constitute for liveability in the global context and with particular reference to Sri Lanka

3. To develop a Liveability Index to enhance the quality of lives of the inhabitants in Sri Lanka

The successive achievement of these objectives will ultimately achieve the aim of the study.

1.4 Originality of the Study

The proposed research identifies the key areas that need to be considered for liveable cities and develop a Liveability Index to the Colombo. Hence, the research outcome is beneficial to policy makers and professionals when designing and planning future development projects. Research outcome would lead them to carryout risk sensitive developments with adequate considerations for the social, built and natural environments.

Further, within the context of Sri Lanka, lack of studies are evident in the area of Liveable Cities. Hence, the proposed research addresses the knowledge gap in the area of Liveable Cities with reference to Sri Lanka. Furthermore, identification of attributes of Liveability Index assist developing innovative approaches such as innovative transportation mechanism, digital platforms to manage stakeholders and 'smart technologies'.

Moving forward, the proposed research lays the foundation to develop a road map to achieve the attributes identified in the Liveability Index with short, medium and long-term timelines. Further, by considering the Liveability Index of the Colombo as the basis, it is possible to develop Liveability Indexes to other parts of the country as well. The research contributes to develop new knowledge in the area of Liveability within the context of developing countries.

Within the context of Sri Lanka, there is a growing need to improve the Liveability of the inhabitants especially with the new urban development projects. Further, this research area is yet to be adequately investigated in Sri Lanka. Therefore, the proposed research has a significant national relevance and would contribute to the economic and social wellbeing of the country, long-term productivity and stability.

1.5 Methodology

The research is initiated in a pragmatist stance where the details from the empirical studies and the foundations of the existing liveability indexes are systematically analysed to reach the aim. As the initial phase, an extensive literature synthesis is conducted to ascertain the existing knowledge related to liveability, liveability indicators and liveability indexes. A comprehensive set of liveability indicators are ascertained at the end of the literature synthesis.

Since the literature emphasised the importance of context specific definition of liveability, a case study strategy has been selected to further explore the liveability of city of Colombo. The data collection for the case consists of expert interviews and document review. The expert interviews represent the perception of the pubic on liveability. Subsequently, the document review is carried out using grey literature, to comprehend the Sri Lankan context on liveability.The resultant set of liveability indicators are refined through experts. The Analytical Hierarchy Process (AHP) is adapted to weight the liveability indicators of the new liveability index based on their importance to urban liveability.

1.6 Scope of the Research

The concepts on liveability and the liveability indexes have a board scope, usually addressing the global context. The scope of this study is to narrow down the focus of these concepts to Sri Lanka and to adapt a focused liveability index, which is best suit the requirements in Sri Lankan context. The Western Region of Sri Lanka is economically the most established area, generating approximately 42% of the Gross Domestic Production (GDP) (Central Bank of Sri Lanka [CBSL], 2018). Yet, the growth momentum in the city has been hindered by diminishing quality of lives due to urbanization. Therefore, the scope of the research is set as city of Colombo to address the liveability issues in the Sri Lankan context.

1.7 Limitations to the Study

The data analysis was done using Analytical Hierarchy Process (AHP) method, with the involvement of expert interviews in academia and industry. Yet, considering the influence of liveability on different stakeholder groups the opinion of the public is significant to this study. There were three main reasons to refrain from collecting public opinion to the study. Firstly, the selection of an unbiased sample to represent the whole population was problematic since the sample size was enormous. Secondly, the limited time was not sufficient to collect data and to analyse those data. Even if the second limitation is managed the public awareness of the concept of liveability is less to get them involved in the policy making process. Therefore, based on the assumption that the experts were capable of providing a balanced opinion based on the interests of the stakeholders, only the expert views were studied.

1.8 Chapter Breakdown

The research writing is completed in Chapters, which evidently feature the steps followed throughout the research. There are six Chapters which are appropriately presented in Sections to effectively comprehend the study.

- **Chapter One- Introduction**

Chapter 01 demonstrates the background of the study which subsequently leads to the research problem understudy. The aim of the study and the objectives to achieve the aim to answer the research problem and the methodology followed to accomplish the objectives are briefly elaborated in Chapter 01.

- **Chapter Two – Research Methodology**

The second Chapter is the methodology, which provides the methodical course of actions to conduct the literature review, data collection analysis and discussion in subsequent Chapters.

- **Chapter Three- Literature Review**

The literature review is a critical analysis of the indexed literature sources and other reliable literature related to the concept of liveability. For the purpose of defining liveability and liveable cities, Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) method is followed. It is a tool that is specifically

introduced for reliable systematic reviews of literature. The filtration procedure enabled to identify the most relevant journal publications for this study. Existing liveability indexes and limitations of liveability indexes are critically analysed in the literature review.

- **Chapter Four – Data Collection and Analysis**

Chapter 04 includes the data collection process through expert interviews, document review and AHP questionnaire survey. The collected data is analysed through manual content analysis and AHP analysis. The key outcomes have been outlined within this Chapter.

- **Chapter Five –Research Findings and Discussion**

The pattern matching process to establish the research findings by revisiting the literature is achieved in the fifth Chapter. Liveability is defined by critically comparing and contrasting the literature with empirical findings. The liveability characteristics, attributes and indicators identified via literature review, expert interviews and the document review are discussed within a single framework. The improved liveability index is presented and contrasted against the limitations of existing liveability indexes.

- **Chapter Six -Conclusions and Recommendations:**

As the final Chapter, Chapter 06 looks over and summarises the achievement of each objective in reaching the aim of the research. The contribution of the study to the theory and practise is demonstrated in this Chapter by extracting the findings of the case. The recommendations and further research areas opened from this study is provided in Chapter 06.

2.0 RESEARCH METHODOLOGY

2.1 Introduction to the Chapter

The research study is aimed at developing a liveability index suitable for Colombo by defining liveability to the applicable context within Colombo through identifying the key areas that constitute for liveability in the global context. A systematic approach is necessary to browse and review available literature in, appropriately merging the literature with the context specific findings. Starting from the research philosophy, research approach, methodical choice, strategies, techniques and procedures to achieve the aim is outlined in this chapter.

2.2 Research Design

The research design is the selection of the appropriate research philosophy, research approach, research strategy, research choice, time horizon, and techniques. In 2019 Saunders, Lewis and Thornhill, have illustrated the most widely practised choices of research design in a form of an onion as given in Figure 2.1.

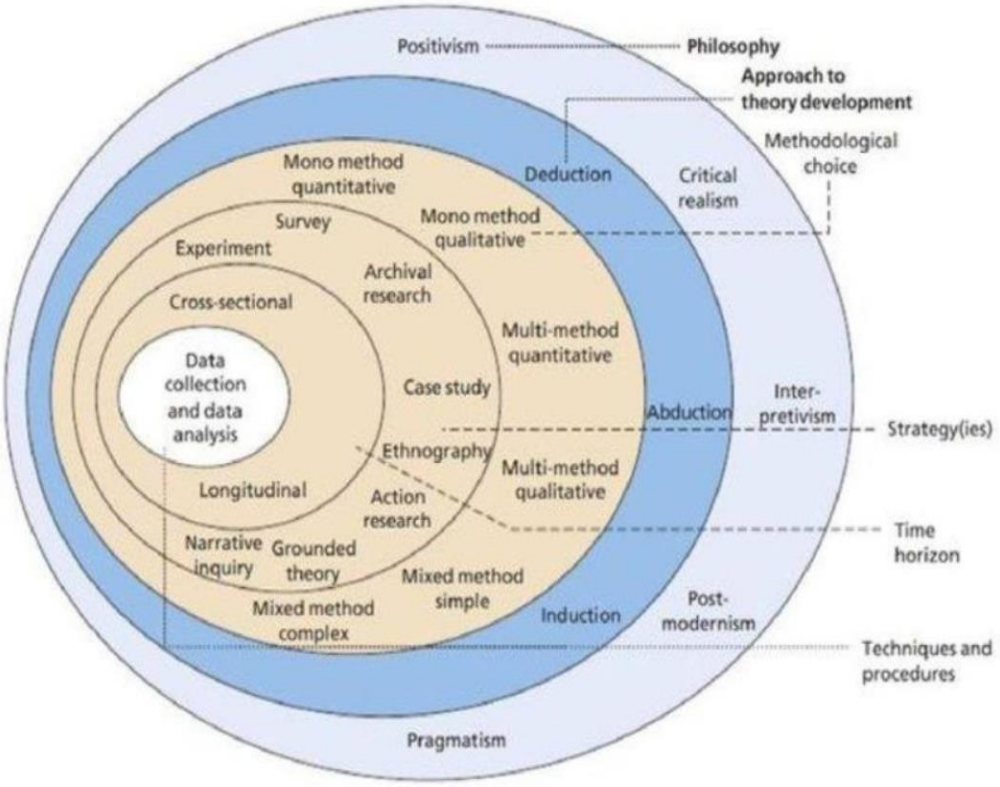

Figure 2.1: Saunders' Research Onion

2.3 Research Philosophy

Based on the core assumptions of the researcher on the nature of the science, there are taxonomies that lay in extreme philosophical positions and in between. Sexton (2003) has explained three perceptions as ontological, epistemological and axiological positioning of the research which determines the philosophy of the research.

2.3.1 The ontological question

The ontological question is, "what is the form and nature of the reality?" The researchers, preferring realism, identify that the individual attributes of understanding, is a single reality (Nind, Holmes, Insenga, Lewthwaite & Sutton, 2019). On the other hand, the matters of moral significance fall outside the realism and more constricted towards idealism.

In this study, liveability and the liveable cities are directly associated with human interactions. The background study highlighted the socio- cultural indicators are idealised by the inhabitants in the considered city. Conversely, for the comparison of the liveability of a city in order to take measures to improve the liveability of that city or to implement new rules and regulations, idealism may not be suitable. Therefore, the ontological positioning of this study remains in between realism and idealism.

2.3.2 The epistemological question

The epistemological question is the nature of the relationship between the researcher and the potential readers of the study. Similarly, it refers to assumptions about knowledge, what constitutes acceptable, valid and legitimate knowledge and how knowledge can be communicate to others (Burrell & Morgan, 2019). The answer for this question is influenced by the answer already given to the ontological question. When the researcher is independent from the subject that is been studied the study has characteristics of positivism. However, in interpretivism the researcher add value to the study through the lived- world experience.

The subjective nature of the liveability draws the research towards interpretivism. Yet, there is a need to maintain the value free nature of the study as much as possible since a liveability index need to be applicable and justifiable to the studied context regardless

of the researcher's perceptions. Therefore, the knowledge for develop the liveability index is not constructed through the interpretation of the respondents who are involved in the research but rather from the context itself, because the respondents were merely a sample from the context.

2.3.3 The axiological question

The axiological question is directly linked to the value concern of the study. A study may be either value free or value laden (Lewthwaite & Nind, 2016). Therefore, the selection of the appropriate methodology depends on the ontology and the epistemology that have been already chosen and the level of value the researcher hopes to add to the study. The inhabitants of a particular city have a clear understanding of the level of liveability of a city. Therefore, the views on the liveability is value laden. Nonetheless, when developing a context specific liveability index, the researcher's values are insignificant and the liveability index need to be objective to the maximum degree. Hence, after considering the mix of the ontology, epistemology and the axiology the research paradigm of the study is not positioned in positivist or interpretivist extremes, but in pragmatism where the practical consideration of the views and the notion of one single reality is at a balanced position.

2.4 Research Approach

Different researchers have argued the choice between the inductive and the deductive research approach for scientific studies. According to Saunders, Lewis and Thornhill, (2019), the deductive approach focuses on developing theory and designing a strategy to hypotheses testing whereas the inductive strategy is to theory developing through data collection and analysis. However, in developing a liveability index both the above research approaches did not satisfy the requirement because those methods did not facilitate to generate testable liveability index starting from the known grounds. Therefore, abductive research approach was used for this research since it fulfils the above requirement. Abductive approach has provisions for theory generation if the liveability index is assumed as a theoretical outcome and to test the liveability index (Attia & Edge, 2017).

2.5 Methodological Choice

The methodological choices include qualitative and quantitative methods. They are further categorised into three methods namely, mono method, multi method and mix method based on the common characteristics (Wright, 2019). The subcategories of methodological choices are given in Figure 2.2. In mono method, a single qualitative or quantitative method is chosen. In multi method, two or more qualitative or quantitative methods are selected (Saunders, Lewis & Thornhill, 2019). In simple mixed method, both qualitative and quantitative methods are selected. The complex mixed method different types of methods representing qualitative and quantitative methods are employed according to the convenient of the researcher (Paul, 2017).

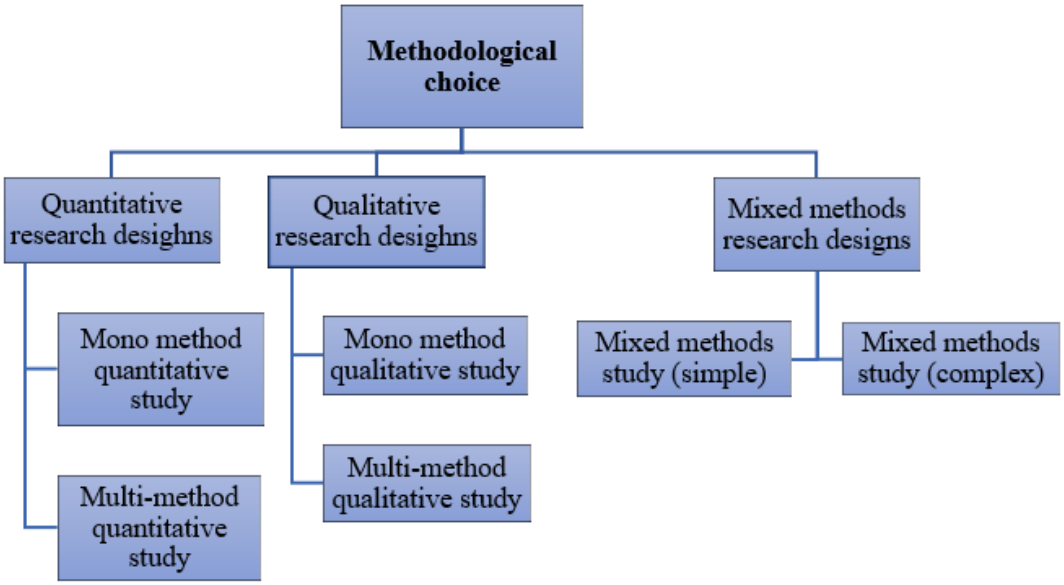

Figure 2.2 : Methodological Choices

Following the literature review, data collection to identify the liveability indicators was done using two different methods and were qualitatively analysed. The prioritizing of the indicators was done quantitatively. Hence, complex mixed method was followed where one method was facilitated to explore new insights and were followed up using other methods. Since these qualitative and quantitative methods were applied at different stages of the research, the methodological choice could be particularised as a partial integrated mixed method research (Greener, 2018).

2.6 Research Strategies

Among the strategies such as experiment, survey, archival research, case study, ethnography, action research, grounded theory and narrative inquiry expressed by Sexton (2003) the most appropriate strategy was selected based on the pragmatist philosophical stance of the research as depicted in Figure 2.3.

Based on the pragmatist view of the research, with the available theoretical prepositions and the empirical studies, case study strategy was apprehended as the most suitable strategy to this study.

2.7 Case Study Strategy

A case study is an in-depth investigation into a matter or phenomenon within its real-life background (Yin, 2014). Selection of cases could be either single cases or multiple cases.

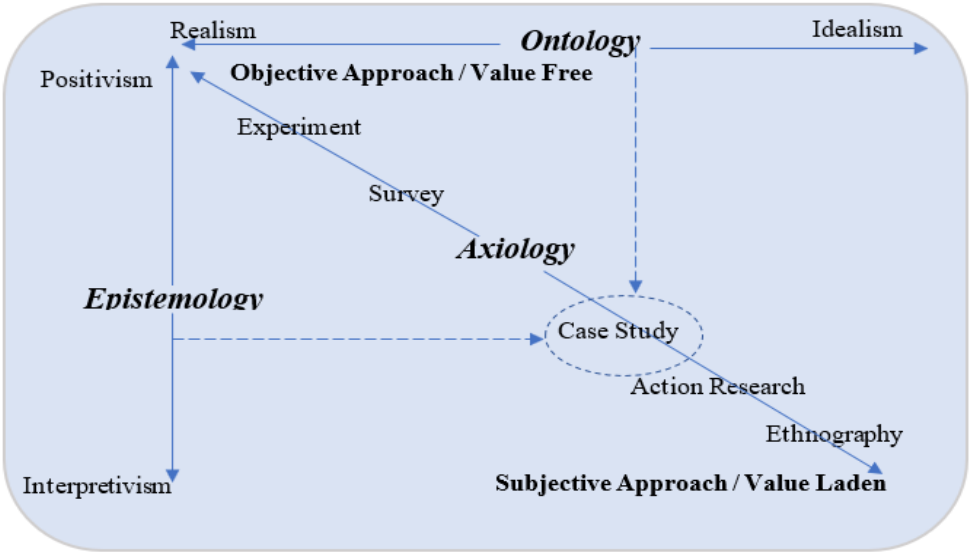

Figure 2.3: Positioning of the Research Paradigm

As stated by Yin (2014) a single case study is suitable for "critical, unusual, common, revelatory or longitudinal case". Additionally, (Yin,2014) stated that this strategy is suitable when the objectives of the research is to "specified a clear set of circumstances within which its prepositions are believed to be true" (p.51). Multiple case studies are selected on the basis that the result could be replicated across the cases or could be predicted the variation of results in cases due to a different contextual factor. Respectively, Yin (2014), terms these as literal replication and theoretical replication.

For this research, a single holistic case study was used to investigate the attributes of liveability in order to identify the liveability indictors applicable to Colombo. The study was conducted within the Colombo, which is considered as a 'critical case' due to the intensive developments, investments and the urban sprawl compared other cities particularly in Sri Lankan context. Moreover, the scope of the study is being limited to developing a context specific liveability index. Hence, literal replication or theoretical replication is not considered at this level. Thus, single case study research strategy was considered as the most appropriate research strategy to define liveability.

2.7.1 The case of Colombo

The selection of case to be studied and establishing the boundaries of the case is a key factor in defining a case study ((Easterby-Smith, Thorpe, Jackson & Lowe, 2008). The case of Colombo represents the rapidly developing commercial capital of Sri Lanka. The dynamic nature of the development of the urban environment, proximity to the administration capital and the higher potential of economic development are among the significant characteristics of the considered case.

The case boundary was selected as the Colombo Commercial City (CCC) considering common characteristics (Urban Develpoment Authority – Sri Lanka [UDA], 2019). It does not delimit to the areas under jurisdiction of Colombo Municipal Council but also considers areas governed under the local authorities of Dehiwala Mount-Lavinia Municipal Council (DMMC) area, Borelasgamuwa, Kolonnawa, Peliyagoda, Wattala – Mabola Urban Council areas and Parts of Wattala and Kelaniya Pradeshiya Sabha areas. Further explanation of the case boundary is given in Section 4.1.

The liveability of citizens of CCC is considered as the unit of analysis for this study. In this case the citizens denote, approximately 1.1 Million of residential population and 0.8 Million of daily commuters of CCC. The development of the index was centred around this unit of analysis.

Expert interviews and documentary review were selected as the data collection methods in the case. The procedures followed in these methods are given in detail at Section 2.7.2, Section4.2 and Section 4.3.

2.8 Time Horizon

A study could be designed in a longitudinal or cross-sectional time horizon (Saunders, Lewis and Thornhill, 2019). Since the study is centred on the status quo of Colombo and the desired state of liveability of the inhabitants in regular basis the chronological attributes of data were not considered. Therefore, a cross sectional time horizon was adapted for the study.

2.9 Techniques and Procedures Followed in Data Collection and Analysis

The techniques followed in literature review and data collection and analysis are listed in Figure 2.4.

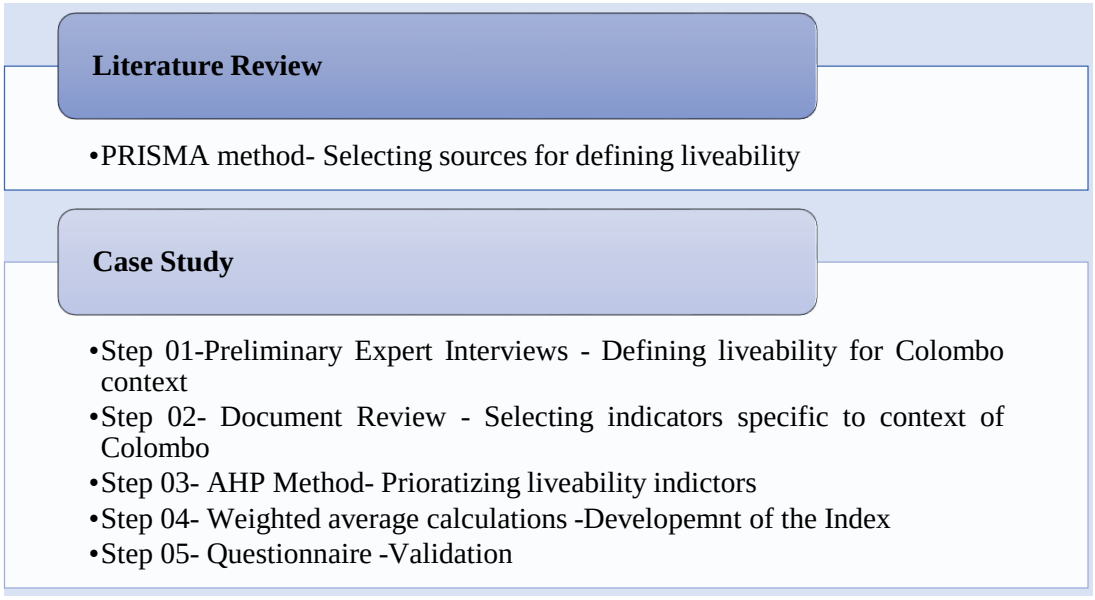

Figure 2.4:Techniques and Procedures

Accordingly, in the literature review (Chapter 03) the selection of key literature sources was done through following PRISMA method. For the data collection purpose of case study, firstly, a round of interviews was conducted. The document review was used to identify the context specific indicators. Subsequently, the technique that was followed to prioritize the liveability indictors.

Finally, a questionnaire survey was conducted to validate the liveability index. The aforementioned data collection techniques are discussed in detail at Section 2.7.1 and Section 2.7.2.

2.9.1 PRISMA method in selecting sources for defining liveability in literature review

The review of a clearly formulated question via systematic and explicit procedures to identify, select and critically investigate that question by collecting data from the considered researches for the review is known as a systematic review (Guetibi, Hammoumi & Brito, 2018). Selecting reliable and relevant sources of literature is equally important in the effectiveness of systematic literature review (Ortiz-Martínez et al., 2019). Hence, PRISMA method (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) was followed as a technique to select the most suitable literature sources.

PRISMA is a method to select evidence based minimum set of sources for recording in systematic reviews, Rather, than selecting random studies for systematic reviews, PRISMA improve the quality of review as it follows a four-phased flow diagram as illustrated in Figure 2.5. "n" denotes the number of records. The stages of PRISMA analysis are identification of records, screening of the records and determining the eligibility of the records.

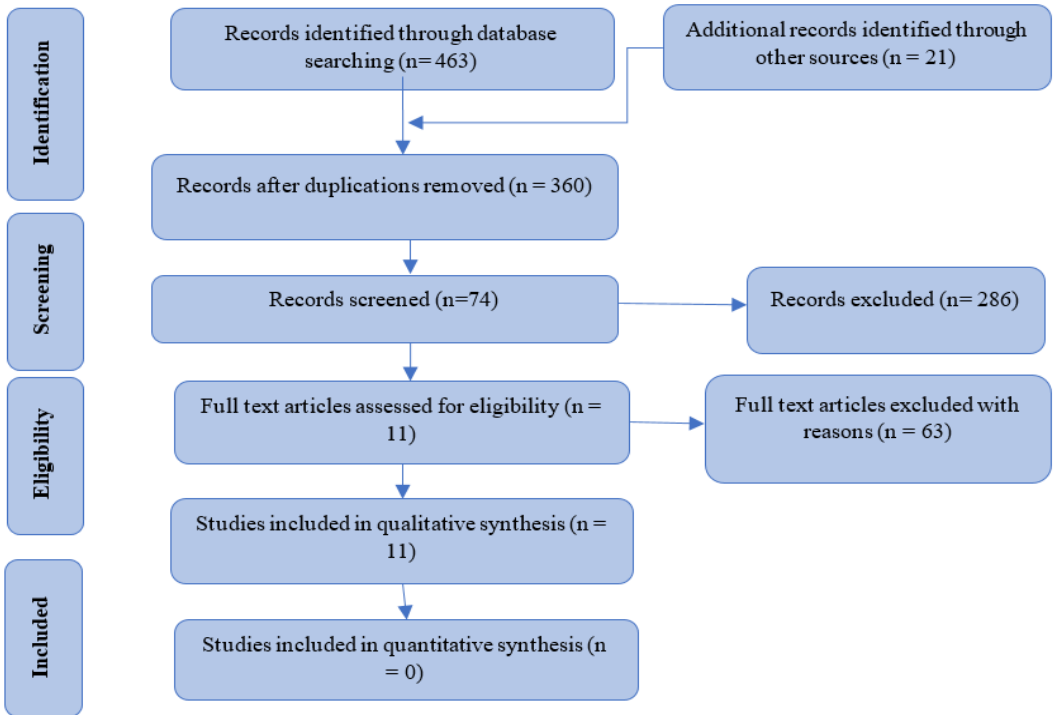

Figure 2.5 : PRISMA Diagram

Subsequently, a set of records are selected for critical reviewing which is denoted from the numbers given in Figure 2.5. The procedure of following these stages are discussed in detail.

- **Identification**

The systematic review based on indexed publications from 2014-2018 since the author wanted the study to represent the most updated knowledge related to the context and being a novel concept to study only the latest publications have a higher gravity in terms of their findings. The databases considered are Scopus Document Search, Emerald Insight, Science Direct, which consist of multidisciplinary publications.

The key words considered were limited to "liveability" and "liveable cities". Alternative spelling for liveability (liveability/ livability) were also considered. Following the identification procedure, 463 records were identified through database search. Additional 21 records were identified through other sources. Only the documents that are explicitly related to the problem statement were selected through other sources. These other sources were found when search through other sources. These other sources were found when searching through articles manually in the reference list and in search engines as google scholar. Table 2.1 demonstrate the key word search conducted to find the relevant sources.

Table 2.1: Key Word Search through Sources

Database	Liveability	liveable cities	liveability index
Scopus Document Search	78	86	10
Emerald Insight	67	28	3
Science Direct	98	83	10

- **Removing duplications and screening**

In order to avoid reviewing of the same article from different databases, the duplications were removed manually. Since the research question is focused on the definition of liveability to the context of Colombo to develop a liveability index to Sri Lanka, all the records were screen by reviewing the titles and abstracts. Two hundred and eighty-six, articles were screened after reviewing the abstracts since those did not provide guidance to answer the research question.

- **Eligibility**

The number of full text article reviewed for eligibility is similar to the difference between the screened records and the exclude records. Sixty-three articles were considered for the eligibility. The reasons for excluding the articles after the full text review were recorded. Among them insufficient reference to liveability indexes was the main reason to exclude journal papers. Five articles that heavily had web references were excluded. Eight articles that had entirely different definition for liveability were also removed. For instance, the medical journal papers had biological definition for liveability. Finally, eleven articles were selected that covered diverse contexts of urban liveability; thus eligible to consider for the concepts of liveability for this study.

- **Included Records**

The number of the included records were the difference between the number of full text articles tested for eligibility and the exclude articles. Altogether eleven records were included to comprehend the concepts and definitions related to liveability. The included records were then again required to categorize as qualitative studies and quantitative studies since it was a useful information if a meta-analysis is carried out at the latter part of the study. However, for this study a meta- analysis is not intended. Therefore, the studies were not categorized as qualitative or quantitative studies.

The selected eleven records are critically analysed to identify an agreeable existing definition for the context or to derive a working definition in Chapter 03 in detail. Moreover, objective 02 was partially covered through there literature review. That is to create a list of liveability indicators using the existing literature. The critical analysis is provided in Chapter 03. Developing a list of liveability indicators based on the considered context was done through studying the case of Colombo.

The background study is conducted to establish the research question, “What are the attributes of liveability that are applicable to Colombo?”. The first objective of the study is to identify definitions related to liveability. A systematic literature analysis was conducted to achieve that objective. Accordingly, an evidence- based minimum set of items were selected by PRISMA method.

2.9.2 Data collection and analysis of the case study

Data collection methods of case study researches include interviews, direct observations, participant observations, questionnaire surveys and relevant documentary reviews (Yin,2014). For the data collection of this study mainly three methods were employed in five steps. First two steps are expert interview and document review which defined and identified elements of liveability. Then AHP questionnaire survey was conducted to prioritized the context specific liveability indicators. Following that the liveability index was developed for the context of Colombo. Finally, the validation was carried out within the case study using questionnaire. In this section these steps are discussed in detail.

- **Step 01- Expert interviews**

Interviews have the capability to investigate the authentic practices, permitting the scholar to illuminate any uncertain responses through interviewees (Kumar, 2011). Therefore, expert interviews were conducted assuming it enabled obtaining a holistic view of the liveability of the inhabitants of Colombo.

Non- probability sampling was executed to conduct the expert interviews. Snowball sampling or otherwise known as chain-referral sampling used where the experts aided in finding other experts to contribute to the study. It allowed the study to continue without lack of participants. In this study the sample size is not determined when the data set reached saturation.

The interviews were semi structured interview which allows obtaining the relevant details from the experts to a maximum level for known and speculated perspectives while maintaining a degree of control over the direction of the interview. The interview guideline is provided in Annexure.

The intention of the interviews was to define liveability to the context of Colombo and to reveal the characteristics of liveability that are observed in the context. Moreover, identifying the challenges to liveability enabled ascertaining the liveability indicators that are required to the context of Colombo. Hence manual content analysis was carried out to analyse the data collected via expert interviews.

- **Step 02- Document review**

Document review is identified as an effective method of data collection by examining context specific documents. Over the years many reports have been generated as development plans for Colombo. However, the is no evidence of a document prepared for specify liveability of Colombo and the ways to enhance liveability.

Hence, reviewing several documents that are relevant to the context was required. The identification of the documents was done by analysing expert interviews. The documents that were referred by more than two experts during the interviews were selected for documents review. The documents were electronic versions which are available online or provided by the interviewees.

The intention of the document review was to identify liveability indicators. Hence, adhering to the liveability characteristics and attributes identified through expert interviews the documents were analysed for liveability indicators under those categories.

- **Step 03 - Analytical Hierarchy Process (AHP)**

When the expected outcome of a problem has different undeniable perspectives a method is required give equal importance to all indicators and then priorities the most important factors. In this study the development of the liveability index requires to prioritize the liveability indicators that has been considered for the liveability index because a prominent criticism of existing liveability indexes is that the liveability indicators are not differentiated based on their significance for the liveability of the reflected context. As a method of prioritising factors Ehrhardt and Tullar (2008) have emphasised the importance Analytic Hierarchy process (AHP) which is a widely used multiple criteria decision-making tool.

AHP has been defined by Saaty (2008) as, "…a theory of measurement through pairwise comparisons and relies on the judgments of expects to derive priority scales" (p.83). The author further elaborated the advantages of AHP in selecting the most appropriate alternatives and the ways to resource allocation. The steps of AHP are illustrated in Figure 2.7. According to that, problem definition and objective determination required to be done as the first step. The research question was "how to

measure the liveability of the city of Colombo?" and the objectives were defined to address the research question at the Chapter 01. The development of the hierarchy of the criteria was done based on the literature findings of Chapter 03 and the document search and the expert interviews.

Questionnaire development for AHP analysis

According to Saunders, Lewis and Thornhill (2019), in order to collect descriptive data questionnaire surveys are much appropriate. Similarly, questionnaires were utilized to obtain specific data for a special proposal (Jones, Murphy, Edwards, and James, 2008). Further, collection of data from a large number of respondents over a small period was enabled through questionnaire (Mathers, Fox and Hunn 2007). The development of liveability index required identifying the liveability indicators. Once identified, the questionnaire was utilized to prioritize these indicators. The questionnaire was developed in a way where the respondent was able to pairwise comparison and to mark the magnitude of the importance (Refer Figure 2.6).

16. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "welfare" attribute.** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B	LEVEL OF IMPORTANCE
A	**Vs**	**B**		
Concessionaries to low income families	Vs	Welfare for elderly people	A B	**1 3 5 7 9**
Concessionaries to low income families	Vs	Orphanages	A B	**1 3 5**
Welfare for elderly people	Vs	Orphanages	A B	**1 3 5 7 9**

Step 01

Step 02

17. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "natural environment" attribute.** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B	LEVEL OF IMPORTANCE
A	**Vs**	**B**		
Air quality	Vs	Noise pollution	A B	**1 3 5 7 9**
Air quality		Restoration of		

Figure 2.6 : Snapshot of the AHP Questionnaire

As the first step the respondents were requested to select a more important indicator out of the pair of indicators. Secondly, the respondent had to select how many times the more important indicator is important than the other indicator.

The steps followed in AHP process is provided in Figure 2.7. The consistency analysis is followed to identify any outlaying responses which could reduce the gravity of the more common responses. Finally, the weightage of each indicator was identified through the analysis.

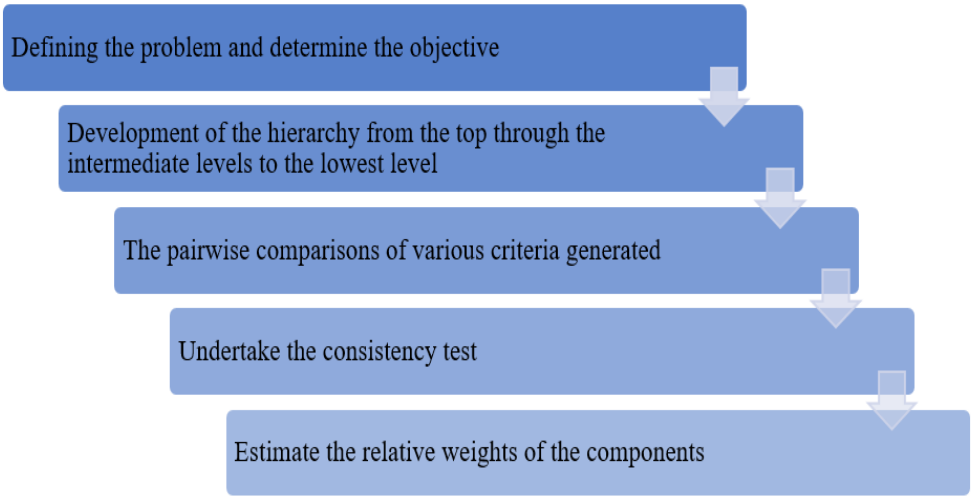

Figure 2.7 : Steps of AHP Process

Adapted from Wong and Li (2008)

In order to make comparisons, a scale is needed to be defined to measure the magnitude of one indicator over another indicator (Saaty,2008). The ratio scale developed by Saaty (2008) is illustrated in Table 2.2.

The pairwise comparison table is based on the vector procedure of Saaty (2008). Following that the priority weights have been calculated. In Table 2.3, the average ratings given by the respondents for each pairwise comparison is given as W1, W2, W3, W4, W5, W6, W7, W8, W9 and W10 in the shaded area and the reciprocals of them are given in the unshaded area. Sum of each column is shown as S1, S2, S3, S4, and S5 in Table 2.3.

Table 2.2 : Ratio Scale Demonstrated by Saaty (2008)

Source: Saaty (2008)

Intensity of importance	Definition	Explanation
1 2	Equal Importance Weak or slight	Two activities contribute equally to be objective
3 4	Moderate importance Moderate plus	Experience and judgement slightly favour one activity over another
5 6	Strong importance Strong plus	Experience and judgement slightly favour one activity over another
7 8	Very strong or demonstrated importance Very, very strong	An activity is favoured very strongly over another, its dominance demonstrated in practice
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If activity i has one of the above non-zero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i.	A reasonable assumption
1.1-1.9	If the activities are very close	May be difficult to assign the best value but when compared with other contrasting activities the size of the small numbers would not be too noticeable, yet they can still indicate the relative importance of the activities.

Pairwise comparisons

Table 2.3 : Pairwise Comparison Matrix for Liveability Indicators

Liveability factors (Main Domain)	A	B	C	D	E
A	1	W1	W2	W3	W4
B	1/W1	1	W5	W6	W7
C	1/W2	1/W5	1	W8	W9
D	1/W3	1/W6	1/W8	1	W10
E	1/W4	1/W7	1/W9	1/W10	1
Sum	S1	S2	S3	S4	S5

Normalizing the comparison

Normalising the entries is done by dividing the entry by the sum of each column in pairwise comparison matrices. Performance score is generated by dividing the row sum from the total sum. Table 2.4. represents a model for normalised comparison matrix for sustainable FM functions and X1, X2, X3, X4, and X5 indicates the sum of each row after normalizing. X is the sum of the sum column.

Table 2.4 : Normalised Comparison Matrix for Liveability Indicators

liveability Indicator	A	B	C	D	E	Sum	Performance score
A	1 S1	W1 S2	W2 S3	W3 S4	W4 S5	X1	X1/X = Y1
B	1/W1 S2	1 S2	W5 S3	W6 S4	W7 S5	X2	X2/X = Y2
C	1/W2 S1	1/W5 S2	1 S3	W8 S4	W9 S5	X3	X3/X = Y3
D	1/W3 S1	1/W6 S2	1/W8 S3	1 S4	W10 S5	X4	X4/X = Y4
E	1/W4 S1	1/W7 S2	1/W9 S3	1/W10 S4	1 S5	X5	X5/X = Y5
Sum						X	

Consistency calculation

A measure of consistency is the Consistency Index (CI). From this a Consistency Ratio (CR), is derived, using a Randomized Index (RI) and the average CI for randomly filled matrices (Goepel, 2015). As the first step the entries in the pairwise comparison matrix is multiplied by performance score to obtain the eigenvector Table 2.5. Z is a new vector obtained through addition of each row. Table 2.5 illustrates the model calculation table for consistency calculations.

Table 2.5: Consistency Calculation for Liveability Indicators

liveability Indicators	A	B	C	D	E	Su m	Sum/ performan ce score
A	1*Y1	W1*Y2	W2*Y3	W3*Y4	W4*Y5	Z1	Z1/ Y1=a1
B	1/W1*Y1	1*Y2	W5*Y3	W6*Y4	W7*Y5	Z2	Z2/ Y2=a2
C	1/W2*Y1	1/W5*Y 2	1*Y3	W8*Y4	W9*Y5	Z3	Z3/ Y3=a3
D	1/W3*Y1	1/W6*Y 2	1/W8*Y 3	1*Y4	W10*Y 5	Z4	Z4/ Y4=a4
E	1/W4*Y1	1/W7*Y 2	1/W9*Y 3	1/W10*Y 4	1*Y5	Z5	Z5/ Y5=a5

The average ratings of each factor were multiplied by the relevant performance score. The summation of that value is calculated afterwards. a_1, a_2, a_3, a_4 and a_5 are added up together and divided by the number of variables present to calculate the value of λ_{max}. Equation 01 could be used for calculating λ_{max} as given in Table 2.6.

Table 2.6: Equations Used in AHP Calculations

No.	Factor calculating	Equation
Equation 01	λ max	$\lambda_{max} = \frac{a_1+ a_2+ a_3+ a_4+ a_5}{n}$
Equation 02	Consistency Index	$CI = \frac{\lambda \text{ max} - n}{n-1}$
Equation 03	Consistency Ratio	$CR = \frac{CI}{RI}$

The third step is to calculate consistence index of the considered set of variables. The Equation 02 in Table 2.6 is used to calculate consistency index.

Finally, the consistency ratio is calculated using Equation 03. The RI is a predetermined constant established for the matrix size and it could be directly employed for the calculation.

Table 2.7 : Average RI for various Matrix Size

Source: Saaty, 2008

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

After analysing the findings of AHP questionnaire a prioritized list of liveability elements was created. In the list has been prioritized the liveability characteristics, prioritized the liveability attributes under that characteristic and the liveability indicators under each attribute have been prioritized. This performance score is known as the local weight. A weightage which is independent from the attributes and characteristics were derived for indicators was calculated by multiplying the local weight of the relevant attribute and characteristic. It is The global weight of an indicator is Accordingly, a list of global weights of the liveability indicators was created.

- **Step 04- Development of the liveability Index**

The development of the index follows two steps as provided in Figure 2.8. The first step is giving priority to the liveability indicators and that step is explained in under Analytical Hierarchy Process. The global weight derived at the end is taken as an input to develop the index.

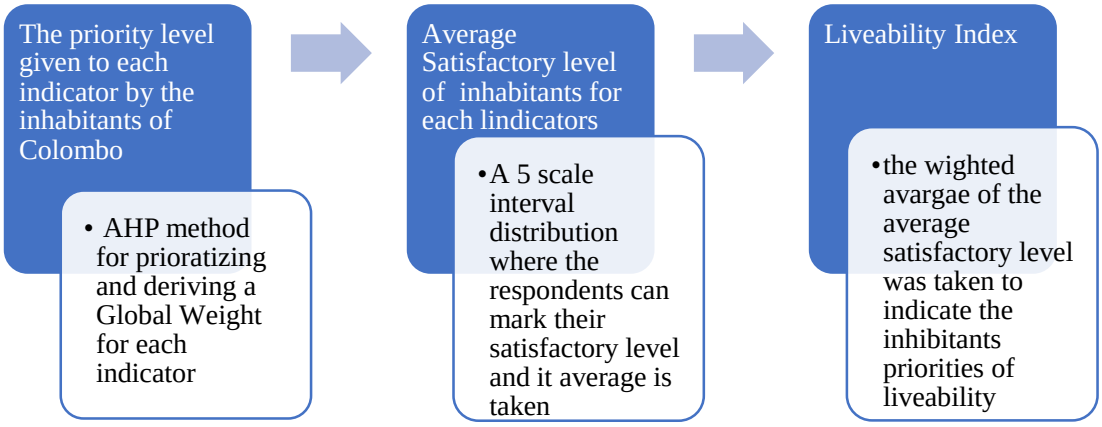

Figure 2.8 : Approach to Develop the Index

To calculate the average satisfaction level of each indicator, a frequency distribution was created as given in Table 2.8.

Table 2.8 : Calculation of the Average of a Frequency Distribution

Class name	Interval	Mid-point of the Interval *(x)*	Frequency *(f)*	*Fx*
Desirable	81-100	90.5		
Acceptable	61-80	70.5		
Tolerable	41-60	50.5		
Unacceptable	21-40	30.5		
Undesirable	0-20	10		
			$\sum_{i=1}^{n} f_i$	$\sum_{i=1}^{n} f_i x_i$

The average satisfactory level is calculated as given in Formula 2.1

$$\overline{\mathrm{X}} = \frac{\sum_{i=1}^{n} f_i x_i}{\sum_{i=1}^{n} f_i}$$

$\overline{\mathrm{X}}$ – average of the frequency distribution

f_i- number of respondents (frequency of the distribution)

x_i – midpoint of the interval

As given in Figure 2.8 the next step was to derive the weighted average of the indicators using Formula 2.2

$$\overline{\mathrm{Y}} = \frac{\left(\sum_{i=1}^{n} \overline{X}_i \times W_i\right)}{\left(\sum_{i=1}^{n} W_i\right)}$$

In the formula,

$\overline{X}_i$ – the average satisfactory level

W – Global weight of the liveability indicator

The summation of the Global weight of all the liveability indicators were equal to 1. Moreover, liveability index is presented as a percentage.

Hence the formula for liveability is,

$$\text{Liveability Index} = \frac{(\sum_{i=1}^{n} X_i \times W_i)}{\max\limits_{0 \le x \le 100} \sum_{i=1}^{n} X_i \times W_i} \times 100\%$$

- **Step 05 – Validation of the liveability index**

The validation of the liveability index was checked in two aspects. Firstly, the validation of the application of the liveability index and secondly, validation of the performance of the liveability index.

According to that the proposed liveability index was applied for the context of Colombo to check if the liveability index is in an operational condition. The accuracy of the formulas used, the relationships of the variables, obtaining credible answers and the potential to handle larger data were tested when validating the application of the index. The performance of the liveability index was measured by respondents' comments on the readability, applicability to the context, use of terms and understandability of the index.

The respondents were selected using cluster sampling where the respondents represent a proportionate sample of a population of the considered local authorities of the case. The pilot implementation considered only a sample of 70 respondents and the template of the liveability index tool was distributed among respondents to evaluate the applicability of the index. A questionnaire was provided to the respondents to evaluate the performance of the index. Based on the responses areas which need further improvement was also highlighted in the study.

2.10 Graphical Representation of the Research Process

Figure 2.9 has been provided to graphically represent the research process that was followed throughout the research. Starting from the background study a synthesis of literature was carried out to achieve first two objectives. Under that the definition of liveability was achieved using PRISMA method which explained in detail at Section 2.7.2. The second objective was achieved as given in Figure 2.9, by synthesising literature and the case study findings. The third objective was to develop a liveability index specific to the context of Colombo and it was achieved through the analysing data collected for the case study and applying AHP method to the case.

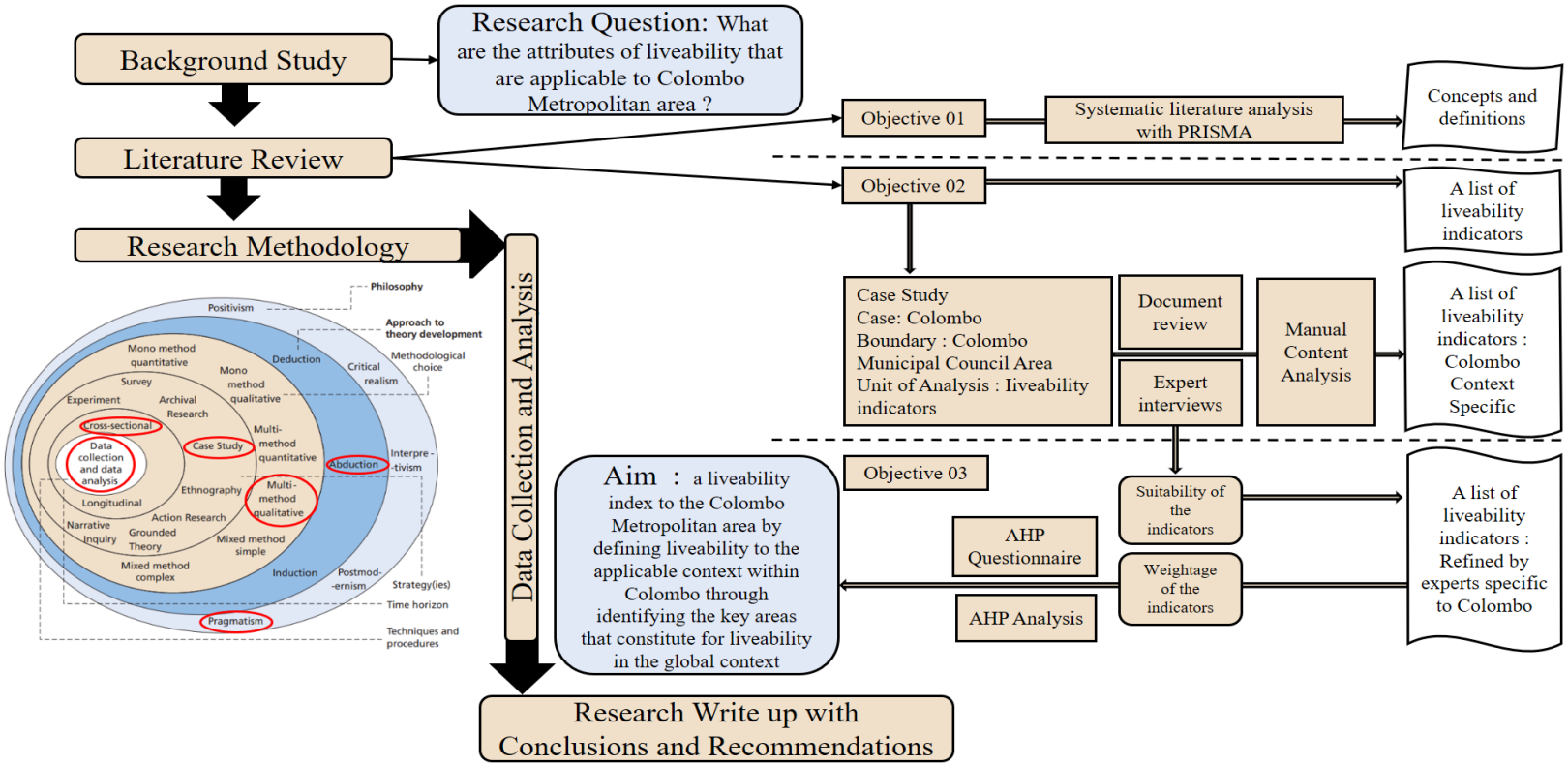

Figure 2.9 : The Research Process

2.11 Chapter Summary

The chapter outline the research process linking the pragmatist philosophy, abductive approach based on the research question of the study. The selection of the strategy was simplified because the philosophical stance selection was done profoundly with much justification. Case study strategy was selected after weighting the context in which the research question was expected to answer. The selection of the techniques and procedures to be followed was explained in detail in the methodology chapter since the comprehensive knowledge of analytical process such as AHP prior to the data collection and analysis is essential to accomplish the aim of the research.

3.0 LITERATURE REVIEW

3.1 Introduction to the Chapter

The third chapter is intended to address the research gap by instituting the current knowledge level via a literature synthesis. The focus is apprehending the concept of liveability and liveable cities along with their definitions. Secondly, the existing global liveability indexes have been identified. PRISMA technique is utilized to select the most appropriate literature sources for the literature synthesis. The limitations of current liveability indexes and the need for a contextualized liveability index have been justified via existing literature.

3.2 The Concept of Liveability

The concept of liveability has emerged in the recent past due to growing interest in increasing the quality of lives of individuals. The precise definition of liveability is still unfilled, with satisfactory review. The differentiated attributes of liveability have resulted in diverse viewpoints among the researchers (Giap, Thye & Aw, 2014; Tan, NIE & Baek, 2016). For instance, liveability is viewed as a construct reflecting the concerns of individual's quality of life and well-being (Giap et al., 2014). Milica (2018) has expressed that the conditions enhancing cultural, environmental, economic, governance and social goals establish liveability of a city. Conferring the above scholar views, the liveability concept is related to a broad spectrum of socio- economic aspects. Therefore, it is critically reviewed using notions such as sustainability, urbanisation and resilience.

3.2.1 Liveability concept and sustainability

To best define the concept of liveability, it is contrasted against a related prevalent notion: sustainability. Sustainability is a vague concept, which is comparatively hard to comprehend by people and practically challenging to instrument at small scale because it conceptualizes in global scale to fortify the well-being of the next generations (Chazal, 2010). The principles such as use of renewable energy reduce the carbon footprint, reduced emissions within the environmental adjustment capacities and recycling are available for sustainability (Sanford, 2013).

However, then the extent to which they should be executed is not defined firmly. Thus, the long-term approaches to achieve sustainability can be subjective and convenient. In contrast, liveability has more immediate concerns which are localized compared to the long term and globalized perspective (Rogers & Hunt, 2019). The tree pillars of social, economic and environmental sustainability are addressed in health, economic, cultural and environmental concepts of liveability (Bijl.2011). Thus, the two concepts are focused on the social well-being, yet with a different scope. The policy makers, local authorities, investors, designers are more conscious in developing liveable communities than sustainable communities since liveability is more tangible, immediate and attainable.

Nonetheless, there are co-benefits of planning sustainable and liveable cities and complementary for environment, urban planning, and public health sectors. To maximally fructify the benefits of sustainability concepts to the liveability, an effective collaboration of the public and private sector and a consistent polices for urban development need to be attained (Rayner & Howlett, 2009; Holden, 2012).

Thus, the common notion emerged comparing the characteristics of sustainability through its definition is that despite the differences in the scope in terms of time and boundaries, the goal of both liveability and sustainability is the well- being of the society.

3.2.2 Liveability concept and urbanization

The word liveability generally associated with urbanization since well-developed infrastructure, increased opportunities in the society for publicly available healthcare, jobs of diverse disciplines denotes liveable surroundings (Titz & Chiotha, 2019). However, it is questionable if liveability is limited to the characteristics of an urbanized environment. Urbanization has been defined as a superficial growth in the environment in response to increased human activities over the encompassing physical boundaries of communities in social, political and economic grounds (Sudhira et al., 2007, Ramachandra et al., 2014). The most likely explanation of the urban sprawl is the increasing population growth in the world.

Currently, there are 34 cities which have a population over 10 million (International Institute for Environment and Development [IIED], United Nations Population Fund [UNFPA], 2012). Out of the world's population, 54% lives in cities or similar urban areas as reported in 2014 and an increment of 3 million in the world population living in urban areas is expected by 2050 (United Nations Department of Economic and Social Affairs [UNDESA], 2014). According to Figure 3.1, the urban population is at the highest level in less developed region. It is assumed that the rapid urbanization in developing region is due the urban sprawl (Peris-Ortiz, Bennett, & Yábar, 2018)..

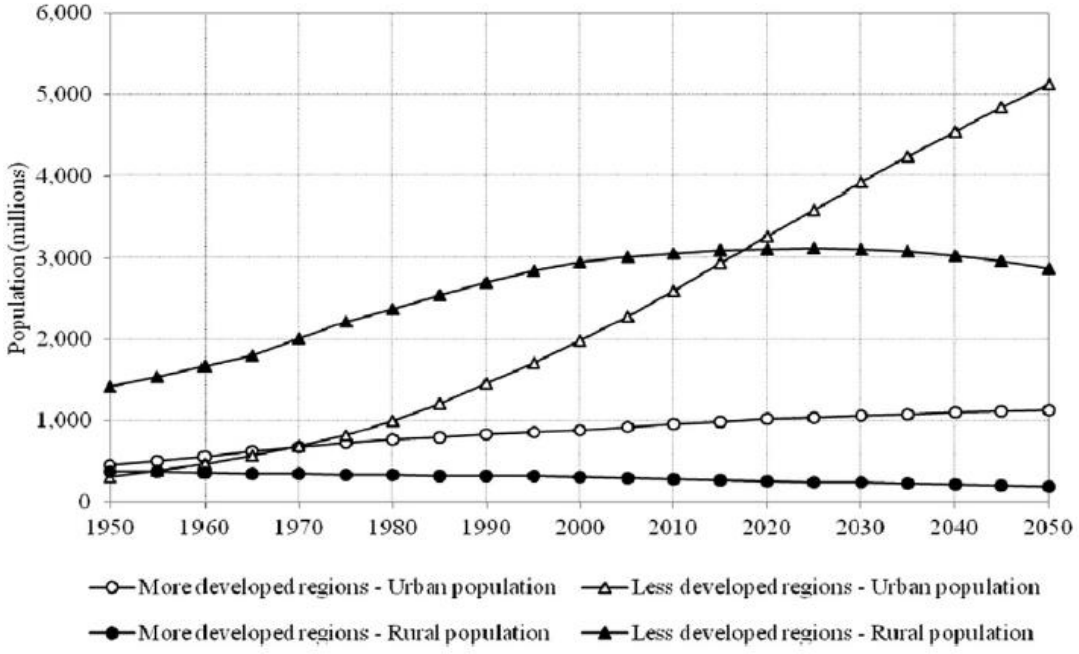

Figure 3.1: The Growth of Population in the World over 100 Years of Time

Source: Adapted from United Nations Department of Economic and Social Affairs (2015).

Mori and Chrisrodoulou (2012) have emphasized the role of cities have to play as an integral part of urbanization for the social and economic well-being of its inhabitants. Because of this, cities have become centres of consumption of resources, greenhouse gas production, generation of waste and pollutants of water and air (Wong, 2019). The ecological footprints of cities have extended far beyond the physical boundaries of cities due to the emissions, consumptions and human activities resulting in negative impacts on the surrounding rural, regional and global ecosystem (Parker & Simpson, 2018).

Thus, it is unfair to interpret that liveability is represented through the urbanisation because the physical infrastructure of a city is not the mere factor that attracts people (Thilakaratna, 2019). Therefore, there is a requirement to distinguish the key characteristics of liveability to accommodate a planned and controlled urbanisation. In the Section 3.3 direct definitions of liveability has been listed down to identify how the defining has been done to different contexts.

3.2.3 Liveability concept and resilience

Liveability is closely associated with concepts of resilience. In order to a city to be liveable, it should be resilience as well (Nastar, et al., 2019). There are two types of resilience discussed. They are ecological resilience and the social resilience (Rogers et al., 2020). In defining resilience, it is important to specify whether resilience is being viewed as a trait, a process, or an outcome, and it is often tempting to take a binary approach in considering whether resilience is present or absent (Angelidou, Balla, Manousaridou, Marmeloudis & Nalmpantis, 2018). However, in reality, resilience more likely exists on a continuum that may be present to differing degrees across multiple domains of life (Pietrzak & Southwick, 2011). Therefore, the concept of resilience is generally applied for disaster resilience, social resilience and economic resilience, which are key constituents of a liveable city (Bush & Doyon, 2019). For instance, the comeback of a nation at a financial crisis, the response of the citizens to a terrorist attack or a civil unrest depends on the resilience that has been developed with in the community (Wang, Shen, Xiang & Wang, 2018). Botzen, Deschenes and Seanders (2019) have also stated that the severity of the impact of a natural disaster on the inhabitants of a city, how critically the city services be affected and availability of adequate measurements as responses to such events are expected by the inhabitants to a city to be liveable.

All in all, the common characteristic of liveability and sustainability is the orientation on well-begin of the society in short term and long term respectively (Sepe, 2020). The urban resilience in terms of economy, society and disaster improves the liveability of cities (Wang, Shen, Xiang & Wang, 2018). Yet the concept of liveability goes beyond resilience since the initiatives taken to improve liveability might not be entirely

resilient but has a focus on business as usual (Nastar, Isoke, Kulabako & Silvestri, 2019). Even though the concept of liveability is often discussed with urbanisation, the indicators of urbanisation such as increased net density of population or development projects as a measure of liveability (Valcárcel-Aguiar, Murias & Rodríguez-González, 2018). That is, because even though the urban sprawl with urbanization attracts people to the cities, the living conditions might not be favourable, thus less liveable (Waitt & Knobel, 2018). Therefore, the concept of liveability has a significantly different scope of concept of urbanization, sustainability and urban resilience which brings out the need define liveability considering its use for the urban society.

3.3 Liveability and Liveable City Defined

Due to the versatile nature of the concept of liveability, precise definition for liveability is not available. Therefore, this section attempts to retrieve a definition for liveability by amalgamating fragments of characterisations provided for liveability. Journal articles within which, "liveability", "liveable cities" and "liveability indexes" are studied, were compared and contrasted within the context of the city or country and the disciplines such as architecture, sociology and ecology.

Conversely, the commercial liveability indexes have not been peer reviewed sufficiently through journal articles. Yet, there are comprehensive reports that contain explaining their liveability indicators, assessment methods and ranking procedures. Therefore, those reports have also been included when critically evaluating the definition of liveability. PRISMA Flow diagram was assisted to select the sources.

3.3.1 Liveability defined

Table 3.1 identifies various delineations available for liveability. According definition R1 of Table 3.1, Shabanzadeh Namini, Loda, Meshkini, and Roknedineftekhari (2019) have stated that the assessment of liveability is dependent upon the place, people and the culture, personalities and the desires of the community. Some of these characteristics are observed in the liveability indicators of EIU liveability index such as place, people and culture (Razavivand Fard, Demir & Trisciuoglio, 2019). However, the attributes related to personalities and desires are not often discussed as indicators of liveability.

In R2 of Table 3.1, liveability is perceived as, "… a human behavioural function that denotes the interaction between individuals and the environment." (Kashef, 2016, p. 240). Similarly, definition R3 also highlights the interaction between individuals and the environment under the concept of liveability. According to that as a place based attribute liveability refers to elements of a home, neighbourhood, or city which ensures the quality of life and well-being (Giap, Thye & Aw, 2014). Valcárcel-Aguiar et al. (2018) have also underlined in definition R4 of Table 3.1, the sustainability aspects of liveability stating that the liveability of a city must be achieved "without compromising the city's future".

Table 3.1: Liveability Definitions

Ref No	Reference	Definition
R1	Shabanzadeh Namini, Loda, Meshini, & Roknedineftekhari, 2019	the assessment criteria of urban liveability vary in different places and for different people depending on their personalities, culture, traditions, and expectations
R2	Kashef, 2016, p. 240	… a human behavioural function that denotes the interaction between individuals and the environment
R3	Giap, Thye & Aw, 2014	… 'place-based' concept that generally refers to those elements of a home, neighbourhood, or city that contribute to quality of life and well-being.
R4	Valcárcel-Aguiar, Murias, & Rodríguez-González, 2018	…the set of attributes or physical, social and economic characteristics of a specific urban area, which, once improved, will have a positive impact on residents' quality of life, yet without compromising the city's future
R5	Capitanio, 2017, p. 13	…the alignment between desired and actual living environment aiming at the betterment of the community as a whole.

The significant differences of these definitions include the difference in the, the lack of precision of the time frame liveability is applicable and incomprehensiveness of the definition in term of representing liveability characteristics. When considering all these definitions together the common characteristic emerged through liveability is that it is a place-based concept, which has a focus on the quality of lives of the inhabitants. It is determined in terms of socio- economic environment and the availability of the housing, quality and availability of services. Emphasise on maintaining the features of natural environment as a part of liveability is observed in given definitions.

The prominent features of these definitions may assimilate in developing a definition for the concept of liveability. Moreover, the working definition may constitute the features identified when comparing concept of liveability with other similar concepts. Hence, the working definition for liveability is used as, the consistency of the desired and actual place-based attribute which reflects the quality of life in terms of the infrastructure, social, economic and environmental characteristics.

3.3.2 Liveable city defined

The intuitive to understand liveability as a 'place-based' concept that generally refers to those elements of a home, neighbourhood, or city that contribute to quality of life and well-being (Giap, Thye & Aw, 2014). Quality of life and well-being are closely related concepts that links dimensions on which an individual's living condition or state can be measured. In Table 3.2 The definitions provided for liveable cities in different contexts are illustrated.

Table 3.2: Definitions for Liveable Cities in Different Contexts

Ref No	Source	Context	Definition
R1	Major Cities Unit, 2011, p. 139	Provides an evidence based support to national urban policy of Australian cities released in May, 2011	a place supports quality of life, health and wellbeing. In broad terms, liveable cities are healthy, safe, harmonious, attractive and affordable
R2	AARP, 2018 as in Shabanzadeh Namini, Loda, Meshkini, & Roknedineftekhari, 2019, p. 2	A non-profit establishment based in USA, with a stated mission, "to empower people to choose how they live as they age".	A liveable community is one that is safe and secure, has affordable and appropriate housing and transportation options, and offers supportive community features and services
R3	Mercer, 2018	to enable multinational companies and other organisations to compensate employees fairly when placing them on international assignments	Cities that attracts international investments and regionally and globally connected in terms of public infrastructure, transport, and talent flows
R4	Lowe, Chirombo, & Tompkins, 2013	a research conducted in the perspective of policy makers and planners in developing healthy, liveable and sustainable cities in Australia	… one that is safe, attractive, socially cohesive and inclusive, and environmentally sustainable; with affordable and diverse housing linked by convenient public transport, walking and cycling infrastructure to employment, education, public open space, local shops, health and community services, and leisure and cultural opportunities.

Department of Infrastructure and Transport Major Cities Unit (2013), for instance is an initiative which focus on an evidence-based approach for the city development of Australia. It characterises liveable city as a place which is healthy, safe, harmonious and attractive and affordable. Alternatively, AARP liveability index is developed by a non-profit organisation in USA, with an emphasis on the "empowering people to choose how they live as they age". A significance is given to aged population. Thus, the definition of liveability is inclined towards making the community secure with appropriate housing, transportation and other social services.

In some instances, liveable city is viewed as one that "provides a vibrant, attractive and secure environment for people to live, work and play and encompasses good governance, a competitive economy, high quality of living and environmental sustainability" (Shamsuddin, Hassan & Bilyamin, 2012, p. 169). In 2013 Lowe, Whitzman, Badland, Davern, Aye, Hes and Corti have defined liveable city as a neighbourhood is one that is safe, attractive, socially cohesive and inclusive, and environmentally sustainable; with affordable and diverse housing linked by convenient public transport, walking and cycling infrastructure to employment, education, public open space, local shops, health and community services, and leisure and cultural opportunities. The definition is extensive and applicable in multidimensional studies effectively.

The most evident fact from the above definitions is that liveable city is a city where quality life style can be maintained. Yet, it is subjective to the individuals within the entity. The elements such as housing, safe and security, environmental sustainability are commonly available in the latter two definitions. The gravity on supportiveness of the community features are high in the first definition since it has been defined for aged people. Form that, it is confirmed that the liveability requires to be defined based on the special needs of the inhabitants and the fulfilment of those needs will make the liveability increased in the perception of the habitants.

3.3.3 Elements of liveability

According to Section 3.3.2 liveability is a concept constituting different characteristics. Hence for the ease of analysis the concept is fragmented into liveability characteristics, liveability attributes and liveability indicators. The liveability characteristics are the intrinsic part of the nature (character) of a liveable city. Liveability attributes are the qualities that constitute the liveability characteristics. The measurement of the liveability attributes is achieved through the liveability indicators. Hence, the indicators collectively provide a measure of the liveability characteristics. The Table 3.3 encompasses main liveability indicators identified in various literature. The attributes have been directly selected from the EIU liveability index since these attributes are simple enough to list other liveability indicators under those attributes. The selection of indicators has been justified with other related literature.

It can be observed that most of the indicators in the Table 3.3 are qualitative while others are quantitative. The scores of the above liveability indicators reflect the liveability of cities.

The validity and relevance of composite indicators in informing policy debate and assisting in policy development is generally limited, as their component, measures have lost their separate meaning through combination, with the nature of the components and their respective weightings in aggregation being the result of subjective decisions (Giles-Corti et al., 2014). Composite indicators say very little about how liveable a city is for all who live and work there as the composition of the indicators reflects the preferences of a specific audience.

Table 3.3:Liveability Indicators Identified through Literature

Liveability Indicator	Literature Source Code																						
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19	L20	L21	L22	Count
Occurrence of violent crime			x				x					x							x				4
Risk of terrorism	x						x									x				x			4
Risk of political conflict				x			x			x			x				x						5
Risk of civil unrest							x		x			x		x				x					5
Accessibility to private health facilities	x						x											x			x	x	4
Standard of private health facilities						x					x				x			x					4
Accessibility to public health facilities		x					x											x			x	x	5
Standard of public health facilities					x		x						x					x					4
Accessibility of over- the- counter drugs						x	x											x					3
Common health indicators				x							x	x		x	x		x				x		7
Humidity/temperature rating			x				x			x						x			x	x			6
Uneasiness of climate to tourists		x									x				x				x				4
Cultural accessibility							x		x					x									3
Level of suppression	x						x					x							x			x	5
Presence of corruption						x	x					x			x				x				5
Food and Beverages	x											x				x							3
Sporting accessibility		x			x							x							x				4
Availability of consumer goods and services	x						x		x		x					x	x				x	x	7
Social and religious restrictions	x							x														x	3
Accessibility of private education							x				x				x				x				4
Standard of private education		x			x		x				x												4
Public education indicators		x	x	x			x										x						5
Standard of road network	x						x															x	3
Standard of public transport						x	x				x				x				x		x	x	7
Accessibility to quality housing		x	x				x						x				x						5
Standard of energy provision						x	x				x				x				x				5
Standard of water provision		x			x		x				x				x						x		6
Standard of telecommunications							x		x					x				x					4
Literature Sources denoted by Code	L1-AARP (2011), L2-Abdelbaset and Mahmoud (2015), L3-Capitanio (2017), L4-Capon (2007), L5-Connecticut's Legislative Commission on Aging (2014), L6 - Dempsey et al. (2012), L7-EIU (2018), L8-Elysia (2008), L9-Forum for the Future (2010), L10-Gleeson et al. (2010), L11-Holden (2012), L12-Jalaladdini and Oktay (2012), L13-Kashef (2016), L14-Li et al. (2009), L15-Miller et al. (2013), L16-Mitchell (2005), L17-Perogordo (2007), L18-Pierson, et al. (2010), L19-Sanford (2013), L20-Timmer and Saymoar (2005), L21-Van, et al. (2010) and L22-Zhao (2010)																						

3.4 The Importance of Concept of Liveability

There is an urgent need of rethinking our approaches to design, construct and operate the cities in order to make them 'liveable' to its inhabitants. Thus, policy programs, business initiatives and political strategies must be designed to increase the liveability of cities (Kaal, 2011). Liveability has been characterized as "a discursive frame that both enables and legitimates entrepreneurial policy initiatives" (McCann, 2004), and as a discourse which enables the individuals to take decisions regarding their consumptions despite the overall responsibilities and ethical usage (Hankins and Powers, 2009). With the emergence of the concepts of liveability over the recent past becoming more than a conceptual objective of policymaking, political propagandas but a method of reflecting the quality of the urban lifestyle (Uitermark, 2009).

Liveability is used in number of contexts including in the field of planning, community development, transportation and resilience (Parker & Simpson, 2018). The authors have argued that ideologies of liveability incorporate enhanced competitiveness in the economy, provision of more transportation choices, and promotion of reasonable and affordable housing, value communities and neighbourhoods and coordinate and influence policies and investment (Ellis & Roberts, 2015; Fleischmann, 2018). In the following sections, some of these requirements has been discussed in detail in next section.

More broadly, this dimension emphasises people's craving for creature comforts and material abundance. It also captures the right to have a decent livelihood. The degree that this craving is satisfied is, determined by the income level and the growth rate of income: two issues that are central to the field of economics (Botzen et al., 2019).

The security and stability stress the natural right of people to live in safety through the maintenance of law and order, the alleviation of natural disasters and the prevention of wars by the state (Vajjarapu et al., 2020). The absence of such psychological pressure in a city increases its liveability in the same way that an improvement in the economic prospects of a city increases its liveability (Botzen et al., 2019).

Though largely neglected by the planners and policy makers, socio- cultural conditions are subsumed within the broader dimension of cultural rights. For a city, this dimension

emphasises the social comfort of living there; the physical ease of living there and the cultural richness of living there (Zahoor, Jamaluddin & Zakaria, 2015). The terminology adopted in the liveability framework to represent this dimension is "Socio-Cultural Conditions".

In addition to physical environment factors, the social environment is also a crucial component of the urban environment that contributes to people's overall satisfaction. The social environment refers to the social setting where people live and includes community structures, resources, and policies that people create to order their lives (Sokolov, Veselitskaya, Carabias & Yildirim, 2019). Specially, the social environment of a city mainly includes a set of immaterial factors, such as high-quality citizens, social inclusion, urban identity, protection of historical culture, as well as a sense of belonging (Shirazi, 2020). However, most of the previous studies have focused on the relationship between the sociocultural environment and satisfaction with the urban environment at the neighbourhood level. Allen, Haarhoff and Beattie (2018) suggested that lacking neighbourhood social attachment significantly reduced residential satisfaction in informal settlements, whereas social features of the neighbourhood play a role in the satisfaction with the neighbourhood and the community.

Political governance is so significant that it is considered specifically one a separate dimension. This dimension covers the effectiveness of the government in providing public services such as extent of corruption and quality of judiciary system, the responsiveness of the government in terms of the degree of transparency and accountability and the openness to political participation through regular elections that are free and fair.

Hence, the importance of liveability for the society could be presumed as people's need of quality urban lifestyle. It has become a conceptual objective of policymaking. Liveability stress the need of security and safety through the maintenance of law and order. The alleviation of natural disasters and the prevention of wars and terrorism improves the liveability of cities. Vice versa, liveability is a globally accepted indicator of a city which reflects the establishment of safety and stability of a country, balanced socio- economic conditions and availability and proximity of quality services. Hence, liveability concept is important to potential investors of the cities to have an idea before

investing in a city. Moreover, this concept could be exploited by policy making authorities to have bench mark the current liveability of the city against the development plans. Moreover, by monitoring the liveability of cities, the policy making authorities can have a clear perception of the real needs of the inhabitants of the city. Therefore, there is an urgent need to measure the liveability of the cities to exploit the full potential of the concept of liveability.

3.5 The Importance of a Measurement of Liveability

The level of liveability of the cities around the world is diverse in nature. Yet, a mode to compare the liveability of the cities is essential in making decisions in individual basis and national basis.

For instance, the individuals who are deciding on the best place to settle in would consider the liveability of the city. Again, this decision can be varied based on the individuals' educational level, income level, age and cultural values. For instance, the elderly generation would have a consideration about the special facilities and services that are available specifically for a group of people exceeding a certain age limit. The attributes such as safety, climate and local level connectivity would be influential in such cases.

Moreover, at national level the level of liveability of a city is crucial in making investment decisions by multinational corporations since the level of liveability is influential to the demand for some businesses. A measurement of the liveability could be used as a marketability tool to promote cities. For instance, the cities such as Vienna and Melbourne are ranked as the most liveable cities in the world and that is exploited by the government and the local businesses to promote tourism in those cities.

Nevertheless, the cities that have been ranked as the least liveable cities also have a use of the measurement of the liveability of those cities. That is to use their status quo as a measure of development and to benchmark themselves against the most liveable cities to identify the potential of growth.

3.6 Liveability Indexes

The methodical constant identification, learning and implementation of the best practises and ways to improve cities through learning through other cities, is considered as city benchmarking (Aksoy & Korkmaz-Yaylagul, 2019). Indicator based approaches to benchmark global cities have been identified in previous studies. (Phillis et al., 2017). Among them, Quality of Life Index (The Economist Intelligence Unit, 2018), Mercer Quality of Living Index (Mercer, 2018), Monocle Annual Quality of Life Survey (2017) and Global Power City Index (Ichikawa, Yamato, & Dustan, 2017; Mori Memorial Foundation, 2016 are significant studies which scrutinize different dimensions of liveability. Conversely, some authors have focused on specific dimensions of urban liveability such as urban water management (van Leeuwen, Frijns, van Wezel, & van de Ven, 2012), urban mobility (Bojković, Petrović, & Parezanović, 2018), air quality (Sheng & Tang, 2016) and economic environment (Giffinger, Haindlmaier, & Kramar, 2010).

Even though the common definition for liveable cities are dispersed through wide spectrum, the liveability indexes consist of liveable indicators shortlisted, used, and updated over a period, which provide a characterisation of liveability (Higgs, Badland, Simons, Knibbs & Giles-Corti ,2019).

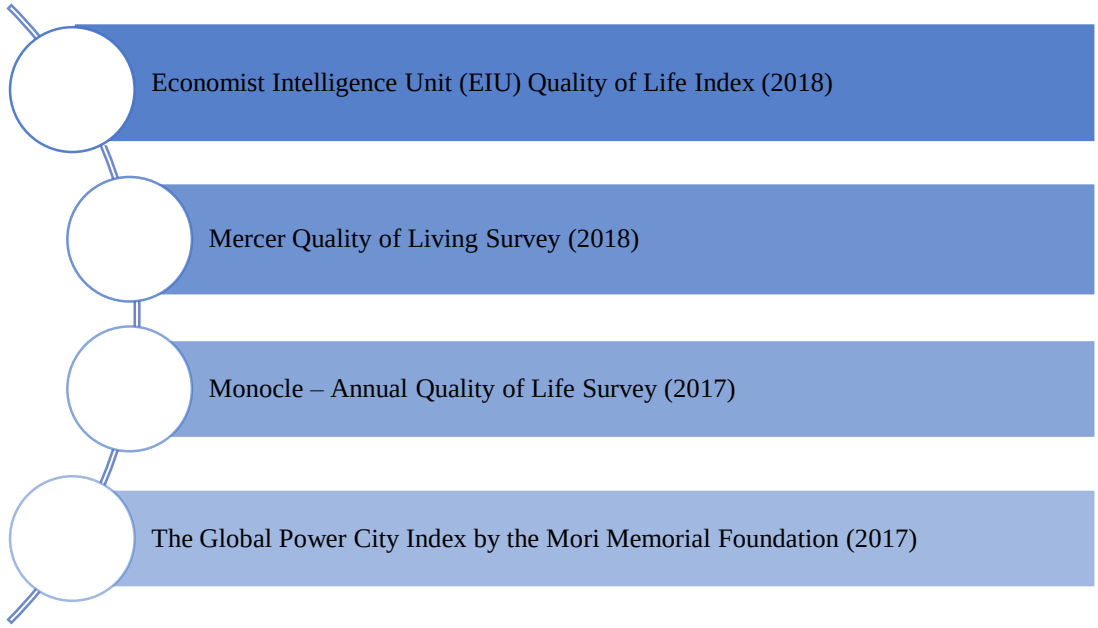

Figure 3.2: Popular Liveability Indexes in the Global Context

Figure 3.2 consist of the widely used liveability indexes in the global context. The selection of the indicators of liveability is based on the purpose the indexes are designed for (Higgs et al.,2019). For instance, global liveable cities indexes such as Economist Intelligent Unit's Liveability Index and the Quality of Living Index by Mercer, are focused to benchmark cities to reflect their suitability for investments (EIU,2018; Mercer,2018).

3.6.1 EIU liveability Index

The Economist Intelligence Unit's (EIU) Global livability ranking is aimed at ranking cities based on their liveability to provide hardship allowances of an expert relocation package (EIU,2018). The index consists thirty qualitative and quantitative indicators representing five dimensions, namely stability, healthcare, culture and environment, education, and infrastructure (EIU, 2018).

- **Methodology**

The cities are assigned a rate as acceptable, tolerable, uncomfortable, undesirable or intolerable between 0 (intolerable) and 100 (acceptable) based on their performance or fulfillment of the livability measures (EIU,2018).

The scores are weighted to provide a score of 1 to 100. The weightages given to each criteria are given in Figure 3.3. According to that, stability has been given 25% weightage when calculating the index. Least (10%) has been given to education.

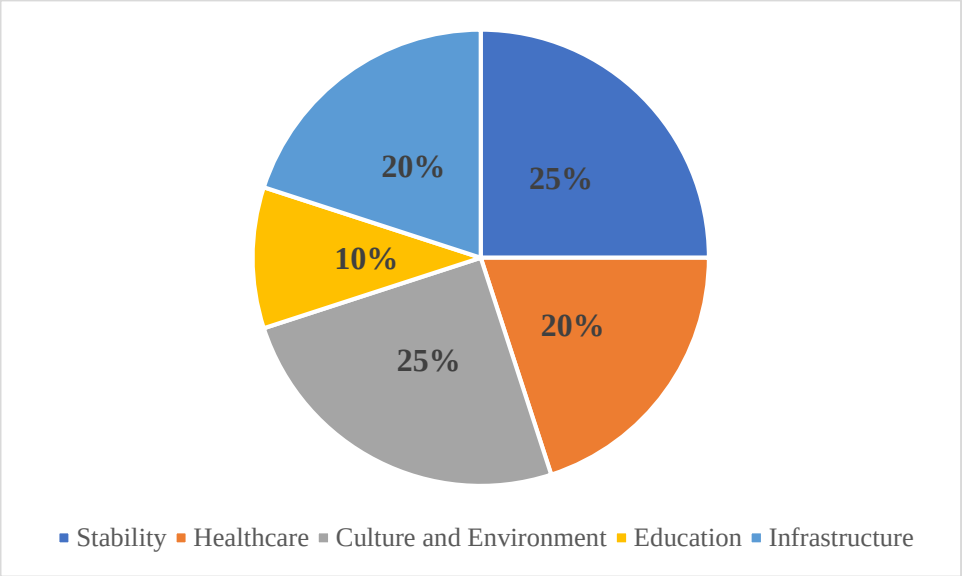

Figure 3.3: Weightage Allocated for Liveability Criteria in EIU Index

The stability measure includes items such as crime rates and threats of civil unrest, military conflicts, and terrorism. Cities score better in the health care category if they offer quality affordable private/ public medical services, including the availability of over-the- counter drugs and preventive care (EIU,2018). It has been observed that EIU index tends to favor English speaking countries, with seven of the top ten scoring cities for 2011 from either Australia or Canada (Manolakis & Kennedy,2012).

3.6.2 The Mercer quality of living survey

The Mercer Quality of Living Survey predominantly assigns a premium on quality of living in over 460 cities worldwide. This survey aims to help companies and expatriate professionals assess appropriate allowances and incentives for relocation. Quality of living is measured via 39 descriptors clustered in 10 classifications. They are namely, socio-political environment, economics, sociocultural environment, health, education, utilities, recreational facilities, market for consumer goods, housing, and natural environment (Mercer,2018). The city of Vienna ranks as the most liveable city according to the mercer index. As opposed to EIU, the Mercer index does not include a provision for job prospects, which is considered highly important by many.

- **Methodology**

Mercer Index does not only provide a comprehensive liveability score but also compares cities across all descriptors. This tool uses a grid that ranks cities according to various aspects related to the quality of living, thereby allowing users to determine which aspect carries more weight for them and then assign an exchange value to the selected variables.

Expatriates, who are already employed in the destination region, primarily base the weights of the liveability descriptors on the Mercer index on evaluations. The Mercer index is especially useful for expatriates sharing common views about urban liveability and assigning similar weights to socioeconomic and environmental conditions.

3.7 Cases of the most liveable cities

The EIU's liveability survey quantifies a range of lifestyle factors and enables comparison between cities by rating cities. The top ranked cities under EIU index is

listed in Table 3.4. According to that each city has been given separate score for the main liveability criteria.

Table 3.4: Top 10 Liveable Cities in 2018

Source: Economic Intelligent Unit, EIU Liveability Report (Global Liveability Survey, 2018)

Country	City	City Rank	Overall rating	Stability	Healthcare	Culture and Environment	Education	Infrastructure
Austria	Vienna	1	99.1	100.0	100.0	96.3	100.0	100.0
Australia	Melbourne	2	98.4	95.0	100.0	98.6	100.0	100.0
Japan	Osaka	3	97.7	100.0	100.0	93.5	100.0	96.4
Canada	Calgary	4	97.5	100.0	100.0	90.0	100.0	100.0
Australia	Sydney	5	97.4	95.0	100.0	94.4	100.0	100.0
Canada	Vancouver	6	97.3	95.0	100.0	100.0	100.0	92.9
Canada	Toronto	7	97.2	100.0	100.0	97.2	100.0	89.3
Japan	Tokyo	8	97.2	100.0	100.0	94.4	100.0	92.9
Denmark	Copenhagen	9	96.8	95.0	95.8	95.4	100.0	100.0
Australia	Adelaide	10	96.6	95.0	100.0	94.2	100.0	96.4

The EIU Liveability index has comprehensively listed the most liveable cities as depicted in Table 3.4, Vienna has ranked at the top with an overall rating of 99.1 and with an overall rating of 98.4 Melbourne is at the second place. Six of the current top ten scoring cities in the EIU's liveability survey are in Australia and Canada (EIU, 2018).

High-ranking cities in the EIU's survey are often small to medium sized (500,000-2.5 million), score highly for healthcare and education, with abundant cultural and recreational enjoyment minus challenges faced by larger cities such as high crime rates and inadequate infrastructure.

3.8 Cases of the least liveable cities

The least liveable cities have been reported in Asia and Africa where a stable political and economic stability is not present. Damascus of Syria is the least liveable city with an overall ranking of 30.7 and Dhaka city of Bangladesh is at the second least liveable city. The increasing focus on global city liveability rankings has prompted planning bodies focused on liveability.

Table 3.5: The Ten Least Liveable Cities in 2018

Source: Economic Intelligent Unit, EIU Liveability Report, Global Liveability Survey, 2018

Country	City	City Rank	Overall rating	Stability	Healthcare	Culture and Environment	Education	Infrastructure
Senegal	Dakar	131	48.3	50.0	41.7	59.7	50.0	37.5
Algeria	Algiers	132	44.1	50.0	45.8	45.4	50.0	30.4
Cameroon	Douala	133	44.0	60.0	25.0	48.4	33.3	42.9
Libya	Tripoli	134	42.9	45.0	41.7	40.3	50.0	41.1
Zimbabwe	Harare	135	42.6	40.0	20.8	58.6	66.7	35.7
PNG	Port Moresby	136	41.0	30.0	37.5	47.0	50.0	46.4
Pakistan	Karachi	137	40.9	20.0	45.8	38.7	66.7	52.8
Nigeria	Lagos	138	38.5	20.0	37.5	53.5	33.3	46.4
Bangladesh	Dhaka	139	38.0	50.0	29.2	40.5	41.7	26.8
Syria	Damascus	140	30.7	20.0	29.2	40.5	33.3	32.1

However, the EIU and other popular liveability indexes report on infrastructure, they do not report on environmental and sustainability factors specifically. However, Mercer recently produced a list of the top 50 eco-cities, in which Calgary ranked first and Perth at number 12. Mercer's ranking includes water availability; water portability; waste removal; sewage; air pollution and traffic congestion (Manolakis & Kennedy, 2012, p. 8). According to the comparison of the liveability ranking, it is evident that they do not provide a holistic view of the liveability. The limitations of the liveability indexes need to be reviewed.

3.9 Limitations of Current Liveability Indexes

The Global liveability indexes rank cities on their present liveability, to facilitate commercial ventures and the suitable wage of emigrants (EIU, 2018). Hence, these indexes emphasis on a narrow set of aspects that influence the economy and way of life of commercial emigrants, and remain less beneficial for updating local policy development. Some indexes are employed to link diverse localities within a city or region, with an expressed focus on policy development (Lowe, 2015). There are indexes with the primarily focus on city bench-marking. Such indexes rely on a checklist of indicators to determine the repercussions of implementing proposed policies on a certain community (Van, Hochstenbach & Uitermark, 2018).

As stated in the given literature, the current liveability indexes in the world have varied focus which leads to limitations in their methodology, indicators when considered for another context. In Section 3.7, the limitations of these liveability indexes have been discussed in general with regards to the urban development with a liveability perspective.

3.9.1 Methodological limitations

The mainly practised methodologies falls under quantitative choices to assist achieving policy implementation. According to EIU (2018), the quantitative methodologies often require larger samples which increases the possibility to extrapolate the results. Yet, major criticism is that the liveability indexes do not provide adequate transparency regarding the methodology used hindering the practitioners to evaluate the index for their purpose (Lowe, 2015). Moreover, Ichikawa et al. (2017) have highlighted that the methodologies employed have not considered the requirements of the public when assessing the quality of lives within cities. Assessing cities requires simultaneously executed techniques to improve the reliability of that assessment (Lim, Yuen & Löw, 1999). Therefore, the methodological limitations include, less transparency of the methodologies, consideration on statistical comprehensiveness and disregarding priority of the stakeholders which highlights the need of proper liveability index.

3.9.2 Data integrity and compatibility

The limitation of availability and comparability of data is a main limitation of liveability indexes (Lowe, 2015). The less integrity affects choice, complexity and variety of the assessment and incompatible data sources limits the number of liveability indicators that can be utilized for comparisons (Salam & Senasu, 2019). The importance and the effectiveness of context specific indexes was highlighted by Waitt and Knobel (2018), to skip data gaps across data sets and to address context specific issues using data within the context.

The extensiveness of the data set to be handle is a fact that affects the integrity of data (Wang,2018). The vast geographical area that has to be covered during data collection makes it difficult to obtain a unratified data set which allow us to obtain per capita or per area data.

3.9.3 Indicators

Meza & Garza (2012) emphasised that, indexes only offer a substitution for performance and might not a flawless or entire measure of liveability. Hence, the association between liveability indexes and general city liveability is not upfront, and no straight reason and result connection can be ascribed. City benchmarking exercises often exaggerate the connection between indictors and characteristics of the city, and data alone could not provide a satisfactory calculation of the liveablity of a city (Sokolov et al., 2019).

To be precise, indicators based on averages tent to neglect the range of the distribution of data (Mori &Chrisrodoulou,2012). Hence, the extremes of the liveability are not accurately reflected through averaged indicators. Such indicators refrain variations of different characteristics of liveability represented by various socio-economic groups (Burrell & Morgan, 2019). The composite indicators restricts through representation of multi-faceted issues in an urban environment (Phillis et al., 2017).Hence, proper selection of liveability indicators is vital to develop a contextualized liveability index.

3.9.4 Ranking

The deviation from the average over the time is not reflected properly through a ranking process (Giap et al., 2014). For an instance, a city that has been ranked low compared to its previous position might have achieved a comparatively high score than the previous score which is not reflected through the rank. The reason behind could be majority of the cities have developed in terms of their liveability over the time across all the liveability indictors (Chazal, 2010). Hence, ranking tables do not give recognition to well performed cities over the time.

Well scored cities in overall performance are ranked top. Yet, the cities that have exceptionally performed well in particular indictors are suppressed. As stated by Bulsas (2004), when different weightages and dimensions are applied based on the functional purpose of the indexes the clarity of an index demonstrating ranking is minimised.

Hence there is urgent need of a context specific liveability index which does not entirely provides its findings as a ranking rather as a breakdown of the scores.

3.9.5 Subjectivity

As explained by Bulsas (2004) the liveability indexes include both qualitative and quantitative objectives. The qualitative objectives are often criticised for being subjective measure (Luque-Marínez & Muñoz-Leiva, 2005). The subjective indicators represent most of the cultural, social, economic, geographical and political aspects. These indicators cannot be neglected considering their importance to the index. Yet, the quality of the index is reduced due to subjectivity of the indictors if the index derives a qualitative result as the end result.

Hence, a liveability index which address the drawbacks related to methodology, integrity and subjectivity is needed to be developed.

3.10 Liveability of Colombo Sri Lanka

Sri Lanka is populated by 20.359 million people, which includes 18.2% of the total population living in municipal areas. When considered proportionately, this urban population of 3.704 million makes Sri Lanka as the 11th least urbanized country in the

world according to the World Urbanisation Prospects (United Nations Department of Economic and Social Affairs [UNDESA], 2018). Nevertheless, the urban liveability conundrum is not effectively reflected from the urban population data. When, using multiple indicators to measure liveability, the urbanised population of Sri Lanka amounts to 35-45% of the total population (Uchida & Nelson, 2010). The recent policy documents of Government of Sri Lanka (GoSL) illustrated 50% of the population is urban population (Department of National Planning, 2017). Similarly, night time light analysis of Sri Lanka demonstrated this significant urban growth in the country (Ellis &Roberts, 2015).

The concentrated population in the commercial capital of Sri Lanka, Colombo has perplexing life style due to the features that has resultant from urbanization. Urban sprawl, becoming compact cities, urbanized economy, labour productivity in various industry, urban housing are some of these features. These features have both challenging and rewarding outcomes which could be synthesis to understand the quality of lives of the inhabitants of Colombo.

3.10.1 Urban sprawl: the effect of rapid urban expansion of Colombo

The rapid urban expansion poses grave threats to important earth systems, globally and in Sri Lanka, with severe implications for environmental sustainability. A major study by Karen Seta of Yale University highlighted the bio sphere of Sri Lanka as one of the top four location globally under threat of urban expansion (Seto, Güneralp & Hutyra, 2012).The rapid land use change from non-urban to urban has shown to have negative effects on urban resilience to climate change, particularly through increasing flood vulnerability. Land use change has drainage capacity in greater Colombo area sustainability, increasing flood risk to urban residents (Hettiarchchi et al., 2014)

Sprawl increases the costs of public service provisions, because population and economic assets are spread over wide areas, relative to more compact cities (Bandara & Hettiarachchi, 2010). This affects the competitiveness of cities by reducing their liveability and cost of services provision. Urban Sprawl creates problems for urban mobility, particularly in the provision of affordable and reliable public transport, and encourages private vehicle usage (Vance & Hedel, 2007). This has implications for

safe cities because increased exposure to traffic accidents. Urban sprawl has been directly linked to road traffic facilities globally (Ewing, Schieber & Zegeer, 2003). Increased private vehicle usage leads to higher greenhouse gas emissions.

3.10.2 Compact cities: effects of mix development approach in Colombo

Compact urban expansion refers to the densification of mixed urban land use over a small area and is widely viewed as preferable to low density sprawl. Compact cities with appropriate urban planning interventions can improve access to urban services, such as solid waste and wastewater management infrastructure, and drive cost effectiveness in services delivered by reducing coverage areas (OECD, 2014). Zhao (2010) has expressed that compact cities improve urban mobility by reducing the need for vehicle usage and enabling effective, efficient and equitable provisions for public transport.

The mobility benefits of compact cities reduce greenhouse gas emission and have been shown to have significant impacts in improving public health outcomes (Stevenson et al., 2016). Spatial analysis suggested the Colombo has more deified land use than other MCs. Remote sensing shows that 90% of Colombo fits into the 'urban' land use category- higher than any other municipal (MMWDSL, 2016). In addition, GoSL land use mapping of very high-resolution satellite imagery shows that high-rise building accounted for approximately 9 per cent of residential land use in the city, in comparison to 1.5 per cent on average across other cities. Colombo also includes the country's most significant (Ministry of Finance Sri Lanka [MOF], 2017).

3.10.3 Urbanized economy: effects of the changing characteristics of economy of Colombo

Sri Lanka is often regarded as an economic success story in South Asia, maintaining high GDP growth and diversifying its economic output. Growth has resulted in large increase in GDP per capita and today Sri Lanka has one of the highest per capita income in South Asia at over USD 4000, and one of the lowest rates of urban poverty (CBSL, 2018). Only 2.1 per cent of the urban population are recorded as being below poverty line (Refer Figure 3.4).

An exception to urban poverty is that large swathes of people living in peripheral city location are not classed as 'urban' because of administrative classification.

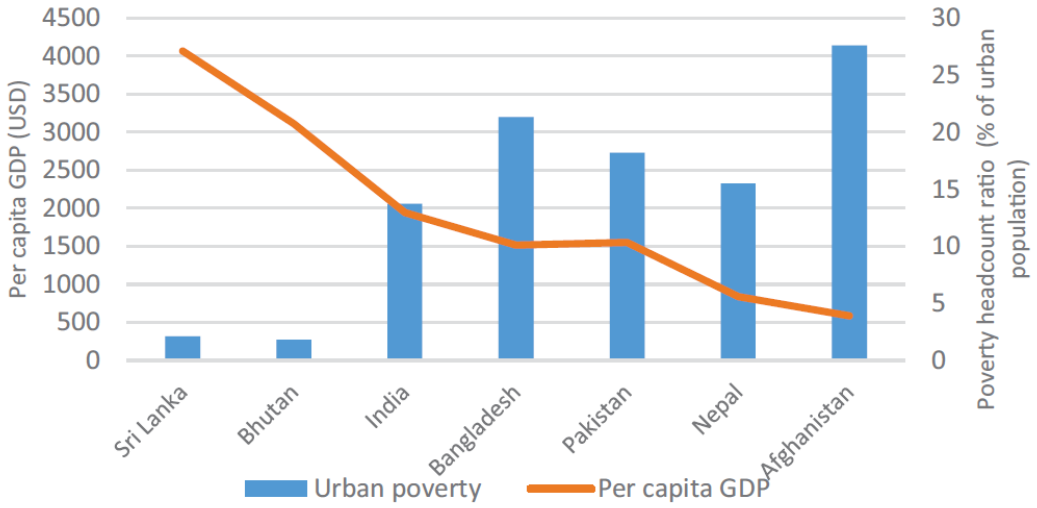

Figure 3.4: Per Capita GDP and Urban Poverty in Selected South Asian Nations

Source: Data from World Bank (2018)

As provided in Figure 3.4 urban poverty of Sri Lanka is considerably less compared to the cities in the South Asian region. The Per capita GDP is also considerably high. This graph indicates the opportunities in the cities of Sri Lanka; particularly Colombo being the commercial capital. Hence, the urbanizing economy in Colombo with 35% of the GDP is generating from service sector is complementary to improve the liveability of the city.

3.10.4 Issues related to urban housing and tenure in Colombo

A key function of cities is to provide housing for the diversity of residents that support urban life (UN-HABITAT, 2016). The importance of this function in Sri Lanka is highlighted as the highest proportion of residential in the municipal areas were "low-rise residential" (under 4 floors) and only 1.5% of the residential categorised as high-rise residential (MOF, 2017).

Urban housing caters to a range of socio economic groups. For an inclusive development perspective, a key policy issue related to low quality and non-durable housing (Peiser, 1989). Understanding the characteristics of these housing and the needs of the inhabitants of them is essential to foster inclusive development.

In Colombo MC, where according to the Department of Census and Statistics (2012), 2 % of residents lived in "temporary" housing, with reminder living in permanent structures. Colombo registered one of the lowest proportions of temporary housing out of the other municipals in Sri Lanka. In contrast, Urban Development Authority (UDA) has categorised over 50% of the Colombo residents as living in "Underserved" housing, equating 68,000 families (MOF, 2017). This is due to the substantial difference in temporary and underserved houses. Underserved houses fall into two categories namely slums housing referring planned residential units often owned by multiple parties which have fallen into a state of despair, and shanty housing referring unplanned and self - built houses (Angel, Parent, Civco, Blei & Potere, 2011). A study of Colombo MC suggested that the underserved housing include self-built areas that have been subjected to upgrading programmes, permanent housing that has been assessed to be in dilapidated condition, as well as temporary housing made of non-durable materials.

3.10.5 Limitations in the cities and municipal services

In order to improve the liveability requirements of the Colombo, a significant investment is required to Water, Sanitation and Hygiene Systems. Less than 30% of households across the Provincial Capitals report a piped sewerage connection, instead relaying on vulnerable on-site disposal methods (Urban Development Authority - Sri Lanka [UDA], 2018).

An important issue in the provision of public services is related city boundaries. Many basic public services and the maintenance of key infrastructure is the responsibility of urban authorities. However, because of the rapid sprawl expansion a large proportion of urban residents and users of municipal services and infrastructure live outside of the municipal boundary (Urban Development Authority - Sri Lanka [UDA], 2019).

3.10.6 Intercity and rural-urban connectivity

Sri Lanka's cities are nodes that facilitate national, regional and global connectivity. At the global and regional scale, increasing connectivity between cities will foster economic and social development, plugging Sri Lanka into global networks of knowledge and capital (MOF, 2017). At the national scale, increasing the connectivity

between cities, particularly those in more remote locations, and between rural and urban populations, can widen access to social and economic opportunities (Parker & Simpson, 2018). Because of this, connectivity is a key strategic aim of Sri Lanka to promote economic growth, and to rebalance growth across the country's 9 provinces (UDA, 2019). Sri Lankan Provincial Capitals play a crucial role as economic and logistics hubs providing access to the supply chains that maintain the country's economy. The road, rail, airport, ports, waterways and telecommunications infrastructure are vital to support the efficient and effective collection and distribution of a wide range of goods and services (Castanho, 2019). In this regard, land use mapping undertaken for the GoSL report highlights the role of cities as hubs of transport and nodes of connectivity. The capital, Colombo municipal, has by far the greatest proportion of built-up area for transport land use. It includes a 300 ha international port, which accounts for around 8 per cent of Colombo municipal's built-up area, highlighting the city as a node for transnational trade and important access point for regional and global supply chains (MMWDSL, 2016). Nearly 2 per cent of all land was used as bus and rail terminals highlighting the importance of Colombo as a national transport hub. A dense network of roads radiates from the city, out across the country, and connect the city to the international airport to the north of the city via an expressway (UDA, 2018).

3.11 The Need for Standardized Indicators for Colombo Sri Lanka

The process of maintaining the resources and opportunities in cities effectively is critical and has been intensified due to the increasing population and demand to the resource available (Urban Development Authority - Sri Lanka [UDA], 2018). The major challenges in the cities are economic development, poverty reduction, facing climatic change and developing cohesive and peaceful community (Wey & Huang, 2018).

Yet, the short-term requirements of the residents may include the proper waste collection of the city, quality schools, availability of the supermarkets or convenient in transport facilities (Ariyawansa, 2010). The point to be emphasized is the livability of a city is the short-term quality of life of the habitats without compromising the long-

term sustainable requirements (Giap, Thye & Aw, 2014). Hence, there is an urgent need of standardized set of indicators that will reflect these phenomena the best.

An indicator is a measure or a set of measures that describes a complex social, economic or physical reality, and a measure is one data point that acts as a gauge to tell us how well or poorly we are doing with respect to an indicator (Balsas, 2004). In the subsequent sections the properties of livability indicators such as city performance measurement, apprehending inclinations across cities and capturing trends over are discussed in detail.

3.11.1 Measuring the performance of the city

Past decade has changed the role of the cities and the local authorities drastically with the increased concerns on climatic changes, spatial disparity and economic vulnerability (Mittal & Sethi, 2018). Therefore, policymaking includes mix development requirements, disaster resilience action plans and initiating public private partnerships (Sokolov, Veselitskaya, Carabias & Yildirim, 2019). The capacity of the city to deliver the services with the fluctuating demand from the public and fine line the areas that the authorities lagging behind (Clements-Croome, Marson, Yang & Airaksinen, 2017).Enhancing the use of liveability indicators to the national level will further the management and financing of the services. Globally, the fiscal policies of the national government are influenced by the well performing cities with good governance.

3.11.2 Capturing trends over time and across cities

The liveability indicators are crucial to identify the inclinations of different cities toward novel concept that brings a competitive advantage to that city (Goodman, 2018). The liveability indicators are essential to assess trends to determine future policy implementation because residents, investors, educational and commercial institutions and other stakeholders desire information on the development of the city (Shamsuddin, Hassan & Bilyamin, 2012). It is essential to distinguish liveability, economic and demographic trends, and environmental measures adopted in cities (Hadi et al., 2018). Hence, liveability indexes are needed to assist comparisons across cities and over time.

3.11.3 Monitoring aid effectiveness of projects

The lack of reliable disaggregated data is a limitation that development institutions face when trying to respond to development assistance needs of cities (Peris-Ortiz, Bennett, & Yábar, 2018). Well-defined, standardized indicators could help in monitoring and evaluating projects (Giles-Corti et al., 2014). Such indicators will be particularly useful in designing policy-based lending instruments, with progress on key indicators, triggering the release of financing tranches based on the achievement of policy reforms and improved service delivery outcomes (Fleischmann, 2018). The liveability indexes allow development authorities to monitor aid effectiveness of projects.

Considering above all, it can be observed that the city of Colombo requires a comprehensive liveability index which consisting of livability indicators which clear reflects the requirements of the inhabitants of Colombo in terms of liveability.

3.12 Development of a Context Specific Liveability Index

All in all, the literature review justifies the need of a context specific liveability index. It is being illustrated in short in Figure 3.5. According to the reviewed literature, the issues in the urban built environment need to be addressed in a participatory planning mechanism to make in more sensitive towards the inhabitants of the particular city. When liveability is selected as the approach to plan the urban renewal it needed to be defined considering characteristics, attributes and indicators, as given in Figure 3.5.

When defining liveability it is observed that liveability need to define across built-enviroenement, socio econmoic environemnt and natural environment. As provided in Section 3.2, a significant deduction from the existing literature is that, the perception of the inhabitants on liveability starts from built enviroenment and move toward the natuaral enviroenement. Conversely, in the studies conducted in planners perspective liveability is the short- term focus of sustainability and priority is given to the natural envireonement over socio- economic enviroenement or the built enviornement. Therefore, liveability need to be defined for the context of the study.

Similarly, the existing liveability indexes have different purposes which eloborate the need to define liveability to the context its applied. Moreover, the limitations in current

liveability indexes as synthesised in Section 3.7, highlight the need of an index to assess liveability by over coming them.

Hence, in this study liveability is defined, segregated into its elements and finally an index is developed with an view to assess liveability to enhance the quality of lives of the inhabitants.

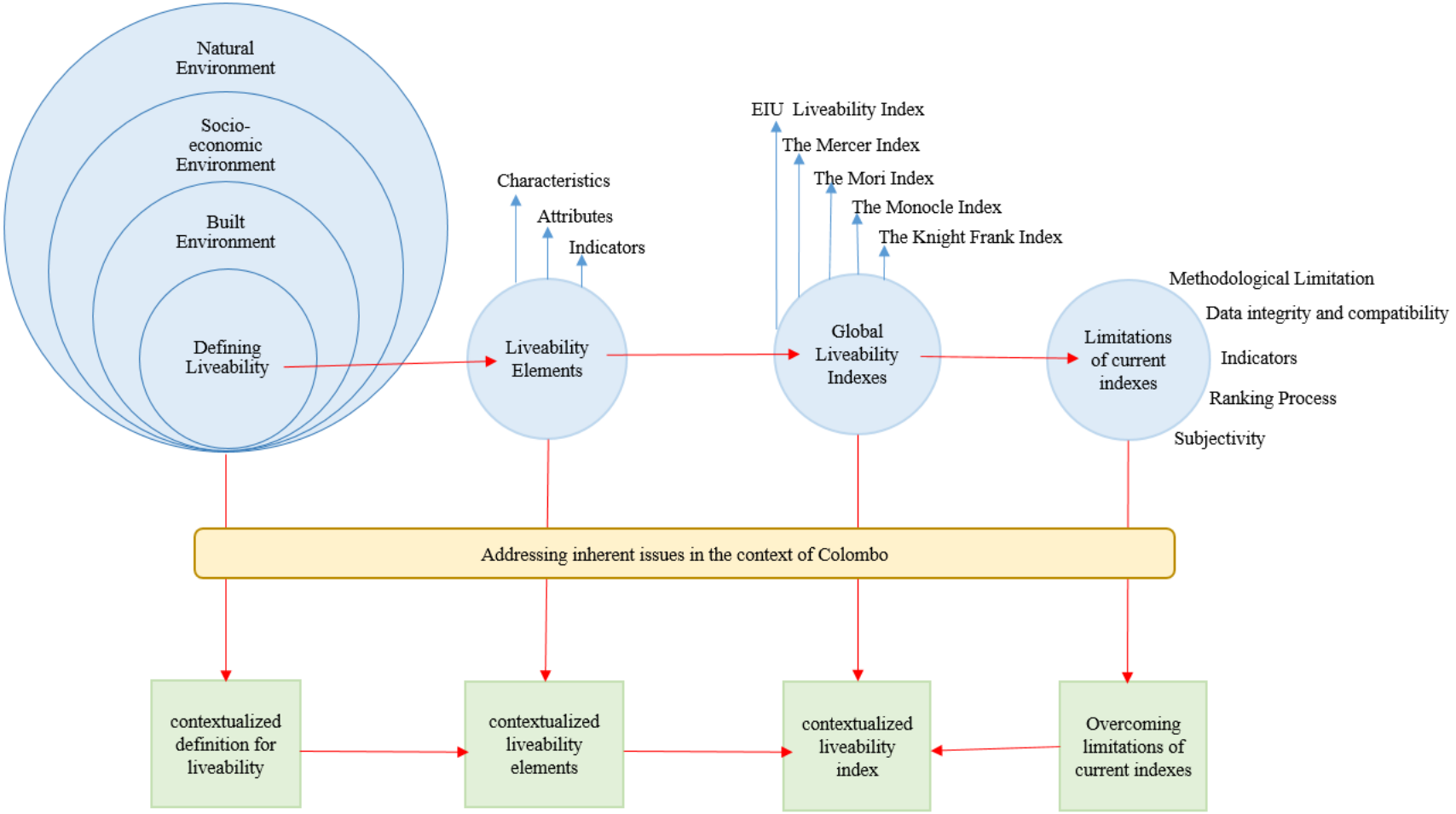

Figure 3.5: Conceptual Framework

3.13 Chapter Summary

The literature synthesis strengthens the background of contextualization of liveability, in developing liveability index to the context of Colombo. A conceptual definition of liveability was provided in this chapter as a solution to the unavailability of established definition for liveability. The synthesised literature was effectively utilized to originate the comprehensive list of liveability indicators. The existing liveability indexes and the cities that have been ranked as most liveable and least liveable were critically analysed to identify the characteristics of liveability. The literature that outlines the global trends have been integrated with liveability of Colombo, Sri Lanka. Subsequently, the limitations of current liveability indexes and the need for standardized indicators for Colombo have been identified as the foundation for developing a context specific liveability index.

4.0 DATA COLLECTION AND ANALYSIS

4.1 Introduction to the Chapter

The aim of the research is to develop a liveability index to enhance the quality of lives of the cities in Sri Lanka to make them more liveable to its inhabitants. In Chapter 03, key areas that constitute liveability in the global context are identified at length. In the fourth chapter, Colombo is studied as a case in the local context of Sri Lanka which have unique characteristics and inherent issues related to liveability compared to global context. The process of data collection and analysis is presented with the findings to achieve the aim.

4.2 Introduction to the Case

Colombo is the epi-centre of Sri Lanka's international relations, branding, cross border transactions and transportation, trade and commerce, and political affairs (UDA, 2019). The Colombo International Port and the Colombo International Airport are the gateways of commercial and administrative activities of Sri Lanka. The city requires higher quality of lives and a harmonious environment to operate as an international city in the global context more than other cities in Sri Lanka. Hence, it is a unique case to be studied. The case boundary is 08 local authorities namely, Colombo MC, Dehiwala Mount Lavinia MC, Boralesgamuwa PS, Kolonnawa PS, Peliyagoda PS, Wattala – Mabola UC, parts of Wattala PS, and Kelaniya PS. These areas capture the overspill of the urbanization, economic activities and service requirements of inner Colombo (UDA, 2019). These have been declared as "Urban Areas" through a series of Gazettes (Refer Table 4.1).

Table 4.1: Declaration of Local Authorities of Colombo Commercial City as Urban Areas

Local Authority	Date of Declaration	Gazette Number
Colombo MC	30.09.1978	No. 4/1
Dehiwala Mount Lavinia MC	30.09.1978	No. 4/1
Kolonnawa UC	30.09.1978	No. 4/1
Boralesgamuwa UC	01.10.1979	No. 56/6
Peliyagoda UC	14.08.1981	No. 154/13
Part of Kelaniya PS	13.02.2001	No. 1171/10
Part of Wattala PS	22.08.1995	No. 885/6
Wattala – Mabola UC	19.04.2002	No. 1231/15

Hence, considering these 8 local authorities as Colombo would be more practical and accommodating since, the latest development plans consider aforementioned urban areas as Colombo (UDA, 2019). The geographical area considered for the case boundary is given in Figure 4.2.

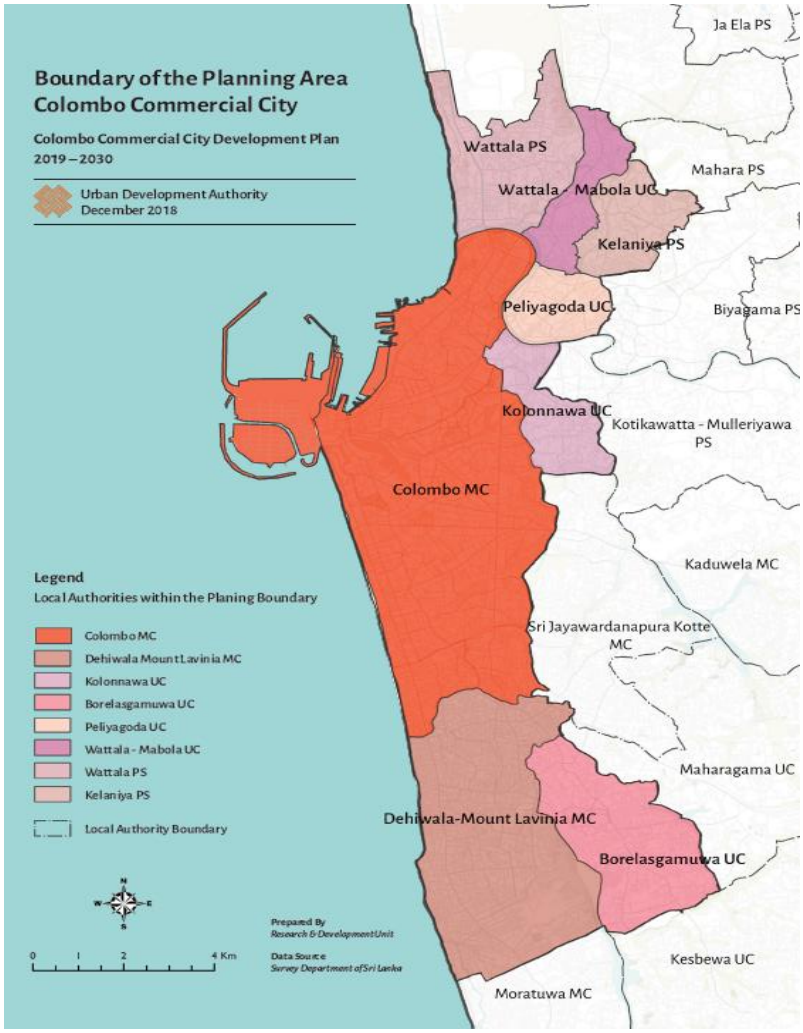

Figure 4.1: The Boundary of CCC

The total land area of 102.3 km^2, consist of 85.2 km2 built up area and 17.1 km2 natural environment. The population density varies between 13,800 -6,400 (Population/km^2). The residential population is 1.06 million whereas the daily commuting population is 0.82 million. There are 250,270 total housing units out of which 36,512 are underserved housing units. The economic sector of Colombo is mainly dependent upon services sector (66.9%) and other prominent sectors are industry sector (30.6%) and agriculture sector (2.5%).

The competitive economic activities in Colombo have made it a major economic hub in South Asian Region. Colombo has been ranked at first place in the south Asian region in Mercer's 2018 Quality of Living Survey. Moreover, it has been ranked at 132 globally out of 140 cities considered for the EIU,2018 survey. In 2017, EIU report Colombo has been identified as one of the biggest improvers who have effectively improved their liveability over last five years. Colombo has been considered as Gamma+ city which contribute to the world economy by integrating small economic regions.

The liveability of citizens is considered as the unit of analysis for this study. In this case the citizens denote, approximately 1.1 Million of residential population and 0.8 Million of daily commuters.

4.3 Analysis of the Expert Interviews

The expert interviews are conducted to define the concept of liveability to the context of Colombo. In Section 4.2 the experts provide the factors that challenge the liveability of Colombo. Based on the challenges a pattern is developed to identify the liveability characteristics of Colombo. Subsequently, a list of liveability indicators is derived through the expert opinions.

4.3.1 Expert selection and demographic distribution of the experts

Development of a liveability index is challenging in terms of outlining the responsible authorities that are executing its implementation, the population or the geographical boundary on which the liveability index is tested upon and the people who make decisions using the liveability index. Their interests regarding the liveability index is diverse and might be conflicting. Hence when selecting a sample for data collection, a sample which represents the three stakeholder groups without or least possible biasness was nominated.

Accordingly, experts are selected from, architecture and built environment, sociology, town and country planning, ecology and economics. Eight experts related to architecture and built environment, town and country planning, sociology, and economics, civil engineering and healthcare sector were selected. Experts were

interviewed until the collected data got saturated. In the Table 4.2 the respective areas of expertise and the experience of the experts have been tabulated.

Table 4.2: Areas of Expertise and Experience of the Experts Interviewed

Respondent	Respondents' area of expertise	Respondents Experience in the relevant filed (years)
A	Architecture and built environment	27
B	Urban planning	10
C	Urban planning	8
D	Civil Engineering	9
E	Sociology	31
F	Ecology	8
F	Economics	15
G	Healthcare sector	17

According to Table 4.2 the minimum level of experience of the experts are 8 years and the maximum level of experience is 31 years. These experts demonstrated their skills in both as professionals and academics in their field of studies. Additionally, all the experts have been participated in national level policy making initiatives. Therefore, their awareness of difference among the perspectives of the policy makers, the subjects and the users are high. The experts were interviewed using a semi-structured interview guideline. The expert opinions were analyzed using manual content analysis.

4.3.2 Experts definition of liveability for the context of Colombo

The expert interviews were conducted to define liveability to the context of Colombo. Firstly, the experts were requested to provide a definition to liveability in their own words. Moreover, they had to provide five distinct words or phrases that impulsively come into their mind about the "*liveability of CCC".* Following that, they commented on the liveability definitions obtained through literature review.

Accordingly, for expert A liveability is, *"the expected living conditions of a particular place, hence in this instance Colombo"*. This definition is similar to the expression by Giap et al. (2014) who viewed liveability as a place-based attribute. This was evident through most of the definitions of the experts, since they indicated it using words such

as “city”, or “environment”. According to expert C, “*liveability is perception of a person regarding his living condition and it is a state of mind about that”*. Expert C did not related liveability to a place or environment but explained in length how individuals view the world ultimately decides the liveability. Expert D stated, *“take a day worker and a shop owner living in same area of the town. The day worker might be satisfied by having ample opportunities to do day works in the area while the shop owner is worried about the practise of business on credit in the area which might lead him to bankruptcy.”* Hence, in the same environment the level of liveability may differ from individual to individual. Shabnazadeh et. al (2019) has address this in their definition that, “*urban liveability varies in different places and for different people depending on their personalities, culture, traditions and expectations”.* Experts B, D, E and F highlighted this factor even they provided liveability as a placed based attribute.

Moreover, the experts linked liveability to availability of services in the city. According to them, the urban sprawl in Colombo is a result of the service availability of the city. According to expert G, availability of advanced medical facilities compared to other parts of the country which makes people attract to this city to live in. He said that it is justifiable to services such as education, uninterrupted power and water supply, waste collection, public transportation and public security. Therefore, a definition of liveability to a context of city may represent the service availability of the city as well.

Therefore, liveability is defined for the context of Colombo as, “*the satisfactory quality of lives of inhabitants of city achieved through its balanced socio-economic environment reflected through the character of the city of Colombo with quality and proximate services, connectivity to amenities through proper infrastructure and preserved natural environment”.* This defintion is utilized in identifying context specific liveability elements and developing the liveability index.

4.3.3 The factors challenging the liveability of Colombo

The liveability of cities may impair due several reasons. Majority of the expert have mentioned urban sprawl as a major challenge. The changes happen in the cities which make them less liveable are illustrated in Table 4.3. According to expert F, *"…these changes are more or less effecting from urban sprawl. The very notion that cities are more liveable that causes urban sprawl has become the reason behind cities becoming less liveable".*

Hence, these challenges are categorised as direct and indirect effects in Table 4.3. views of the experts on the effects of the urbanization were broadly categorized as direct and indirect effects. The direct effects include impaired air and water quality, imbalanced temperature and precipitation. Expert A, has specifically emphasised the difficulty to prevent floods since the water ways are obstructed by unrestricted constructions and land improvements. Respondent E highlighted that genetic and biological diversity is also threatened. Consequently, the land development replaces the natural eco systems and destroy the habitats of the plants and the animals.

The indirect effects consist of the uneven distribution of the jobs and business opportunities. Expert B has outlined that the administration buildings, the business head office are clustered in the inner city which has resulted in clustering of the highly commented job opportunities within the inner city. Therefore, there is a need to commute daily to the main city. The experts pointed out aforementioned reason as an influential factor to many consequences. For instance, expert D highlighted, the traffic congestion generated through the daily commuting individuals to the city from other parts of the country. It is considered as a waste of human hours which is a loss to the government and the business entities. The air pollution caused by the emissions from the vehicles reduces the air quality. According to expert C, this is highly obvious in Colombo MC. It has been highlighted by the expert that was interviewed representing the healthcare sector as well. Moreover, he has emphasised the indirect effects in congested urban environment. The increased depression level of the inhabitants, the sick building syndrome caused by being in improperly ventilated buildings and obesity

due to lack of walkability in the urban areas are some of the examples for the health effects on inhabitants in cities.

Table 4.3: The Factors Challenging the Liveability of Colombo

Ref No.	Factor	Experts							
		A	**B**	**C**	**D**	**E**	**F**	**G**	**D**
	Direct Factors								
1	Impairment of air quality	*X*	*X*		*X*	*X*	*X*	*X*	*X*
2	Impairment of water quality	*X*	*X*	*X*	*X*	*X*	*X*		*X*
3	The productivity and quality of the soil diminished						*X*		
4	The bio diversity and eco systems are threatened		*X*	*X*		*X*	*X*	*X*	*X*
5	More disposed to natural disasters like floods	*X*	*X*	*X*	*X*		*X*	*X*	*X*
6	The historic and cultural monuments are at risk	*X*	*X*	*X*	*X*	*X*		*X*	
7	Resource sustainability is challenged	*X*	*X*		*X*	*X*	*X*		*X*
	Indirect Factors								
1	Increased traffic congestion	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*
2	The health effects such as depression, obesity and respiratory issues				*X*	*X*	*X*	*X*	*X*
3	The social polarization increases		*X*	*X*		*X*			
4	Crime rates increases			*X*				*X*	*X*
5	The business governance is challenged		*X*	*X*		*X*		*X*	*X*
6	The prices of the housing increases.	*X*	*X*	*X*	*X*	*X*	*X*	*X*	
7	Difficulty to manage recreational activities		*X*	*X*		*X*			

When considering these challenges, the direct factors are mostly related to changes in the natural environment. The indirect factors are caused by development take place as the improvements in the built environment. Despite a factor is direct or indirect, it challenges the liveability of the inhabitants. According to majority of respondent the liveability is most challenged in the Kolonnawa UC area and Peliyagoda UC areas.

According to expert B, average population in these areas is comparatively high and there is a high demand for services which has not been catered properly. Expert C highlighted the social polarization in Colombo which has resulted due to the income

levels ranging from a high level to a low level. Majority of the experts emphasise the importance of making Colombo liveable to all, despite the social polarization which affect the affordability of services.

4.3.4 The liveability characteristics of Colombo

Consequently, through a manual content analysis of the expert interviews the liveability characteristics of Colombo were identified. These characteristics are given in Figure 4.2

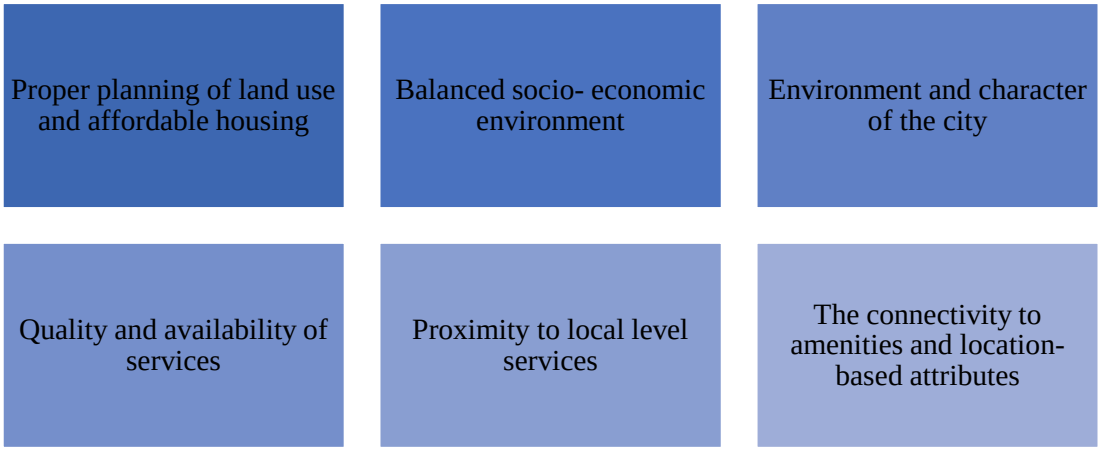

Figure 4.2 : Liveability Characteristics Emerged through Expert Interviews

These liveability characteristics are extensively discussed as follows.

- **Proper planning of land use and affordable housing**

Expert C highlighted the necessity to decentralize housing and industrial zones to the outer city, away from the highly commercialized areas and the administrative areas. According to him, *"the services such as schools, libraries and recreational facilities can be located along with the housing zones whereas services such as industrial waste recycling plants, powerhouses can be located in the industrial zone"*. Expert A held a different perspective stating that, *"Colombo has undergone a mix development over the time. Decentralizing housing from inner city would not be practical because of the interdependency of housing and livelihood of some people".* As further elaborated by expert A there are people who might protest against separating housing from the cities even when they are less liveable. Expert E, provided the slums and shanties in Colombo as an example where the inhabitants live under minimum facilities but finds

them more liveable than Colombo suburbs, because they extensively dependent upon casual works around the urban areas.

- **Balanced Socio- economic Environment**

As stated by expert B, *"mere development of the built environment is not a reflection of the socio and economic development of the city"*. Majority of the experts conform the aforementioned statement using different reasoning. Experts expressed that in Sri Lankan context the social polarization is at a highest level in city of Colombo. The expert in sociology, E emphasised, a concept named "Right to the City". That is a progressive approach to the social change due to the development of urban built environment as a response to the disposition and disempowerment of the inhabitants in the process of the economic reshaping. According to expert E, *"the sense of belonging to the community is crucial to make the inhabitant satisfied within the city"*. The political stability within the country and the local authorities was viewed as the attributes that are contributing to the liveability of a city and in return, shapes the urban built environment.

- **Environment and Character of the City**

According to expert F, the character of the city is largely dependent upon the natural environment rather than the built environment in emerging cities since the values of the inhabitants has shifted to a sustainable stance. The inhabitants consider the cleanliness of environment. The experts highlighted the importance of proper waste management policies within the city. Expert C stated that, in third world countries like Sri Lanka the character of the city is greatly disturbed by the shanties in the inner city. The population per square meter is comparatively less in these areas, yet the issues regarding waste management, epidemics breakouts and the crimes are high in these areas.

The experts in ecology; F pointed out the shanties and poverty are issues that should be addressed through the socio- economic aspects even though they are disturbance to the character of the city. The liveability concepts such as the water and air quality need to be indirectly addressed through the planned development of the urban built environment. Interviewed environmentalists expressed that experiments done in the Colombo regarding the air quality has indicated, the basin effect generated through the

high-rise buildings in the inner city has refrained the air movement of the city and caused a toxic effect. Similarly, the urban sprawl is the main reason for traffic congestion in the city thus a reason for air pollution

- **Quality and Availability of Services**

According to B, the services availability is one of the main reasons that attract stakeholders to the cities. Thus, the availability of both public and private services are crucial. Specially, the experts in the health care sector emphasised the availability of quality hospitals and secondary healthcare services decide the liveability of a city. Further, the secondary education facilities and universities need to be positioned in the city. Yet, the quality of the education for the inhabitant need to be prioritised.

As stated by expert C and E, the transport services with choices such as public and private, buses and trains are important services. Expert C stated, *"the waste management services, the disaster management services and fire brigades in the city increases its liveability to the inhabitants. Yet, they are not obvious to the inhabitants unless otherwise a need arises"*. The experts exquisitely, linked the quality and availability of the services with the built environment. According to them, the development projects within a city need to be strictly regulated because non-profit oriented nature of the public services infrastructure, gives least priority.

- **Quality and the Proximity to the Local Level Services**

The availability of public amenities and the ease of accessibility those facilities are significant attributes of liveability. Therefore, the urban built environment must have the sufficient provisions for recreational facilities such as parks, aquatic centres, playgrounds and the inhabitants expect community pools. According to expert D, the planned cities are concerned about the ease of the accessibility to the recreational facilities and other public amenities. The rapid construction of condominiums in the city of Colombo was given as an example. The proximity to the existing recreational facilities, shopping facilities, cafes and restaurants, which creates Colombo an ideal place to live in terms of the proximity to services.

- **The Connectivity to Amenities and Location based Attributes**

According to the experts' view, the most practical method of expanding a city is to develop a proper infrastructure to increase the connectivity. Further, the commuting system established in cities like Tokyo, Beijing decentralize the services, housing from the inner city while accommodating the inhabitants to access the services easily. In that way, the location-based attributes can be maximally utilized. For an example, the expert in ecology emphasised the importance of the city of Colombo as only commercial capital, which is located in a wetland. The ability to use the city as a tourist destination for the foreigners on short business trips was pointed out.

Nevertheless, the planners highlighted the necessity to decentralize housing and industrial zones to the outer city, away from the highly commercialized areas and the administrative areas. According to them, the services can also be decentralized to a certain extent. For an example, the services such as schools, libraries and recreational facilities can be located along with the housing zones whereas services such as industrial waste recycling plants, powerhouses can be located in the industrial zone. Through that, the location base attributes such as wetland mashes, lagoons and cannels may have conserved which in return serves as a barrier for natural disasters such as floods.

According to the expert opinion the current liveability indexes are marketability tools which have an emphasis on attracting more investments towards a particular city. According to expert E, these liveability indexes has less emphasis on preserving cultural value of cities. For instance, there are archaeological sites within the Sri Jayawardhanapura Kotte area which need restoration despite the rapid development projects around. Moreover, expert F emphasises the need of a dedicated liveability index to Colombo because Colombo is the one of the main commercial capitals that is situated in a wetland in the Global context. Hence, there is a higher chance to integrate the urban development with natural environment and promote liveability of the inhabitants towards sustainability aspects. The experts suggested that there should be liveability indicators which are inherent to the context of Colombo to safeguard the natural eco systems around the Colombo and to address the ground level issues such

as shanties, unauthorised services lines, threat of terrorism, unauthorised drug dealings and environmental pollution.

All things considered, the issues and trends in the urban built environment of the context of Colombo, these characteristics have been appeared from the comments of the experts. Based on their perspective, the liveability characteristics could be elaborated using sub categories of the characteristics. These characteristics represent the context of Colombo in terms of the requirements of maintaining the quality of lives of the inhabitants.

4.3.5 The liveability characteristics, attributes and indicators identified via expert interviews

During the expert interviews, the experts were mainly responsive of the composition of liveability characteristics. They are identified as liveability attributes in the study. The means of measuring the liveability attributes were identified as liveability indictors. By manually analysing the content of the expert interviews the liveability attributes and liveability indicators listed in Table 4.4 were identified.

Table 4.4: Liveability Characteristics, Attributes and Indicators Identified via Expert Interviews

Livability Characteristic	Liveability Attribute	Liveability Indicator	Expert								Count
			A	B	C	D	E	F	G	H	
Proper planning of land use and affordable housing	Mix use of land	Percentage of mix land use out of the total land use		*X*	*X*		*X*	*X*	*X*	*X*	*6*
		Net density	*X*	*X*	*X*	*X*					*4*
	Use of underutilized land	Percentage of slum areas covered by basic services				*X*	*X*		*X*		*3*
	Housing	Average housing rent per month (affordability of housing)	*X*	*X*		*X*	*X*	*X*		*X*	*6*
		Percentage of housing available in the market (Choice of housing)		*X*			*X*	*X*	*X*	*X*	*5*

Livability Characteristic	Liveability Attribute	Liveability Indicator	Expert								Count
			A	B	C	D	E	F	G	H	
	Public open spaces	Per capita availability of public and recreational places	*X*			*X*		*X*		*X*	*4*
Balanced socio-economic environment	Culture	Percentage of budgetary allocations for culture/sport activities	*X*	*X*	*X*	*X*	*X*		*X*		*6*
		Percentage of historical buildings restored and reused	*X*	*X*		*X*	*X*	*X*		*X*	*6*
		Restaurants per 5000 population		*X*	*X*		*X*	*X*	*X*	*X*	*7*
	Governance	Percentage of public services available online	*X*	*X*	*X*	*X*		*X*	*X*	*X*	*7*
		Percentage of services integrated via government authorities	*X*	*X*	*X*	*X*	*X*		*X*		*6*
		Percentage of public using online government services	*X*		*X*		*X*	*X*	*X*		5
	Safety	Percentage of public spaces covered by surveillance cameras	*X*	*X*	*X*	*X*		*X*	*X*	*X*	*7*
		Percentage of violent crimes	*X*	*X*	*X*	*X*	*X*		*X*	*X*	*7*
		Percentage of terrorist activities	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*8*
		Percentage of trivial crimes	*X*		*X*		*X*	*X*	*X*		5
		Percentage of crimes recorded against women and children per year	*X*		*X*		*X*	*X*	*X*		5
		Number of recorded crimes per 10,000 population	*X*	*X*	*X*	*X*		*X*	*X*	*X*	*7*
		Unemployment Rate	*X*	*X*	*X*	*X*	*X*		*X*	*X*	*7*

Livability Characteristic	Liveability Attribute	Liveability Indicator	Expert								Count
			A	B	C	D	E	F	G	H	
	Working Environment	Average percentage of paid leave			X	X	X	X	X	X	6
		Percentage of professionals charged with tax			X		X		X		3
	Well-Being and welfare	Life expectancy at birth	X	X		X	X	X		X	6
		Risk to mental health	X	X	X		X	X	X		6
		Concessionaries for low income families	X	X	X	X	X	X	X	X	8
		Welfare for elderly people	X			X			X	X	4
		Orphanages	X		X	X	X		X	X	6
Environment and character of the city	Air quality	Level of CO2 concentration					X		X		2
		Level of SO2 concentration				X	X				2
		Level of PM10 concentration					X				1
	Water quality	Quality of surface water bodies	X	X	X	X	X	X		X	7
	Climate	Annual average rainfall	X	X	X	X	X	X	X	X	8
		Annual average temperature	X		X	X		X	X	X	6
	Community Cohesion	Social acceptance in the residential area	X		X	X		X	X	X	6
	Prevalence of noise pollution	Level of noise pollution	X	X		X	X		X	X	6
Quality and availability of services	Solid waste management	Frequency of municipal solid waste collection	X	X	X	X	X	X		X	7
	Waste water management	Percentage of city area with adequate public toilets	X		X	X	X	X	X	X	7

Livability Characteristic	Liveability Attribute	Liveability Indicator	Expert								Count
			A	B	C	D	E	F	G	H	
		Percentage of treatment and reuse of waste water	*X*	*X*		*X*	*X*	*X*	*X*	*X*	*7*
		Percentage of coverage of storm water drains	*X*	*X*	*X*	*X*		*X*	*X*	*X*	*7*
	Water supply	Household level coverage of water supply connection	*X*	*X*	*X*	*X*	*X*		*X*	*X*	*7*
		Percentage of non-revenue water	*X*		*X*	*X*	*X*	*X*		*X*	*6*
	Healthcare	Average response time for emergencies	*X*		*X*	*X*	*X*	*X*	*X*	*X*	*7*
		Availability of public hospitals per residential area	*X*	*X*		*X*		*X*	*X*	*X*	*6*
		Availability of private hospitals per residential area	*X*	*X*	*X*	*X*		*X*	*X*	*X*	*7*
		Percentage prevalence of water borne diseases	*X*	*X*	*X*	*X*	*X*		*X*	*X*	*7*
		Percentage prevalence of vector borne diseases	*X*		*X*	*X*	*X*	*X*		*X*	*6*
		Number of healthcare professionals per 5000 population	*X*		*X*	*X*	*X*	*X*	*X*	*X*	*7*
	Power supply	Number of electricity interruptions per year	*X*		*X*	*X*	*X*		*X*	*X*	*6*
		Percentage of population with metered connection	*X*	*X*		*X*	*X*	*X*		*X*	*6*
	Education	Percentage of school-aged population enrolled in schools	*X*	*X*	*X*		*X*	*X*	*X*		6
		Student-teacher ratio	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*8*

Livability Characteristic	Liveability Attribute	Liveability Indicator	Expert								Count
			A	B	C	D	E	F	G	H	
		Percentage of school with access to ICT	*X*		*X*	*X*	*X*		*X*	*X*	*6*
Proximity to local level services	Service availability	Percentage of services availability in 300m walking distance	*X*		*X*	*X*	*X*		*X*	*X*	*6*
	Non-motorized transport	Percentage of roads with dedicated bicycle tracks	*X*	*X*		*X*	*X*	*X*		*X*	*6*
		Percentage of non-motorized transport modes	*X*	*X*	*X*		*X*	*X*	*X*		*6*
		Percentage of roads with pedestrian pavements	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*8*
The connectivity to amenities and location-based attributes	Mobility	Percentage of city area coverage from public transport	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*8*
		Percentage of the public transport modes	*X*		*X*	*X*	*X*		*X*	*X*	*6*
		Number of multimodal transport hubs	*X*	*X*		*X*	*X*	*X*		*X*	*6*
		Distance to nearest airport	*X*	*X*	*X*		*X*	*X*	*X*		6

Twenty-three liveability attributes and fifty-nine liveability indicators have been identified in total under six liveability characteristics. Under the liveability characteristic “proper planning of land use and affordable housing”, four liveability attributes have been identified. They are, “mix use of land”, “use of underutilized land”, “housing” and “public open spaces”.

To represent them in more measurable level 4 liveability indicators have been identified namely, “percentage of mix land use out of the total land use”, “net density”, “percentage of slum areas covered by basic services”, “average housing rent per month (affordability of housing)” and “percentage of housing available in the market choice

of housing)". Majority of the experts (six out of eight) have mention the average housing renting per month as a livability indicator in the context of Colombo. Moreover, percentage of housing availability has also been stated.

Likewise, when considering other liveability characteristics, the mentioning of the liveability indicators related to "balanced socio-economic environment" and "quality and availability of services" is higher as a number. Compared to that the experts have stated liveability indicators under, "environment and character of the city" and "proper planning of land use and affordable housing". Opinion of expert B stated in Section 4.2.4 itself explains the reason behind as, "the *sustainability initiatives to protect the environment through managed land use is not always the expectation of the inhabitants."* As stated by expert F the indicators that have been developed as planning measurements to improve liveability of people have not yet caught the inhabitants' attention. According to him still the driving factors of liveability are socio- economic conditions such as availability of job opportunities and service availability because still it is not impossible to find affordable housing in Colombo despite the quality.

Hence, it is evident through the liveability elements identified via expert interviews, their respective count of mentioning and the experts' comments on them demonstrate the need to order these liveability elements based on how they prioritized in the context of Colombo.

4.4 Analysis of the Document Review

The identification of liveability indicators is done through both expert interviews and document review. It ensured the reliability of indicators and worked as a method of validation via triangulation. Hence, in Section 4.3 the details of the reviewed documents and the liveability indicators identified via document reviewed have been explicated.

4.4.1 Details of the reviewed documents

Following the pattern in the literature review in Chapter 03, grey literature survey was done at Chapter 04 to specify the liveability characteristics of Colombo. Accordingly, 13 literature sources were scrutinized to identify the liveability characteristics, liveability attributes and liveability indicators. These sources are given in Table 4.5.

Most of the sources referred are annual reports, census reports and development plans developed in national level and local authority level. Some of the earliest sources such as City of Colombo development Plan outlines the speculated development in 1985 which is more or less achieved by today. That report benchmarks the urban development and how urban development has shaped the liveability of the citizens of Colombo.

Table 4.5 : Document Reviewed to Comprehend Sri Lankan Context

Ref No.	Source Name	Published Year	Nature of the Source
D1	City of Colombo Development Plan	1985	Development Plan
D2	Colombo Metropolitan Regional Structure Plan (CMRSP)	1998	Development Plan
D3	City of Colombo Development Plan	1999	Development Plan
D4	Western Region Megapolis Plan (CESMA)	2004	Development Plan
D5	Sri Lanka National Report on Disaster Risk, Poverty and Human Development Relationship.	2019	Census Report
D6	Census of Population and Housing	2012	Census Report
D7	Sri Lanka Labour Force Survey - Annual Report	2016	Annual Report
D8	Urban Transport System Development Project - For Colombo Metropolitan Region & Suburbs; CoMTran s Urban Transport Master Plan	2014	Development Plan
D9	Public Investment Programme 2017-2020	2017	Development Plan
D10	Central Bank of Sri Lanka, Annual Report	2018	Annual Report
D11	Vision 2025: a Country Enriched. Colombo: GoSL; UNDESA	2018	Development Plan
D12	World Urbanization Prospects: the 2018 Revision. New York: UNDESA; UN-Habitat.	2018	Census Report
D13	Colombo Commercial City Development Plan	2019	Development Plan

These reports have not been generated for the purpose of assessing liveability. The census reports outlined the current economic condition, level of employability, average income levels of the families which outlined the liveability of the inhabitants of Colombo. Colombo Commercial City Development plan has been developed to facilitate upcoming built environment development programmes of the city of Colombo. Yet, these documents consist of factors that can be used as liveability indicators.

4.4.2 The liveability characteristics, attributes and indicators identified via documentary review

Adhering to the liveability characteristics identified in Section 4.2.4, the documents were scrutinized. The liveability attributes and indictors short listed are demonstrated in Table 4.6.

Table 4.6 : Liveability Characteristics, Attributes and Indicators Identified via Documentary Review

Livability Characteristic	Liveability Attribute	Liveability Indicator	Reference No. of the Document (From Table 4.5)
Proper planning of land use and affordable housing	Use of underutilized land	Percentage of slum areas covered by basic services	D4, D5, D6
		Percentage of shanty dwellers resettle per year	D5
	Public open spaces	Per capita availability of green spaces	D4
Balanced socio-economic environment	Culture	Percentage of ecologically significant areas restored per year	D4
		Percentage of historical buildings restored and reused	D4, D11
		Occupancy in Hotels	D7
	Governance	Percentage of tax collected out of billed	D9,D10
		Percentage of public using online government services	D11, D13
	Safety	Percentage of violent crimes	D5,D6
		Percentage of trivial crimes	D5,D6
		Percentage of unauthorized drug related crimes	D5
	Working Environment	Unemployment Rate	D9,D10
	Well-Being and welfare	Life expectancy at birth	D9,D13
		Orphanages	D9
Environment and character of the city	Air quality	Level of CO2 concentration	D6
		Level of SO2 concentration	D6
		Level of PM10 concentration	D6
	Water quality	Quality of surface water bodies	D5

Livability Characteristic	Liveability Attribute	Liveability Indicator	Reference No. of the Document (From Table 4.5)
Quality and availability of services	Waste water management	Percentage of city area with adequate public toilets	D13
	Water supply	Per capita supply of water	D13
		Household level coverage of water supply connection	D 11, D13
	Healthcare	Average response time for emergencies	D11
		Number of in- patient beds per 5000 population	D11
		Availability of public hospitals per residential area	D11
	Education	Percentage of school-aged population enrolled in schools	D11
		Student-teacher ratio	D11
		Percentage of school with access to ICT	D13
		Percentage of private education facilities	D13
		Percentage of student completing secondary education	D13
Proximity to local level services	Non-motorized transport	Percentage of roads with dedicated bicycle tracks	D8
		Percentage of traffic intersections with pedestrian crossings	D8
		Percentage of roads with pedestrian pavements	D8

Significant liveability indicators such as “percentage of slum areas covered by basic services”,” percentage of shanty dwellers resettle per year”, “percentage of historical buildings restored and reused” and “occupancy in hotels” were identified through the documents review. In Table 4.6 the source from which the liveability index was retrieved, is also being given. It was noted that some of the liveability indicators were already recognised by the experts. Hence, a proper synthesis of the expert opinions and the documents review was required.

4.5 The List of Liveability Elements for the Liveability Index

The findings of the interviews and the documentary review were synthesized and a set of liveability characteristics, attributes and indicators were shortlisted. Specially, the liveability indicators that were repeatedly mentioned in literature sources, expert interviews, and context specific documents were included. In Table 4.7 these elements of liveability have been identified.

Table 4.7: The Final List of Liveability Characteristics, Attributes and Indicators Selected to Construct the Liveability Index

#	Livability Characteristic	#	Liveability Attribute	#	Liveability Indicator
A	Proper planning of land use and affordable housing	A1	Mix use of land	A1.1	Percentage of mix land use out of the total land use
				A1.2	Net density
		A2	Use of underutilized land	A2.1	Percentage of slum areas covered by basic services
				A2.2	Percentage of shanty dwellers resettle per year
		A3	Housing	A3.1	Average housing rent per month (affordability of housing)
				A3.2	Percentage of housing available in the market (Choice of housing)
		A4	Public open spaces	A4.1	Per capita availability of public and recreational places
				A4.2	Per capita availability of green spaces
B	Balanced socio-economic environment	B1	Culture	B1.1	Percentage of budgetary allocations for culture/sport activities
				B1.2	Percentage of ecologically significant areas restored per year
				B1.3	Percentage of historical buildings restored and reused
				B1.4	Occupancy in Hotels
				B1.5	Restaurants per 5000 population
		B2	Governance	B2.1	Percentage of tax collected out of billed
				B2.2	Percentage of public services available online
				B2.3	Percentage of services integrated via government authorities
				B2.4	Percentage of public using online government services
		B3	Safety	B3.1	Percentage of public spaces covered by surveillance cameras
				B3.2	Percentage of violent crimes
				B3.3	Percentage of terrorist activities
				B3.4	Percentage of trivial crimes
				B3.5	Percentage of unauthorized drug related crimes
				B3.6	Percentage of crimes recorded against women and children per year
				B3.7	Number of recorded crimes per 10,000 population
		B4	Working Environment	B4.1	Unemployment Rate
				B4.2	Average percentage of paid leave
				B4.3	Percentage of professionals charged with tax
		B5	Well-Being and welfare	B5.1	Life expectancy at birth
				B5.2	Risk to mental health
				B5.3	Concessionaries for low income families
				B5.4	Welfare for elderly people
				B5.5	Orphanages
C		C1	Air quality	C1.1	Level of CO2 concentration

#	Livability Characteristic	#	Liveability Attribute	#	Liveability Indicator
	Environment and character of the city			C1.2	Level of SO2 concentration
				C1.3	Level of PM10 concentration
		C2	Water quality	C2.1	Quality of surface water bodies
		C3	Climate	C3.1	Annual average rainfall
				C3.2	Annual average temperature
		C4	Quality of architecture	C4.1	Social acceptance in the residential area
		C5	Community Cohesion	C5.1	Social acceptance in the residential area
		C6	Prevalence of noise pollution	C6.1	Level of noise pollution
D	Quality and availability of services	D1	Solid waste management	D1.1	Frequency of municipal solid waste collection
		D2	Recreation	D2.1	Number of sports and cultural events hosted by government
		D3	Waste water management	D3.1	Percentage of city area with adequate public toilets
				D3.2	Percentage of treatment and reuse of waste water
				D3.3	Percentage of coverage of storm water drains
		D4	Water supply	D4.1	Per capita supply of water
				D4.2	Household level coverage of water supply connection
				D4.3	Percentage of non-revenue water
		D5	Healthcare	D5.1	Average response time for emergencies
				D5.2	Number of in- patient beds per 5000 population
				D5.3	Availability of public hospitals per residential area
				D5.4	Availability of private hospitals per residential area
				D5.6	Percentage prevalence of water borne diseases
				D5.7	Percentage prevalence of vector borne diseases
				D5.8	Number of healthcare professionals per 5000 population
		D6	Power supply	D6.1	Number of electricity interruptions per year
				D6.2	Percentage of population with metered connection
		D7	Education	D7.1	Percentage of school-aged population enrolled in schools
				D7.2	Student-teacher ratio
				D7.3	Percentage of school with access to ICT
				D7.4	Percentage of private education facilities
				D7.5	Percentage of student completing secondary education

#	Livability Characteristic	#	Liveability Attribute	#	Liveability Indicator
E	Proximity to local level services	E1	Service availability	E1.1	Percentage of services availability in 300m walking distance
		E2	Non-motorized transport	E2.1	Percentage of roads with dedicated bicycle tracks
				E2.2	Percentage of non-motorized transport modes
				E2.3	Percentage of traffic intersections with pedestrian crossings
				E2.4	Percentage of roads with pedestrian pavements
F	Connectivity to amenities and location-based attributes	F1	Mobility	F1.1	Percentage of city area coverage from public transport
				F1.2	Percentage of the public transport modes
				F1.3	Number of multimodal transport hubs
				F1.4	Distance to nearest airport

Accordingly, there are 6 liveability characteristics, then divided into 25 liveability attributes on which the liveability characteristics are built upon. These attributes are measurable through liveability indicators identified subsequently. The triangulation process followed has been provided in Chapter 5.

4.6 AHP Analysis

The prioritization of the liveability elements was done using AHP method. Hence, with reference to the mentioned steps of implementing AHP tool under Chapter 2, disintegration of the research into a hierarchy of goal, criteria and sub criteria. Then a AHP Hierarchy tree was developed which is given in Annexure 02. The AHP questionnaire (Refer Annexure 03) of the was developed using the hierarchy tree. AHP, questionnaire development and sample selection are explained in detail at Section 2.8.2. The demographic distribution of the selected sample is given in Figure 4.3.

The questionnaire was not distributed for receiving responses, rather was used as an instrument of structured interviewing. Hence, using snow ball method 22 respondents were approached representing architecture and built environment, sociology, town and country planning, ecology landscape architecture and economics subject disciplines. Saathy (2008) have implied that the number of respondents is not significant in AHP method as far as the respondents comprehensively and unwaveringly did the pair wise comparison.

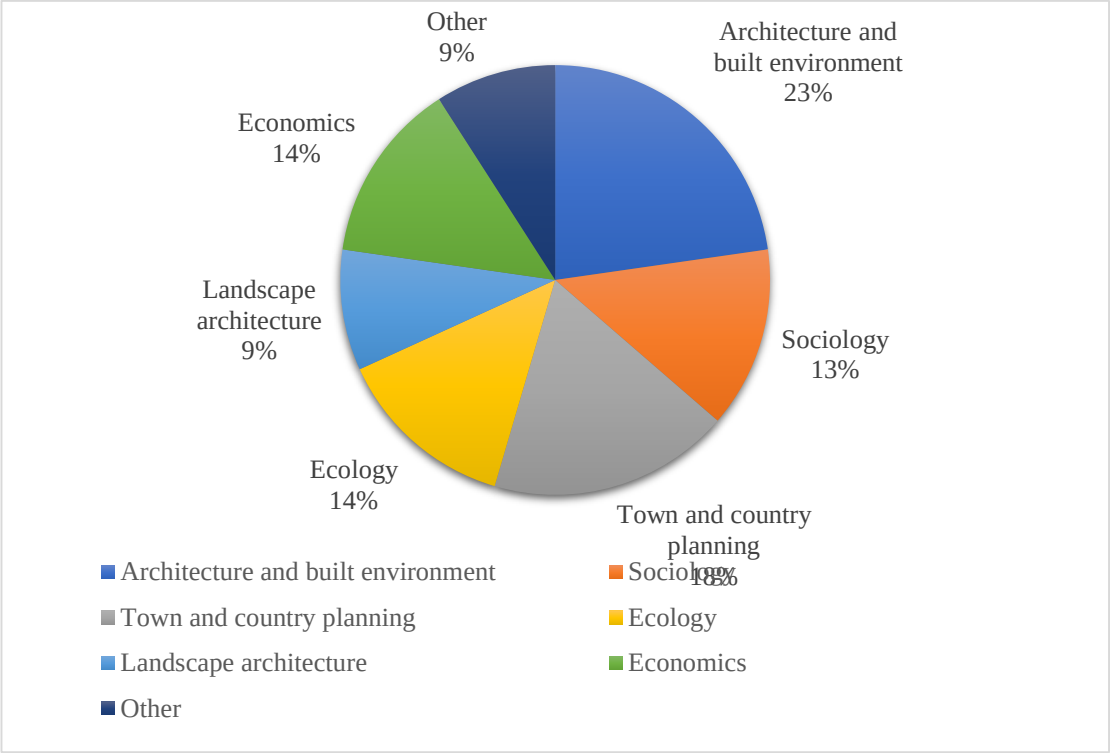

Figure 4.3:The composition of the respondents of the AHP questionnaire

Hence,22 respondents were considered as sufficient sample to carry out the analysis. Out of that, 23% represented architecture and built environment and the respondents demonstrated as 'other' category represented local administration authorities of CCC. These respondents had directly involved as professionals or academics in planning, policy making or conducting research projects related to urban planning, sustainability, disaster resilience, social activism and development of the built environment. Hence, they construe liveability concept in depth sufficient for this study.

4.6.1 Performance score calculation of liveability characteristics, attributes and indicators

The steps of AHP explained in Section 2.7 are used for the prioritization of liveability characteristics.

- **Pairwise comparison**

The averages of the responses and their reciprocals were recorded in the matrices and the sum of each column was calculated afterwards as given in Table 4.8.

Table 4.8: Pairwise Comparison of the Liveability Characteristics

Liveability Characteristics	Proper planning of land use and affordable housing	Balanced socio-economic environment	Environment and character of the city	Quality and availability of services	Proximity to local level services	The connectivity to amenities and location-based attributes
Proper planning of land use and affordable housing	1.0000	0.3872	0.3333	0.3872	0.3872	0.3872
Balanced socio-economic environment	2.5826	1.0000	2.4568	2.5826	2.5826	2.5826
Environment and character of the city	3.0000	0.4070	1.0000	0.3872	0.3872	0.3872
Quality and availability of services	2.5826	0.3872	2.5826	1.0000	2.5826	2.5826
Proximity to local level services	2.5826	0.3872	2.5826	0.3872	1.0000	2.5826
The connectivity to amenities and location-based attributes	2.5826	0.3872	2.5826	0.3872	0.3872	1.0000
Sum	14.3305	2.9559	11.5380	5.1314	7.3268	9.5222

In pair wise comparison all the liveability characteristics were compared against others. The reciprocal value of each comparison pair is calculated when they were compared vise versa. For instance, the geometric mean of responses when “balanced socio-economic environment “compared against “proper planning of land use and affordable housing” is 2.5826. In return when “proper planning of land use and affordable housing” compared with “balanced socio-economic environment “the reciprocal is calculated as 0.3872.

- **Normalise the comparisons**

The normalization process was conducted by dividing each characteristic in Table 4.8 by sum of each column. Following the normalization, the sum of each row was calculated to obtain the performance score or the relative weight of each liveability characteristic. The performance score of the liveability characteristics at the end of normalization is given in Table 4.9 : Normalization of the Liveability Characteristics

According to Table 4.9 the highest performance score has been obtained by “Balanced socio – economic environment” (0.3097). The least performance score (0.0664) is received by “Proper planning of land use and affordable housing”.

Table 4.9 : Normalization of the Liveability Characteristics

Liveability Characteristics	Proper planning of land use and affordable housing	Balanced socio-economic environment	Environment and character of the city	Quality and availability of services	Proximity to local level services	The connectivity to amenities and location-based attributes	Sum	Performance Score
Proper planning of land use and affordable housing	0.0698	0.1310	0.0289	0.0755	0.0528	0.0407	0.3986	0.0664
Balanced socio-economic environment	0.1802	0.3383	0.2129	0.5033	0.3525	0.2712	1.8585	0.3097
Environment and character of the city	0.2093	0.1377	0.0867	0.0755	0.0528	0.0407	0.6027	0.1004
Quality and availability of services	0.1802	0.1310	0.2238	0.1949	0.3525	0.2712	1.3536	0.2256
Proximity to local level services	0.1802	0.1310	0.2238	0.0755	0.1365	0.2712	1.0182	0.1697
The connectivity to amenities and location-based attributes	0.1802	0.1310	0.2238	0.0755	0.0528	0.1050	0.7684	0.1281
							6.0000	

It can be observed that "Balanced socio-economic environment" is five times higher than "Proper planning of land use and affordable housing". "Quality and availability of services", "Proximity to local level services", "The connectivity to amenities and location-based attributes", "The connectivity to amenities and location-based attributes" and "Environment and character of the city" have received second, third, fourth and fifth palaces respectively based on their performance scores.

- **Consistency calculation**

Since AHP is a subjective measure, the responses of the respondents may be inconsistent. Hence, in validating the findings of AHP method, consistency calculation is very significant. (Cheng & Li, 2001). In Chapter 2 the formula that is used to calculate consistency ratio has been given. The analysed data is acceptable if the consistency ratio is less than 0.1 (Saaty,2008). The consistency calculation matrix of the liveability characteristics is given in Table 4.10

Table 4.10: Consistency Calculation of Liveability Characteristics

Liveability Characteristics	Proper planning of land use and affordable housing	Environment and character of the city	Quality and availability of services	Proximity to local level services	Balanced socio-economic environment	The connectivity to amenities and location-based attributes	Sum/Performance Score
Proper planning of land use and affordable housing	0.0664	0.0335	0.0874	0.0657	0.1199	0.0496	6.3593
Balanced socio-economic environment	0.1716	0.2468	0.5827	0.4383	0.3097	0.3307	6.7145
Environment and character of the city	0.1993	0.1004	0.0874	0.0657	0.1261	0.0496	6.2569
Quality and availability of services	0.1716	0.2594	0.2256	0.4383	0.1199	0.3307	6.8507
Proximity to local level services	0.1716	0.2594	0.0874	0.1697	0.1199	0.3307	6.7102
The connectivity to amenities and location-based attributes	0.1716	0.2594	0.0874	0.0657	0.1199	0.1281	6.4974
							39.388

λ_{max} = (a1+a2+a3+a4+a5+a6)/6

= 39.388/6

= 6.5648

Consistency Index = (λ_{max} –n)/ (n-1)

= (6.5648-6)/6

= 0.0941

Consistency Ratio = Consistency Index/ Randomized Index

= 0.0941/1.25

= 0.075

According to the above calculations, CR of characteristics of liveability is 0.075. The CR is less than 0.1. Therefore, the data collected has the required level of consistency.

4.6.2 Prioritization of liveability characteristics

In the same way, all the liveability attributes and indicators were matched in pairwise comparison matrix and a performance score was obtained for all the attribute and indicators (Refer Annexures 05). The performance score obtained by liveability characteristics are given in Table 4.11The prioritization of the liveability indicators makes the liveability index more context specific and could be justifiable to the context of Colombo. The toped ranked liveability characteristic is "Balanced socio-economic environment" with a performance score of 0.3097. "Proper planning of land use and affordable housing" has the lowest performance score (0.0664) of the liveability characteristics identified in the list. It demonstrates that the stakeholders of the city of Colombo have a higher priority on "Balanced socio- economic conditions" over other liveability characteristics in decision making regarding investments, finding housing and developing the built environment.

Prioritization and assigning global weights to liveability attributes and indicators under balanced socio- economic environment

Alternatively, performance score is known as the local weight. It represents the level of prioritization within a sub criterion. In this case, performance score of a particular indicator provides only its status within the liveability attribute it is considered. Instead, the liveability indicators require a weighting factor which is justifiable when the liveability indicators considered alone. For that the local weight (i.e. performance score) could be converted into a global weight given in Table 4.12 by multiplying the local weight of the liveability indicator by the local weights of the liveability attribute and the liveability characteristic relevant to that particular liveability indicator.

Table 4.11: Global Weight of Liveability Indicators under Balanced Socio- economic Environment

Number	Liveability Element	Performance Score	Global Weight (Wi)
1	Balanced socio- economic environment	0.3097	0.3097
1.1	Safety	0.4176	0.1293
1.1.1	Number of recorded crimes per 10,000 population	0.2337	0.0302
1.1.2	Percentage of terrorist activities	0.1982	0.0256
1.1.3	Percentage of violent crimes	0.1604	0.0207

Number	Liveability Element	Performance Score	Global Weight (Wi)
1.1.4	Percentage of crimes recorded against women and children per year	0.1439	0.0186
1.1.5	Percentage of unauthorized drug related crimes	0.1203	0.0156
1.1.6	Percentage of trivial crimes	0.0827	0.0107
1.1.7	Percentage of public spaces covered by surveillance cameras	0.0607	0.0079
1.2	Governance	0.224	0.0694
1.2.1	Percentage of services integrated via government authorities	0.4085	0.0283
1.2.2	Percentage of public services available online	0.3682	0.0255
1.2.3	Percentage of public using online government services	0.1167	0.0081
1.2.4	Percentage of tax collected out of billed	0.1067	0.0074
1.3	Working Environment	0.1805	0.0559
1.3.1	Unemployment Rate	0.5007	0.028
1.3.2	Average percentage of paid leave	0.189	0.0106
1.3.3	Percentage of professionals charged with tax	0.3102	0.0173
1.4	Culture	0.1022	0.0317
1.4.1	Restaurants per 5000 population	0.3582	0.0113
1.4.2	Percentage of historical buildings restored and reused	0.2894	0.0092
1.4.3	Percentage of budgetary allocations for culture/sport activities	0.1758	0.0056
1.4.4	Percentage of ecologically significant areas restored per year	0.098	0.0031
1.4.5	Occupancy in Hotels	0.0787	0.0025
1.5	Well-Being and welfare	0.0758	0.0235
1.5.1	Concessionaries for low income families	0.3993	0.0094
1.5.2	Welfare for elderly people	0.2763	0.0065
1.5.3	Life expectancy at birth	0.1666	0.0039
1.5.4	Risk to mental health	0.0953	0.0022
1.5.5	Orphanages	0.0625	0.0015

For instance, in Table 4.12 of Section 4.5.3, the global weight of "Number of recorded crimes per 10,000 populations" is obtained by multiplying performance score of "Number of recorded crimes per 10,000 populations", by performance score of "Safety" and performance score of "Balanced socio- economic environment" (0.3097x 0.4176 x 0.2337). in the same vain, the global weights of the liveability indicators under "Balanced socio-economic environment" were calculated and given in Table 4.12. The prioritization of the liveability indicators makes the liveability index more context specific and could be justifiable to the context of Colombo. The toped ranked liveability characteristic is "Balanced socio-economic environment" with a

performance score of 0.3097. “Proper planning of land use and affordable housing” has the lowest performance score (0.0664) of the liveability characteristics identified in the list. It demonstrates that the stakeholders of the city of Colombo have a higher priority on “Balanced socio- economic conditions” over other liveability characteristics in decision making regarding investments, finding housing and developing the built environment.

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For instance, in Table 4.12 of Section 4.5.3, the global weight of "Number of recorded crimes per 10,000 populations" is obtained by multiplying performance score of "Number of recorded crimes per 10,000 populations", by performance score of "Safety" and performance score of "Balanced socio- economic environment" (0.3097x 0.4176 x 0.2337). in the same vain, the global weights of the liveability indicators under "Balanced socio-economic environment" were calculated and given in Table 4.12.

Under "Balanced socio-economic environment", "Safety" has been prioritized over all other liveability attributes (0.1293). Within the "Safety" attribute, "Number of recorded crimes per 10,000 populations" has the highest score (0.0302). It denotes the citizens concern on the security of the city as a whole. Interestingly "Well-being, and welfare" has been ranked as the least prioritized liveability attribute (performance score of 0.0758). Under that "Orphanages" and "Risk to mental health" have the lowest performance score.

Obtaining a less score for “Orphanages” can be explained referring to the perspective of the inhabitants. The need of an orphanage is not within the speculated insight of the inhabitants. Yet this indicator was included in the list as per the consultation of the experts who emphasised the need of such welfare facilities for street urchins in the cities.

4.6.4 Prioritization and assigning global weights to liveability attributes and indicators under quality and availability of services

“Quality and availability of services” has been ranked as the second most prioritized liveability characteristic in Section 4.5.2. with a performance score of 0.2256. In Table 4.13 the liveability attributes and indicators under “Quality and availability of services” have been prioritized after AHP analysis. Among the services the water supply has been ranked over power supply. The performance score of “water supply” is 0.3494 which is nearly 2.4 times higher than the performance score of “power supply”. Other ranks have received by healthcare (0.1315), education (0.1303), solid waste management (0.1281) and waste water management (0.1146) respectively.

Table 4.12: Global Weight of Liveability Indicators under Quality and Availability of Services

Number	Liveability Element	Performance Score	Global Weight (Wi)
2	Quality and availability of services	0.2256	0.2256
2.1	Water supply	0.3494	0.0788
2.1.1	Per capita supply of water	0.4673	0.0368
2.1.2	Household level coverage of water supply connection	0.3117	0.0246
2.1.3	Percentage of non-revenue water	0.221	0.0174
2.2	Power supply	0.1461	0.033
2.2.1	Number of electricity interruptions per year	0.6342	0.0209
2.2.2	Percentage of population with metered connection	0.3658	0.0121
2.3	Healthcare	0.1315	0.0297
2.3.1	Availability of public hospitals per residential area	0.2156	0.0064
2.3.2	Availability of private hospitals per residential area	0.1943	0.0058
2.3.3	Number of healthcare professionals per 5000 population	0.1429	0.0042
2.3.4	Number of in- patient beds per 5000 population	0.1245	0.0037
2.3.5	Average response time for emergencies	0.1163	0.0035

Number	Liveability Element	Performance Score	Global Weight (Wi)
2.3.6	Percentage prevalence of vector borne diseases	0.1042	0.0031
2.3.7	Percentage prevalence of water borne diseases	0.1022	0.003
2.4	Education	0.1303	0.0294
2.4.1	Student-teacher ratio	0.3223	0.0095
2.4.2	Percentage of school with access to ICT	0.2264	0.0067
2.4.3	Percentage of private education facilities	0.2179	0.0064
2.4.4	Percentage of student completing secondary education	0.127	0.0037
2.4.5	Percentage of school-aged population enrolled in schools	0.1064	0.0031
2.5	Solid waste management	0.1281	0.0289
2.5.1	Frequency of municipal solid waste collection	1	0.0289
2.6	Waste water management	0.1146	0.0259
2.6.1	Percentage of treatment and reuse of waste water	0.4332	0.0112
2.6.2	Percentage of city area with adequate public toilets	0.3144	0.0081
2.6.3	Percentage of coverage of storm water drains	0.2524	0.0065

As a liveability attribute solid waste management have only one indicator. Hence, “frequency of municipal solid waste collection” has a performance score of 1. However, when considering the global weight of that indicator it is 0.0289 which shows its weightage out of all the liveability indicators.

4.6.5 Prioritization and assigning global weights to liveability attributes and indicators under proximity to local level services

“The proximity to local level services” is ranked at third place. There are two liveability attributes considered under this characteristic. These attributes have been prioritized in Table 4.14.

Table 4.13: Global Weight of Liveability Indicators under Proximity to Local Level Services

Number	Liveability Element	Performance Score	Global Weight (Wi)
3	Proximity to local level services	0.1697	0.1697
3.1	Service availability	0.8095	0.1374
3.1.1	Percentage of services availability in 300m walking distance	1	0.1374
3.2	Non-motorized transport	0.1905	0.0323
3.2.1	Percentage of non-motorized transport modes	0.5342	0.0173
3.2.2	Percentage of roads with pedestrian pavements	0.2134	0.0069

Number	Liveability Element	Performance Score	Global Weight (Wi)
3.2.3	Percentage of roads with dedicated bicycle tracks	0.1492	0.0048
3.2.4	Percentage of traffic intersections with pedestrian crossings	0.1032	0.0033

Out of them, "service availability" has a performance score of 0.8095. Non-motorized transport is also considered under this characteristic which have a performance score of 0.1905. When considering the non- motorized transport, the availability of different types of non-motorized transport modes has been prioritized over others. As a measure of walkability, the percentage of traffic intersections have a global weight of 0.0033.

Compared to other liveability indicators the "proximity to local level services", have less liveability indicators. It does not have an impact on the final index because the global weight provides an individual score for all the indicators which can be used independently from the score of liveability attributes.

4.6.6 Prioritization and assigning global weights to liveability attributes and indicators under the connectivity to amenities and location-based attributes

The fourth place of the liveability characteristics has been obtained by connectivity to amenities and location-based attributes as given in Table 4.11. The attributes and indicators under that characteristics have been ranked in Table 4.15.

Table 4.14:Global Weight of Liveability Indicators under Connectivity to Amenities and Location-Based Attributes

Number	Liveability Element	Performance Score	Global Weight (Wi)
4	The connectivity to amenities and location-based attributes	0.1281	0.1281
4.1	Mobility	1	0.1281
4.1.1	Percentage of city area coverage from public transport	0.4103	0.0525
4.1.2	Number of multimodal transport hubs	0.2533	0.0324
4.1.3	Percentage of the public transport modes	0.215	0.0275
4.1.4	Distance to nearest airport	0.1214	0.0155

The only attribute discussed under, “connectivity to amenities and location-based attributes” is “mobility”. The global weight of mobility is 0.1281. The priority has been given to “percentage of city area covered from public transportation. The performance score is 0.4103.

4.6.7 Prioritization and assigning global weights to liveability attributes and indicators under environment and character of the city

Table 4.16 has provided the liveability attributes and indicators under environment and character of the city.

Table 4.15: Global Weight of Liveability Indicators under Environment and Character of the City

Number	Liveability Element	Performance Score	Global Weight (Wi)
5	Environment and character of the city	0.1004	0.1004
5.1	Air quality	0.3259	0.0327
5.1.1	Level of CO2 concentration	0.5222	0.0171
5.1.2	Level of SO2 concentration	0.2611	0.0085
5.2	Water quality	0.2023	0.0203
5.2.1	Quality of surface water bodies	1	0.0203
5.3	Climate	0.1707	0.0171
5.3.1	Annual average rainfall	0.7236	0.0124
5.3.2	Annual average temperature	0.2764	0.0047
5.4	Prevalence of noise pollution	0.1325	0.0133
5.4.1	Level of noise pollution	1	0.0133
5.5	Community Cohesion	0.1033	0.0104
5.5.1	Social acceptance in the residential area	1	0.0104
5.6	Quality of architecture	0.0653	0.0066
5.6.1	Average design approvals from authorities	1	0.0066

In Table 4.16, there are six liveability attributes namely, “air quality”, “water quality”, “climate” and “prevalence of noise pollution”, “community cohesion” and “quality of architecture” which have performance scores of, 0.3259,0.2023,0.1707,0.1033 and 0.0653 respectively. There are four attributes which have only one liveability indicator to represent them.

4.6.8 Prioritization and assigning global weights to liveability attributes and indicators under proper planning of land use and affordable housing

In Table 4.17, the global weight of liveability Indicators under proper planning of land use and affordable housing have been listed down. Out of the four-liveability attribute "housing" has a performance score of 0.5407 and ranked at the first place.

Table 4.16: Global Weight of Liveability Indicators under Proper Planning of Land Use and Affordable Housing

Number	Liveability Element	Performance Score	Global Weight (Wi)
6	Proper planning of land use and affordable housing	0.0664	0.0664
6.1	Housing	0.5407	0.0359
6.1.1	Average housing rent per month (affordability of housing)	0.6097	0.0219
6.1.2	Percentage of housing available in the market (Choice of housing)	0.3903	0.014
6.2	Public open spaces	0.2478	0.0165
6.2.1	Per capita availability of public and recreational places	0.5743	0.0095
6.2.2	Per capita availability of green spaces	0.4257	0.007
6.3	Mix use of land	0.1333	0.0089
6.3.1	Net density	0.6974	0.0062
6.3.2	Percentage of mix land use out of the total land use	0.3026	0.0027
6.4	Use of underutilized land	0.0782	0.0052
6.4.1	Percentage of slum areas covered by basic services	0.6385	0.0033
6.4.2	Percentage of shanty dwellers resettle per year	0.3615	0.0019

When considering Table 4.11 to Table 4.17 together, "Percentage of services availability in 300m walking distance" has been ranked topped with the highest global weightage (0.1374). This prioritization is an amalgamation of the position of the liveability indicator's respective attribute and the characteristic. Out of the 71 liveability indicators, "Percentage of city area coverage from public transport", "Per capita supply of water", "Number of multimodal transport hubs" and "Number of recorded crimes per 10,000 populations" have the highest global scores and have been prioritized over other liveability indicators.

4.7 Liveability Index as a Tool to Assess Liveability of Colombo

The work of Babbie (2011) and Spector (1992), in particular, provides academic and theoretical reference in the process of index construction. Accordingly, the process of index development is three-fold including item selection, examining the empirical relationships and validating.

4.7.1 Data collection instrument of the liveability index

The data collection instrument consists of a preliminary section providing the profile of the respondent regarding age, income level, gender, profession. A sample of the data sheet is provided in Figure 4.4. The respondents could indicate their satisfaction level of the status of the liveability indicators.

Liveability Indicator	***Satisfaction level of the status of the liveability indicator***				
	Desirable	***Acceptable***	***Tolerable***	***Unacceptable***	***Undesirable***
Indicator 1					
Indicator 2					
Indicator 3					
Indicator 4					
Indicator 5					

Figure 4.4 Sample of the Data Sheet

The satisfactory levels could be stated as, desirable, acceptable, tolerable, unacceptable or undesirable. The respondent could be selected through cluster sampling of 9 local area considered for the context or stratified sampling where the population is stratified into age groups, professions, gender or income levels. Minimum Sample size may vary depending on the cluster or stratified group population.

In this way the public opinion could be categorized under the geographical area they are located in and on the background of the respondents. It could be utilized in evaluating liveability issues in the perspective of various income levels, age groups and professions apart from calculating the liveability of Colombo as a separate context.

4.7.2 Average satisfactory level of the inhabitants

The liveability index employs the global weights obtained in Section 4.5.4 and average satisfactory level of the inhabitants. The average satisfactory level is determined by establishing an interval scale denoting if the status of the particular indicator is undesirable, unacceptable, tolerable, acceptable or desirable. Figure 4.4 illustrate how it is employed in collecting data from the respondents. Using a frequency distribution table as given in Table 4.13, the average satisfaction level of each indicator could be calculated. For a one sample 71 tables will be generated.

Table 4.17: Average Satisfactory Level of Each Indicator

Class name	Interval	Mid-point of the Interval *(x)*	Frequency *(f)*	*fx*
Desirable	81-100	90.5		
Acceptable	61-80	70.5		
Tolerable	41-60	50.5		
Unacceptable	21-40	30.5		
Undesirable	0-20	10		
			$\sum_{i=1}^{n} f_i$	$\sum_{i=1}^{n} f_i x_i$
$\overline{\mathrm{X}} = \frac{\sum_{i=1}^{n} f_i x_i}{\sum_{i=1}^{n} f_i}$		$\overline{\mathrm{X}}$ – average satisfactory level f_i- number of respondents (frequency of the distribution) x_i – midpoint of the interval		

The global liveability indexes use weighted average to derive the index (EIU,2018; Mercer,2018). Therefore, this index is also based on the weighted average calculations. The weightage of each indicator is the global weight (W_i) derived through AHP calculations. The global weight provides the priority level given to liveability indicator in the context of Colombo. Hence, the value of the global weight is kept as a constant. The index value is calculated using following Formula.

$$\text{Index Value} = \mathrm{Y} = \frac{\left(\sum_{i=1}^{n} \overline{X_i} \times W_i\right)}{\left(\sum_{i=1}^{n} W_i\right)}$$

$\overline{X_i}$ – the average satisfactory level

W – Global weight of the liveability indicator

In Table 4.12 the summation of the global weight ($\sum_{i=1}^{n} W_i$) of all the liveability indicators were equal to 1. Therefore, that is disregarded in the final liveability index formula. For the presentation purpose the liveability index has provided as a percentage. According to the values allocated to average satisfactory level the maximum and minimum values of the average satisfactory level vary between 100 to 0. Accordingly, maximum of total of index value ($\max_{0 \le x \le 100} \sum_{i=1}^{n} X_i \times W_i$) is equal to 100. Hence the formula for liveability is,

$$\text{Liveability Index} = \frac{(\sum_{i=1}^{n} X_i \times W_i)}{\max_{0 \le x \le 100} \sum_{i=1}^{n} X_i \times W_i} \times 100\%$$

The liveability index consists of the index values of each liveability indicator considered. It can be observed that the global weight could also be considered as a variable depending on various context. For example, if analogical validation of the index is done in generalizing the finding the priority level given by the inhabitants of a particular context would vary. In that instance, the global weight is also a variable which should be calculated using AHP method. Hence, the general priority levels have been considered as a constant as the case study particularly conducted for the context of Colombo.

4.7.3 Validation of the liveability index as a tool to measure liveability of Colombo

The developed liveability index could be used as a tool to evaluate the liveability of the city of Colombo. The prioritization of the liveability indicators of the index is represented via the performance score and the derived scores are specific to the context of Colombo. Those values can be used as a bench mark to identified the areas that should be given priory in urban development or investing in housing market.

Accordingly, the proposed liveability index will be utilized by various types of stakeholders in decision making. Hence the validation of the application of the liveability index was piloted for a sample of 45 respondents. Moreover, since the users of the index represent various cognitive levels the index was validated in terms of its applicability to the context of Colombo, user friendliness, readability, clarity of terms and understandability.

The respondents who participated in validating the result represented the 08 local authorities that were considered for the case study in Section 4.1. The number of respondents selected is proportionate to the population of the respective local areas. The respondent represented different ethnicities, income levels, educational backgrounds, age groups. The Table 4.14 provides the profiles of the respondents.

Table 4.18: Profile of the Respondents Participated in Validation

Area	No of Respondents
Colombo MC	7
Dehiwala Mount Lavinia MC	6
Boralesgamuwa UC	6
Kolonnawa UC	7
Peliyagoda UC	7
Wattala – Mabola UC	5
Part of Wattala PS	3
Part of Kelaniya PS	4

The questionnaire given to the respondent has been given in Annexure 04.

4.7.4 Validation of the application of the liveability index

The proposed liveability index work as a tool in obtaining a measure of liveability of Colombo. This liveability index more preferable to be known as a context specific liveability index since the liveability indicators considered in this study are more suitable to the context of Colombo. Hence, in the piloting of the liveability index the performance score obtained through prioritization was not considered as a variable. Only the average satisfactory level of each indictor was considered.

The pilot test of the index disclosed the possibility to use this liveability index to measure the perception of liveability in terms of income levels, age levels, occupations or any other demographic category. Some of the indicators which provide a desirable satisfactory level to some users, whereas those factors are undesirable to the others.

The subjectivity of the responses was observed during the validation of the application of the index. Hence, it could be highlighted that a higher sample size is needed to be employed when applying the liveability index.

4.7.5 Validation of the performance of the liveability index

When analysing the performance of the liveability index, factors such as applicability, readability, clarity of terms and understandability were assessed in Table 4.14. Accordingly, 60% of the respondents are satisfied that the index's applicability to the context of Colombo. 40% of the respondents have indicated that the user-friendliness and clarity of assessment criteria is in a satisfactory level. Majority of the respondents held that the readability of the index is high. Yet, only 30% of the respondent held that understandability of the index is in a satisfactory level.

Table 4.19 : Validation of the Performance of the Liveability Index

Criteria	Outstanding	Satisfactory	Moderate
Applicability		60%	40%
User friendliness		40%	60%
Clarity of terms		35%	65%
Clarity of assessment criteria		40%	60%
Readability	10%	70%	20%
Understandability		30%	70%

Compared to other criteria, clarity of terms and understandability have been acknowledged as poor. The technical terms that were presented in some of the liveability elements had been given as challenging to understand the index.

4.7.6 Suggestions for further improvements

The respondents commented on the extensiveness of the questionnaire. The users requested more integrated set of liveability elements to be analysed such as liveability attributes. It was suggested that prior to asking for the satisfaction level of each indicator a quantitative measurement of the liveability indicator is preferred. Moreover, the respondents appreciated the potential of this liveability index to be protracted to other cities of the world as well.

4.8 Chapter Summary

Development of a liveability index specific to Colombo, with a view to enhance the quality of lives of its inhabitant was considered as the objective of this study. In achieving that, a case study research has been conducted. Chapter 04 of the research presents the analysed data which were collected through expert interviews, document review and AHP questionnaires distributed within the case study. The synthesis of the expert interviews and the document review provides a comprehensive list of liveability characteristics, attributes and indicators. They are prioritized through a multi criterial decision making tool known as AHP. Using the global weight obtained through AHP method and the literature findings, the context specific liveability index has been developed and validated at the end of the chapter.

5.0 RESEARCH FINDINGS AND DISCUSSION

5.1 Introduction to the Chapter

The research was aimed at developing a liveability index to enhance the quality of lives of the inhabitants of cities in Sri Lanka to make them more liveable to its inhabitants. The objectives had designed to achieve the aim in a systematic way. First objective was mainly achieved through the literature synthesis and the fourth and fifth chapters are focused on achieving the remaining objectives. Hence, achieving the aim required to be justified using the analysed data and matching the theories identified in the literature review. This chapter established the findings through pattern matching between the findings established from the empirical data with literature.

5.2 Defining Liveability Specifically for the Context of Colombo

This research study is centred on increasing the quality of lives of individuals addressing the context specific issues in Sri Lanka. Quality of life is often viewed as the liveability of a particular area. Liveability is a concept that has been emerged in the recent past which still lacks a firm definition. For that the concept of liveability is defined comprehensively for the general context in Section 3.3 and for the context of Colombo specifically in Section 4.3.2.

The approach to define liveability in Section 3.3 concluded from two directions as provided in Figure 5.1. It allowed contrasting and comparing of the features of liveability and derive a triangulated definition.

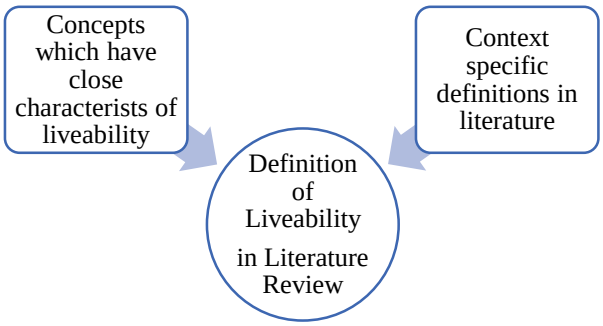


Figure 5.1 : Deriving the Definition of Liveability

The definition constructed based on literature could be stated as, *"the consistency of the desired and actual place based attribute which reflects the quality of life in terms of the infrastructure, social, economic and environmental characteristics"*.

This definition is derived from scrutinizing concept such as sustainability, urbanization and urban resilience in Section 3.2.1, 3.2.2. and 3.2.3. respectively, and synthesising other context specific definitions. In contrast to concepts on sustainability reviewed in Section 3.2.1, it is identified that liveability has a short-term orientation in terms of its goals. The principles such as use of renewable energy reduce the carbon footprint, reduced emissions within the environmental adjustment capacities and recycling are sustainability goals (Innes & Buhuor, 2000; Sanford, 2013). These sustainability goals can be vague due to their focus on long term and they may interfere the liveability certain groups in the community. These features are reflected in the liveability definition by Valcárcel-Aguiar, Murias, and Rodríguez-González, (2018) identified in Section 3.2.1 which stresses that the liveability should not compromise the city's future. In contrast, in Section 4.3.2 experts expressed that in the context of Sri Lanka improving liveability is possible while achieving sustainability goals by balancing socio-economic conditions and improving the character of the city by maintaining the natural environment. Hence, those characteristics were included in the context specific definition.

Moreover, as identified in Section 3.2.2 urbanisation is misconstrued as liveability assuming that people are attracted to cities because of the higher liveability of the cities. However, issues such as uncontrolled and unplanned development, waste management, traffic congestion, crime and complicated access to resources arise in cities with the urbanisation and the liveability of the cities is diminished (Peris-Ortiz, Bennett, & Yábar, 2017). This behaviour is observed in the findings of Section 4.3.2 which identifies the challenges to liveability such as impairment of air and water quality, risk of natural disasters, increased traffic congestion and increased crime rates. Experts have expressed that these issues could minimised by increasing the urban connectivity, quality of services, availability services and the mobility. Hence, the context specific definition was developed with component that eliminate challenges to liveability as well.

Accordingly, the context specific definition is set as, "*the satisfactory quality of lives of inhabitants achieved through its balanced socio-economic environment reflected through the character of the city of Colombo with quality and proximate services,*

connectivity to amenities through proper infrastructure and preserved natural environment". This definition was utilized in Section 4.2.3, Section 4.2.4. in understanding the liveability attributes and liveability indicators that adhere to the definition.

This definition is found more effective when applied for the case study. For instance, when analysing the liveability characteristics of the Colombo, the expert views were adhering to the definition. Especially, the balance of the socio- economic environment, connectivity to amenities and location-based attributes were mentioned by Expert E and constitute the definition of liveability.

5.3 The Attributes and Indicators that Constitute Liveability in the Global Context and with Particular Reference to Colombo

To identify the liveability attributes and indicators with particular reference to the context of Colombo, the expert interview findings and the document review was synthesized in this study. The liveability indicators identified via expert interviews as given in Section 4.2.5 have significant differences compared to the indicators identified in Section 3.2.3. For the discussion purpose the list of liveability indicators that was used for the development of questionnaire has been viewed based on the sources it is retrieved from in Table 5.1.

Table 5.1: Triangulation of the Findings from Literature Review, Expert Interviews and Document Review

Livability Characteristic	Liveability Attribute	Liveability Indicator	Retrieved Source		
			Literature	Expert interviews	Document review
Proper planning of land use and affordable housing	Mix use of land	Percentage of mix land use out of the total land use		X	
		Net density		X	
	Use of underutilized land	Percentage of slum areas covered by basic services		X	X
		Percentage of shanty dwellers resettle per year			X
	Housing	Average housing rent per month (affordability of housing)		X	
		Percentage of housing available in the market (Choice of housing)		X	

Livability Characteristic	Liveability Attribute	Liveability Indicator	Retrieved Source		
			Literature	Expert interviews	Document review
	Public open spaces	Per capita availability of public and recreational places		X	
		Per capita availability of green spaces		X	X
Balanced socio-economic environment	Culture	Percentage of budgetary allocations for culture/sport activities	X	X	
		Percentage of ecologically significant areas restored per year			X
		Percentage of historical buildings restored and reused			X
		Occupancy in Hotels	X		X
		Restaurants per 5000 population		X	
	Governance	Percentage of tax collected out of billed			X
		Percentage of public services available online		X	
		Percentage of services integrated via government authorities		X	
		Percentage of public using online government services			X
	Safety	Percentage of public spaces covered by surveillance cameras	X	X	
		Percentage of violent crimes	X		X
		Percentage of terrorist activities	X	X	
		Percentage of trivial crimes	X		X
		Percentage of unauthorized drug related crimes			X
		Percentage of crimes recorded against women and children per year		X	
		Number of recorded crimes per 10,000 population		X	
	Working Environment	Unemployment Rate			X
		Average percentage of paid leave		X	
		Percentage of professionals charged with tax		X	
	Well-Being and welfare	Life expectancy at birth			X
		Risk to mental health		X	
		Concessionaries for low income families		X	
		Welfare for elderly people	X	X	
		Orphanages	X		X
Environment and character of the city	Air quality	Level of CO2 concentration	X		X
		Level of SO2 concentration	X		X
		Level of PM10 concentration	X		X
	Water quality	Quality of surface water bodies			X
	Climate	Annual average rainfall		X	
		Annual average temperature		X	
	Quality of architecture	Social acceptance in the residential area	X	X	
	Community Cohesion	Social acceptance in the residential area		X	

Livability Characteristic	Liveability Attribute	Liveability Indicator	Retrieved Source		
			Literature	Expert interviews	Document review
	Prevalence of noise pollution	Level of noise pollution	X	X	
Quality and availability of services	Solid waste management	Frequency of municipal solid waste collection		X	
	Recreation	Number of sports and cultural events hosted by government		X	
	Waste water management	Percentage of city area with adequate public toilets			X
		Percentage of treatment and reuse of waste water		X	
		Percentage of coverage of storm water drains		X	
	Water supply	Per capita supply of water	X		X
		Household level coverage of water supply connection			X
		Percentage of non-revenue water	X	X	
	Healthcare	Average response time for emergencies			X
		Number of in- patient beds per 5000 population			X
		Availability of public hospitals per residential area	X		X
		Availability of private hospitals per residential area	X	X	
		Percentage prevalence of water borne diseases		X	
		Percentage prevalence of vector borne diseases		X	
		Number of healthcare professionals per 5000 population	X	X	
	Power supply	Number of electricity interruptions per year		X	
		Percentage of population with metered connection		X	
	Education	Percentage of school-aged population enrolled in schools			X
		Student-teacher ratio			X
		Percentage of school with access to ICT		X	X
		Percentage of private education facilities			X
		Percentage of student completing secondary education		X	X
Proximity to local level services	Service availability	Percentage of services availability in 300m walking distance		X	
	Non-motorized transport	Percentage of roads with dedicated bicycle tracks	x	X	X

Livability Characteristic	Liveability Attribute	Liveability Indicator	Retrieved Source		
			Literature	Expert interviews	Document review
		Percentage of non-motorized transport modes	x	X	
		Percentage of traffic intersections with pedestrian crossings		X	
		Percentage of roads with pedestrian pavements			X
Connectivity to amenities and location-based attributes	Mobility	Percentage of city area coverage from public transport		X	
		Percentage of the public transport modes		X	
		Number of multimodal transport hubs		X	
		Distance to nearest airport		X	

According to Table 5.1 the number of context specific liveability indicators are higher than the liveability indicators identified via literature review. That might be a prerequisite was present as to available in more than one source if it is to be included for the list of liveability indicators selected via literature. The significant difference of the indicators of the literature review and the case study indicators includes emphasis on ground issues and bridging the gap to reach the level of global indexes as discussed in Section 3.2.3 and Section 4.5.2

5.3.1 Emphasis on the grounded issues

The liveability indictors identified for the context of Colombo, have an emphasis on the context specific issues. For instance, the percentage of slum areas covered by basic services is identified as a liveability indicator in Colombo. The experts' argument is that a liveability index developed specifically for a context should contain the real requirements of liveability of the inhabitants of that context.

In contrast, the liveability attributes and indicators that were commonly used in constituting liveability in the global context were identified in Chapter 3. The Global liveability indexes identified in Section 3.5 consist of liveability indicators shortlisted and used over a period.

These liveability indicators do not represent the ground level issues related to safety in public places, waste management issues, underutilized housing of slums and shanties. The experts interviewed held that insensitivity towards these issues probed

form poverty and social polarization could not improve the liveability of the society as a whole.

Hence, this dissimilar distribution of the liveability indicators in the global context and local context could be explained as a result of the definition of liveability and focus in different contexts. The liveability index of Colombo acts a tool of developing the liveability whereas majority of the liveability indexes are marketability tools.

5.3.2 Bridging the gap to reach the level of global indexes

In EIU liveability index Colombo, Sri Lanka has been ranked at 132 out of 140 cities (EIU, 2018). The liveability indicators included in EIU liveability index are mostly focused on commercial purposes, hence does not reflect the liveability adequately. For instance, the liveability indicators on education are mostly on availability of private education and quality of private education provisions. Yet, it does not reflect the quality of public education provided in the government schools of Sri Lanka (Mercer,2018). Moreover, liveability indicators related to services and transportation are not assessed in depth but as aggregation of many indicators. Hence, it is difficult to locate the areas that need development within such aggregated indicator.

The liveability indicators selected for the context of Colombo either addresses existing issues in the context as explained in the Section 5.2.1. or bridges the gap to reach the level of the global indexes. For instant, the liveability indicators such as "Percentage of public spaces covered by surveillance cameras" specifically addresses the quality of life requirements of the citizens of Colombo regarding the safety. This liveability indicator has been available in global liveability indexes. The experts held that even though these liveability indicators are not the short-term suspense of the inhabitants, these smart cities related indicators would be soon become essentials. Therefore, the indicators of potential importance are included.

Similarly, the liveability indicators such as "Percentage of non-motorized transport modes", "Percentage of non-motorized transport modes" and "Number of multimodal transport hubs" have been included in the index with a futuristic view to upheld the living condition of the inhabitants. Hence, the liveability indicators incorporated in the liveability index are expected to bridge the gap of improving the liveability of

Colombo, by precisely identifying what elements need specific attention to improve liveability of Colombo.

5.4 Prioritization of Liveability Characteristics, Attributes and Indicators

As a part of developing the liveability index the liveability characteristics, attributes and the indicators were prioritized (Refer Section 4.5.2). The aim of prioritization of the liveability indicator was to identify how, a set of random liveability indicators are ranked by the public based on their priorities. As emphasised by the experts, a community would have varied priorities and usually it is common to specified geographical area. This finding similar to the finding of Shabanzadeh et al. (2019), who highlighted that on quality of lives is varied in different communities.

In Section 4.5.2 the local weight obtained by balanced socio-economic environment is 0.3097 out of 1. From the 6 liveability characteristics considered 0.3097 is considerably high. These findings of the study are consistent with those of Mulligun and Carruthers (2011) who highlighted that the government approach to sustain the quality of lives of the citizens, maintain the law and order of the city, and job availability is considered as a priority by the inhabitants.

Under that safety has been given emphasis over other liveability attributes from the city of Colombo Perspective. Interestingly, safety related indicators were available in most of the global liveability index (EIU,2018; Mercer,2018). However, in other liveability indexes such as Monocle it has not been identified as a priority to the inhabitants of a city. Another, likely reason for safety to be ranked as an important liveability indicator is, during the data collection stage a severe terrorist attack had been executed in Colombo and the public was shocked because of that. Hence, imprudently, the inhabitants have recognised safety as a significant attribute of liveability.

Contrariety to expectation proper planning of land use and affordable housing has obtained only 0.0664 for its performance score because many of the literature finds land use planning and housing affordability is significant characteristic of liveability.

The most possible explanation of this result is that the perspective on which the liveability elements were prioritized in this study. In the AHP questionnaire the respondents were advised to response in the perspective of the inhabitants of Colombo. The inhabitants have less control over the land use planning of the city. In the study by Stevenson et al., (2016), this phenomenon has been described as the inhabitants of a particular geographical area is less concerned about the land plan until the socio-economic condition of that area is acceptable in their individual perspective.

Moreover, other than being an interim stage of developing the liveability index, the prioritization process has a contribution towards using these liveability elements as development indicators. As explicated by expert C, the development authorities face issues in prioritizing their projects in local authority levels and in national levels. When the priorities of the citizens have been identified, the local authorities may consider taking actions towards listing those as priorities.

Hence, the importance of prioritization of the liveability indicators could not be undermined in developing a context specific liveability index. Firstly, it prioritizes the requirements of the inhabitants of Colombo. It makes the liveability index more defined and unique in representing the inhabitants of the city of Colombo. Secondly, the prioritized list of liveability indicators could be utilized as a reference point in executing development of the built environment.

5.5 Development of the Composite Liveability Index for the Context of Colombo

This study provides significant findings regarding the assessment of liveability of the city of Colombo. The liveability index is an integration of the importance level given by inhabitants to each liveability indicator and average level of satisfaction of the inhabitants regarding the indicator. This approach to development of liveability index agrees with the studies done by Poumanyvong, Kaneko and Dhakal, (2012) who emphasised that liveability is eventually decided by inhabitants of the cities. In accordance with the present result, expert B emphasised the importance of examining the empirical relationships of the liveability indicators using literature and combining the items into an index.

5.5.1 Examining the empirical relationships of variables and combining of these items into an index

The establishment of empirical relationships were done through referring to liveability indexes such as EIU liveability Index (EIU,2018) and Mercer Liveability Index (Mercer,2018). Considering the subjective nature of the concept of liveability as underlined by Shabnazade et al. (2019), the most appropriate establishment of empirical relationship was the one used in EIU liveability index (EIU,2018).

However, one of the main limitations of these liveability indexes is that they consider all the variables with same importance. Yet, in reality, inhabitants have a priority to these indicators. As exemplified by experts for the countries where urban development is still under progress, systematic approaches to ensure security, waste collection, uninterrupted water supply, availability of schools and emergency mobile healthcare facilities are prioritized over indicators such as recreational facilities and availability of airports. Therefore, the AHP method was applied to prioritize the liveability indicators.

Consequently, after establishing the empirical relationships, weighted average calculated by using the normalized global weights of the liveability indicators as the weighing factor was chosen as the most appropriate method to construct the liveability index. Instead of the traditional expert validations the validation was conducted among public. Suggestions to further improvements were given and the process of addressing them after validation is provided in Table 5.2.

Table 5.2: Addressing the Comment on the Index on Validation

Comment	**Addressing the comment**
Extensive lists	Have the possibility to consider the lists in a simpler manner when the characteristics or attributes are analysed
Integrate the indicators	Only the 71 indicators were listed in the questionnaire Hence, the respondents were unaware of 25 liveability attributes and 6 liveability characteristic discussed in the study. They have global weights which provides the same result. Hence,

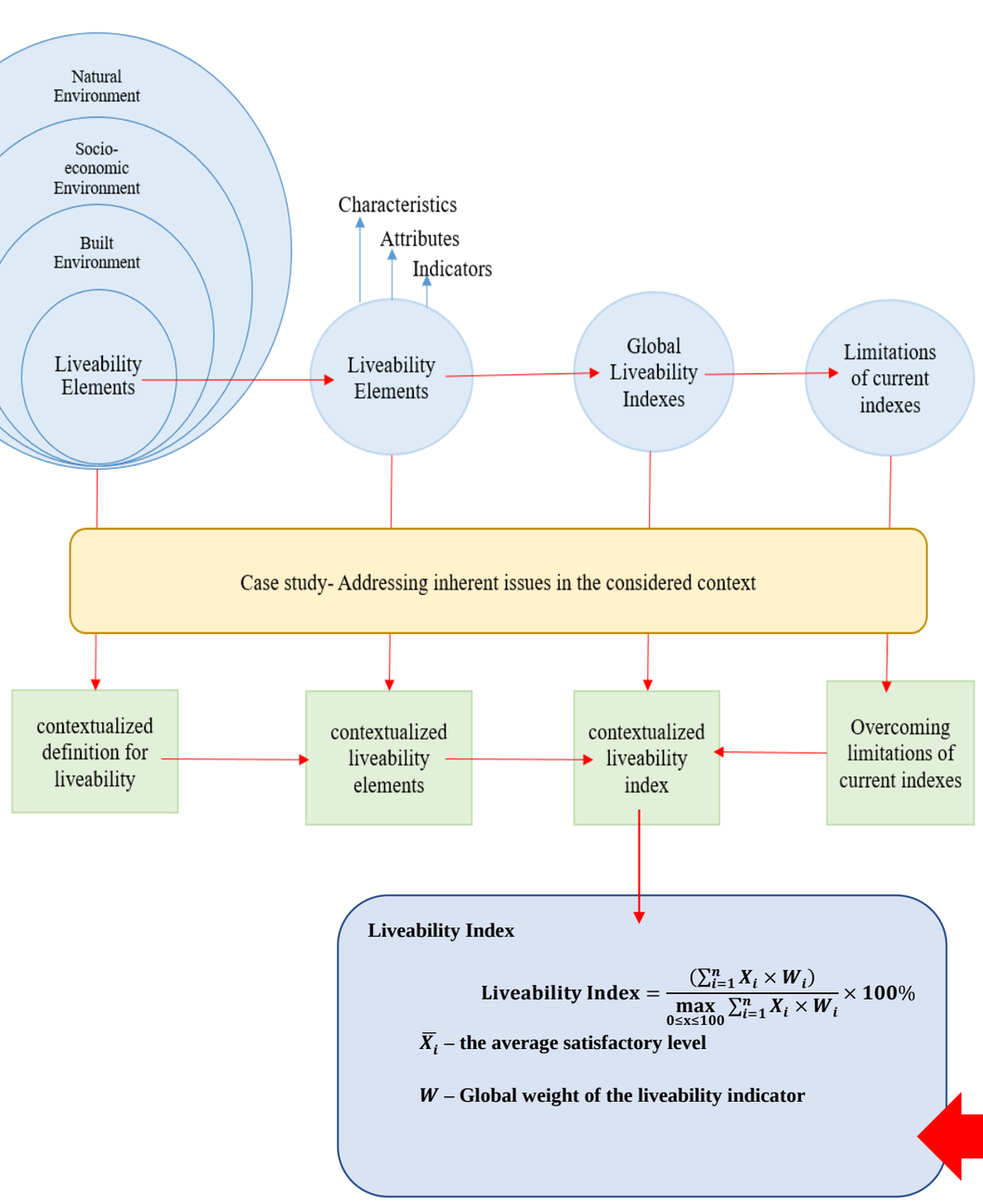
Comment	Addressing the comment
	for anyone who prefer a summarised version the result can be analysed based on characteristics or attributes.
Understandability of some indicators	This comment was on terms such as CO_2, SO_2 and PM10 which are unreplaceable technical terms. Other liveability indicators are provided in colloquial terms.
A quantitative measurement of the indicators	A reasonable comment to comprehending an indicator better. Yet, it is not applicable because the index is not developed to obtain a precise value for each indicator, but assess liveability based on general understanding

After addressing these comments, the presentation of the index was restructured as in Figure 5.2

As illustrated in Figure 5.2 the liveability index was developed based on the suggestions at the validation. The liveability characteristics, attributes and indicators have not been given extensively. They are included in the data collection instrument provided at annexure 04. A priority is given to illustrate the difference between the contribution to the context of Colombo and the theory. The blue colour shapes denote the theoretical flow of the study and the green colour shapes denote how to contextualize the findings.

The findings of Chapter 03 considered as the basis for the theoretical generalization. Literature demonstrated the possibility to use a liveability index as a tool in obtaining a measure of liveability. The index is also developed by visiting back and forth in literature findings and empirical data owing to the abductive research strategy followed. Therefore, the liveability index as a tool, has been given under theoretical generalization because it could be applied distinctly from the context of Colombo with minimum changes.

Liveability Index for the Context of Colombo, Sri Lanka
- A Tool to Assess Liveability



Steps of implementing liveability index

Step 01- Distribution of the data collection instrument among the respondents
*The respondent of the liveability index could be selected through cluster sampling of 9 local area considered for the context
* Stratified sampling where the population is stratified into age groups, professions, gender or income levels.
*Minimum Sample size may vary depending on the cluster or stratified group population.
* Refer Annexure 04 for data collection instrument

Step 02- Calculation of the average satisfactory level of individual indicators
A 5 scale interval distribution where the respondents can mark their satisfactory level is given.
The average of the satisfactory level was taken

Class name	Interval	Mid-point of the Interval *(x)*	Frequency *(f)*	*fx*
Desirable	81-100	90.5		
Acceptable	61-80	70.5		
Tolerable	41-60	50.5		
Unacceptable	21-40	30.5		
Undesirable	0-20	10		
			$\sum_{i=1}^{n} f_i$	$\sum_{i=1}^{n} f_i x_i$
$\bar{X} = \frac{\sum_{i=1}^{n} f_i x_i}{\sum_{i=1}^{n} f_i}$			$\bar{X}$ – average satisfactory level f_i- number of respondents (frequency of the distribution) x_i – midpoint of the interval	

Step 03- Derive the weighted average of the liveability indicators
The weightage is the global weight calculated using AHP process. That value is considered as context specific.

Index Value $= Y = \frac{\left(\sum_{i=1}^{n} \bar{X}_i \times W_i\right)}{\left(\sum_{i=1}^{n} W_i\right)}$
$\bar{X}_i$ – the average satisfactory level W – Global weight of the liveability indicator

Liveability Index

$$\textbf{Liveability Index} = \frac{\left(\sum_{i=1}^{n} \boldsymbol{X_i} \times \boldsymbol{W_i}\right)}{\max\limits_{0 \le x \le 100} \sum_{i=1}^{n} \boldsymbol{X_i} \times \boldsymbol{W_i}} \times 100\%$$

$\bar{X}_i$ – the average satisfactory level

W – Global weight of the liveability indicator

Figure 5.2: Liveability Index after Addressing Comments at Validation

The case study done using the context of Colombo extensively provides the behavior of the liveability index. The components which are context specific have been clearly outlined in Figure 5.2. There are some components that are specific to the context of Colombo which have not explicitly illustrated. The definition of liveability provided at the end of Section 4.2.2. is centred around the context of Colombo. Hence, the liveability characteristics, attributes and indicators also represent the context. The global weight obtained through AHP process is also specific to the context of Colombo. A respondent in a different context might prioritize the liveability elements differently. Therefore, as a tool or methodology this liveability index is applicable to similar contexts or even to different context with adjustments to the liveability indicators considered.

For instant, the pilot test of the index disclosed the possibility to use this liveability index to measure the perception of liveability in terms of income levels, age levels, occupations or any other demographic category. Therefore, it justifies the creation of a liveability index where the users have the ability to prioritize the indicators which is a unique characteristic of this liveability index.

5.6 Overcoming the Limitations of Previous Liveability Indexes

A prominent reason of developing this liveability index is to overcome the limitations of the existing liveability indexes. These limitations are extensively discussed in Section 3.10.6. The validation of the applicability of liveability of the index allowed observing how these limitations have been addressed in the new liveability index.

5.6.1 Methodological limitations

Existing liveability indexes have methodological limitations in terms of the sample sizes, irrational determination of the variables and the subjective prepositions presented in objective manner without explanations. Another main methodical limitation is avoided by using AHP method to prioritize the liveability indicators. The fact that individual gives priority for certain factors regarding livability had been disregarded in many cases when the index makers attempt to be objective.

5.6.2 Data integrity and compatibility

The data considered in the study are of different nature and often incompatible. Hence most of the liveable indicators which are deriving liveability score strait from the values of the indicators are comparing incompatible data. Since liveability is a subjective concept it is not compulsory to solely depend on the indicator values. In this study the values of the indicators were given only as a reference material when making decisions. Hence, the end results are compatible. This liveability index may effectively use factual data in decision making regarding a subjective matter.

5.6.3 Indicators

Selection of indicators is a challenging task and the unavailability of the primary level liveability indicators in previous indexes was a reason to develop this index. This research provided that defining of the context clearly and defining the concept of liveability to the considered context is crucial to make the liveability indicators relevant. Besides, the indicators cannot be set aside solely due to unavailability of data or incompatibility because those indicators may become relevant to the context in the future with the development of the city and the quality of lives of the inhabitants. In this index these provisional indicators have also been included. Yet they rank the loves in priority ranking, hence less contributory to the final liveability score.

5.6.4 Ranking

The importance of being context specific is evident when ranking because some cities have improved over the time even though it has fallen in the ranking table. This liveability index is not only designed to compete in a group but to benchmark the city on its status quo until reaching the desired level of improvement. Hence this liveability index is preferably used in longitudinal studies because the liveability index value is not relative.

5.6.5 Subjectivity

In Section 3.6 subjectivity of the liveability indexes were viewed as a limitation. However, when validating the study, the opportunities from the subjectivity of the index was identified. The ability to personalize the index and to customize it to

different purpose is achievable only because of the subjectivity. Hence, the subjectivity of the liveability index is declared as a positive trait of the index. All in all, the composite liveability index that was developed, has been able to overcome the limitations of liveability indexes in the global context and has achieved a uniqueness which represent the context of Colombo.

5.7 Chapter Summary

The fifth chapter provides a discussion of the findings present in Chapter 04 by revisiting the literature findings in Chapter 02. The requirement and the effectiveness of redefining the concept of liveability to the context of Colombo have been discussed. Moreover, the liveability characteristics, attributes and the indicators have been scrutinized by comparing and contrasting with the liveability elements of the global context. Prioritization of the liveability indicators was an interim finding of the study which has been discussed separately in Section 5.3 regarding its contribution to the Context. The development of the index and the validation process has been discussed in detail. As a final note, the method of overcoming the context specific limitations of other liveability indexes has been expounded by reflecting the limitations identified in the literature review.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction to the Chapter

The sixth chapter is established on the entire research constructing the aim achievement through the literature review following in depth analysis and the discussion in the forgoing chapters. Consequently, the contribution of the research to the theories and practices have been highlighted. Recommendations to enhance the liveability of Colombo through the liveability index, enrich the urban development practises and application of the liveability index have been proposed based on the final discussion of the research. The researcher has acknowledged certain limitations to the study and proposed further research areas to expand the study in other related directions.

6.2 Accomplishment of Objectives

The research aim of enhancing the quality of lives of the inhabitants in Sri Lanka by making cities more liveable was achieved through the systematic accomplishment of the objectives as follows.

6.2.1 Accomplishment of first objective

To investigate the concepts and definitions related to 'Liveability' and 'Liveable Cities'

The concepts related to liveability is discussed in Section 3.1. The definitions related to liveability and liveable cities are synthesised via an extensive literature review with filtered literature sources using PRISMA method in Section 3.2.

Consequently, it is identified that the concepts of sustainability, urbanisation and resilience have close notions related to liveability. The principles of sustainability on economy, society and environment are reflected in the concept of liveability as well with a focus on short term.

Considering the concepts and definitions, liveability is defined as, the consistency of the desired and actual place-based attribute which reflects the quality of life in terms of the infrastructure, social, economic and environmental characteristics. Moreover, the investigation provided that defining liveability is more effective when it is defined for a particular context.

Hence, liveability is defined for the context of Colombo as, *"the satisfactory quality of lives of inhabitants achieved through its balanced socio-economic environment reflected through the character of the city of Colombo with quality and proximate services, connectivity to aminities through proper infrastructure and preserved natural environment"*.

6.2.2 Accomplishment of second objective

To identify the attributes and indicators that constitute for liveability in the global context and with particular reference to Sri Lanka

The literature synthesis features the indicators that constitute the liveability in the global context. These liveability indicators are in existing liveability indexes and other liveability. In Section 3.2.3., 29 liveability indicators are identified such as occurrence of trivial crimes, standard of health facilities, availability of consumer goods and services and public education indicators and standard of road network.

Subsequently, adhering to the context specific definition liveability characteristics are identified by analysing the expert opinions. The liveability characteristics explained in Section 4.2.3 include planning of land use and affordable housing, balanced socio-economic environment, environment and character of the city, quality and availability of services, proximity to local level services and the connectivity to amenities and location-based attributes.

Consequently, liveability attributes which form the liveability characteristics have been listed down by expanding the thematic analysis. The elusive list of attributes given in Section 4.2.4, includes but not limits to mix use of land, housing, public open spaces, governance and safety. As a measurement of the liveability attributes, 72 liveability indicators have been identified at Section 4.3.

Since these liveability characteristics, attributes and indicators have been identified following a synthesis of literature, expert interviews and document review, a fair representation of the context of Colombo in terms of its liveability is provided.

Hence, the achievement of the second objective accommodate the development of liveability index which is specifically addressing liveability issues in the context of Colombo.

6.2.3 Accomplishment of third objective

To develop a Liveability Index to enhance the quality of lives of the inhabitants in Sri Lanka

The city of Colombo was considered as the case study. The liveability elements identified are developed as a liveability index. As the first step the liveability elements are prioritized. The prioritization reflects the importance of a context specific liveability index. For instance, the safety of the city is prioritized as the most prominent attribute of the liveability in the city of Colombo. Recent Easter bomb attack by religious extremist and the experience of a civil war of 30 years have resulted in considering safety as a main indicator of liveability.

Likewise, the list of liveability indicators is rearranged to reflect the Colombo context. The empirical relationships are established by synthesising the methodologies of liveability indexes provided in Section 3.5. Then, the constructed liveability index is validated as in Section 4.5.3.

6.2.4 Conclusions

The city of Colombo is developing at a pace resulting a rapid urbanization. The development itself brings issues that impacts the daily operations of the city of Colombo. Traffic congestion, affordable housing deficiency, waste management issues, issues related capacity of water supply are among the most common issues within Colombo. These issues have reduced the liveability of the city of Colombo in a significant way. Urban planners are focusing on minimizing these issues using a sustainable approach. Yet, the short-term suspense of the inhabitants is the liveability of the city of Colombo. Hence, a measurement of benchmarking the liveability of Colombo is an urgent requirement.

Identifying the definition of liveability of Colombo, prioritizing the factual importance of the each liveability indicators for the inhabitants was achieved through this research. Research findings provided that the inhabitants give a priority to balanced socio-economic conditions of the city as a main measure of liveability in the context of Colombo. The safety of the city, proper governance, working environment and the culture of the city is considered important. Following that, the availability of quality

services has also been prioritized over characteristics such as land use, environment and character of the city. The issues arising along with the urbanization which makes the city of Colombo uninhabitable to its citizens could be effectively addressed with a specific focus on the requirements and priorities of the inhabitants through the developed liveability index.

6.3 Implications to the Theories

The theoretical stance of the concept of liveability is not fully formed via defined methodological researches in built environment. Hence, this study establishes a proper definition for the concept of liveability synthesising the empirical studies that have been conducted so far. That definition of liveability is the consistency of the desired and actual place-based attribute which reflects the quality of life in terms of the infrastructure, social, economic and environmental characteristics.

Furthermore, the study outlines the definition of liveability for the context of Colombo, which includes the context characteristics of liveability. This definition could be applied as a unified perception of liveability, in the instances where urban planning of city of Colombo is focused on making the city more liveable to the inhabitants of Colombo.

6.4 Implications to the Practices

The findings of the study could be effectively utilized by the practitioners in urban planning and development, sociologist, investors and inhabitants of Colombo. Since the study provides a prioritized list of liveability indicators, the stakeholders of the city of Colombo could distinguish the actual requirements of liveability in the city. For instance, planning authorities could prioritize improving the socio-economic conditions of Colombo when there are budgetary limitations to select urban development projects.

Moreover, the liveability index could be applicable as a tool of identifying the liveability of Colombo for a certain group of individuals. The liveability index is not only limited to prioritizing the liveability indicators of Colombo but emphasis on measuring each liveability indictors as well. The practical use of this tool includes measuring the liveability for people representing different ethnicities, age groups,

genders and income levels. Furthermore, the liveability index is applicable as a tool to benchmark the improvement in the liveability of the city of Colombo over the time.

Recommendations

- ***Consideration of concept of liveability in planning urban built environment, public infrastructure and other public services***

The findings of this study provide ample information regarding the applicability of liveability concept to reveal the real-life requirements of the citizens of a city. Hence, the liveability characteristics, attributes prioritized in this study could be recommended to be improved when developing the built environment.

- ***Increase investments on the prioritized liveability indicators to improve the quality of lives of the inhabitants of Colombo***

Investing more on the areas that are perceived by the public as contributory to liveability of Colombo such as prevalence of crimes, surveillance of public places and quality of public services.

- ***Benchmark the urban development in terms of liveability using liveability index as a tool***

The liveability index constructed in this study is recommended to be used as a benchmarking tool of the development of the city of Colombo. This index will particularly check whether the development of the built environment is facilitating an improved quality of lives.

6.5 Limitations of the Research

The study has been limited to the context of Colombo. The unavailability of cities which have similar population, service distribution and rate of development delimited the study to a single case study. Moreover, due to the limited time and resources a comparison or contrasting of the results with a different context was difficult. Due to the same reason the sample sizes selected for the study have been limited.

6.6 Further Research Directions

The following further research directions were proposed to overcome aforementioned limitations and to extend the research further.

- Extend the research to study the behaviour of the prioritization of liveability indicators in groups of different ethnicities, age groups, income levels, professions and genders.
- Develop a mechanism to objectively measure the liveability indicators after the prioritization process
- Conduct a deductive study to assess the applicability of the liveability index using data from a larger sample size.
- Enhance the research by theoretical replication where other set of cases are selected with different contextual factors to establish the contextual suitability of the liveability index.
- The suitability of this liveability index to other cities could be assessed by conducting literal replication using cities with a near similar development rate.

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Annexure 01: Expert Interview Guideline

T.M.M.P. Tennakoon
Research Scholar,
Department of Building Economics,
University of Moratuwa.
……

……
……
……
……

Dear Sir/ Madam,

Request to Conduct Expert Interviews

I am a postgraduate from University of Moratuwa following a master degree (Major Component by Research). I am involved in a study on developing a Livability Index to the city of Colombo by shortlisting the most suitable liveability indicators that reflect the city of Colombo the best. For that, I am expecting to gather the opinion of professionals and academics of multidisciplinary stance.

This round of interview would assist in understanding the concept of liveability, specifically in the Context of Colombo and identifying context specific liveability characteristics, attributes and indicators, which is an integral part in developing a Liveability Index to the city of Colombo.

The information collected through this interview will be kept strictly confidential and should be used only for the purpose of this research. Any of your personnel information will not be disclosed within the research.

The information shared, and the time dedicated despite of the busy schedule is highly appreciated.

Thank you.

Yours faithfully,

Maheshi Tennakoon.
Research Scholar/Postgraduate Student,
MSc. (Major Component by Research),
Department of Building Economics,
University of Moratuwa,
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ra-maheshi@uom.lk
+94712216226

Supervisor
Dr. Udayangani Kulatunga
Senior Lecturer,
Department of Building Economics,
University of Moratuwa,
Sri Lanka.
ukulatunga@uom.lk
+94764072339

Section 1 - Details of expert

1. Name of the respondent (Optional):

……

2. Organization (Optional):

……

3. Designation:

……

4. Expertized field of study:

……

5. Experience in the field (years)

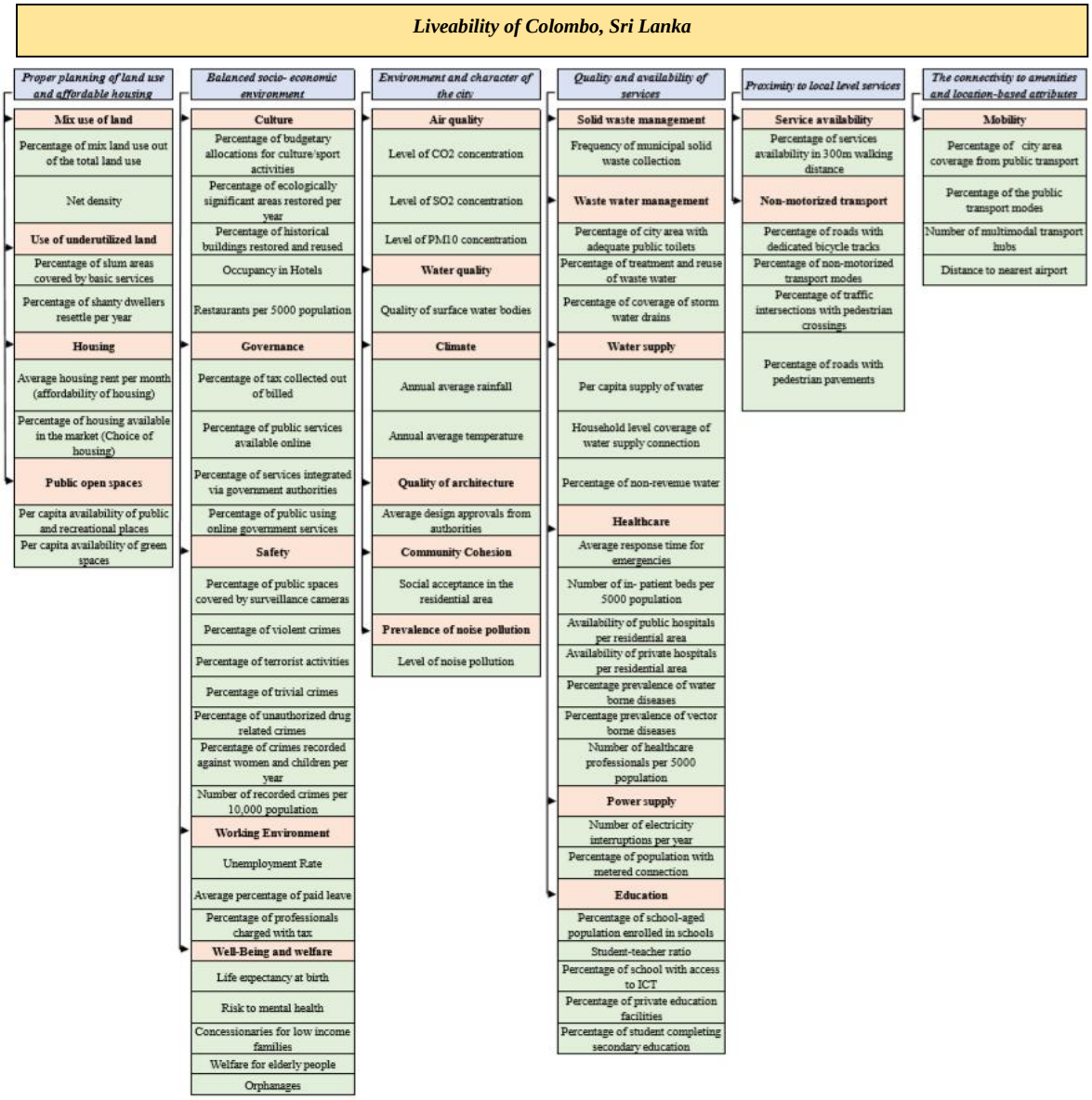
……

Section 2 - Expert's Awareness of the Concept of Liveability

1. What does the word "liveability" means to you?
   .....
   .....
   .....
   .....
   .....
2. Do you think Colombo is a liveable city?
   ……
3. As per your knowledge name three of the most liveable cities in the world.
   ……
   ……
   ……
4. As far as you know name three least liveable cities in the world.
   ……
   ……
   ……
5. Name main five factors you consider when you are selecting a city to live in?

   ……
   ……
   ……
   ……

Annexure 02: AHP Hierarchy Tree



Annexure 03: AHP Questionnaire

T.M.M.P. Tennakoon
Research Scholar,
Department of Building Economics,
University of Moratuwa.
……

……
……
……
……

Dear Sir/ Madam,

Request to Participate in a Questionnaire Survey

I am a postgraduate from University of Moratuwa following a master degree (Major Component by Research). I am involved in a study on developing a Livability Index to the city of Colombo by shortlisting the most suitable liveability indicators that reflect the city of Colombo the best. For that, I am expecting to gather the opinion of professionals and academics of multidisciplinary stance.

The questionnaire survey would assist in ranking the liveability characteristics, attributes and indicators, which is an integral part in developing a Liveability Index to the city of Colombo.

The information collected through this survey will be kept strictly confidential and should be used only for the purpose of this research. Any of your personnel information will not be disclosed within the research.

The information shared, and the time dedicated despite of the busy schedule is highly appreciated.

Thank you.

Yours faithfully,

Maheshi Tennakoon.
Research Scholar/Postgraduate Student,
MSc. (Major Component by Research),
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Senior Lecturer,
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University of Moratuwa,
Sri Lanka.
ukulatunga@uom.lk
+94764072339

Section 1 - Details of respondent

1. Name of the respondent (Optional):

……

2. Organization (Optional):

……

3. Designation:

……

4. Specialized field of study:

……

5. Experience in the field (years)

……

Section 2 – Respondent's Awareness of the Concept of Liveability

6. What does the word "liveability" means to you?
   .....
   .....
   .....
   .....
   .....
7. Do you think Colombo is a liveable city?
   ……
8. As per your knowledge name three of the most liveable cities in the world.
   ……
   ……
   ……
9. As far as you know name three least liveable cities in the world.
   ……
   ……
   ……
10. Name main five factors you consider when you are selecting a city to live in?
    ……
    ……
    ……
    ……

Section 3 – Importance of Liveability Characteristics, Attributes and Indicators in Measuring Liveability of Colombo

Please indicate which category in the pair is more important for measuring liveability of Colombo. If one category is more significant than the other, please indicate the magnitude of its importance over the other category.

The scale for magnitude is as follows.

Intensity of Importance	Definition	Description
1	Equal importance	Two compared categories have equal importance in city's liveability
3	Moderate importance	One of the categories is slightly more important than the other category
5	Strong importance	One of the categories is moderately important than the other
7	Very strong importance	One of the categories is strongly favored over the other, and its dominance is obvious
9	Extreme importance	The difference in importance between the two categories is so extreme that the categories are on the verge of not being comparable

Example 1: If, "proper land use, housing and planning" is judged as strongly more important (5 times more important) than "balanced socio-economic aspects" in measuring the liveability of Colombo, please indicate as follows.

Comparison Pair			More Important A or B		Level of Importance				
A	Vs	B							
land use, housing and planning	Vs	balanced socio-economic aspects	A	B	**1**	**3**	**5**	**7**	**9**

Example 2: If, "culture" is equally important (Level of Importance=1) to "political environment" for measuring "balanced socio – economic aspects" of city of Colombo, please indicate as follows.

Comparison Pair			More Important A or B		Level of Importance				
A	Vs	B							
culture	Vs	political environment	A	B	**1**	**3**	**5**	**7**	**9**

1. Please indicate **which category in the pair is more important for measuring liveability of Colombo**. Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE				
A	**Vs**	**B**							
Proper land use, housing and planning	Vs	Balanced socio- economic aspects	A	B	**1**	**3**	**5**	**7**	**9**
Proper land use, housing and planning	Vs	Environment and character of the city	A	B	**1**	**3**	**5**	**7**	**9**
Proper land use, housing and planning	Vs	Quality and availability of services	A	B	**1**	**3**	**5**	**7**	**9**
Proper land use, housing and planning	Vs	Proximity and connectivity to the local level services and location based attributes	A	B	**1**	**3**	**5**	**7**	**9**
Balanced socio-economic aspects	Vs	Environment and character of the city	A	B	**1**	**3**	**5**	**7**	**9**
Balanced socio-economic aspects	Vs	Quality and availability of services	A	B	**1**	**3**	**5**	**7**	**9**
Balanced socio-economic aspects	Vs	Proximity and connectivity to the local level services and location based attributes	A	B	**1**	**3**	**5**	**7**	**9**
Environment and character of the city services	Vs	Quality and availability of services	A	B	**1**	**3**	**5**	**7**	**9**
Environment and character of the city services	Vs	Proximity and connectivity to the local level services and location based attributes	A	B	**1**	**3**	**5**	**7**	**9**
Quality and availability of services	Vs	Proximity and connectivity to the local level services and location based attributes	A	B	**1**	**3**	**5**	**7**	**9**

2. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "proper land use, housing and planning"**. Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE				
A	**Vs**	**B**							
Housing	Vs	Use of under -utilized land	A	B	**1**	**3**	**5**	**7**	**9**
Housing	Vs	Pro-active policy developments	A	B	**1**	**3**	**5**	**7**	**9**
Use of under -utilized land	Vs	Pro-active policy developments	A	B	**1**	**3**	**5**	**7**	**9**

3. Please indicate **which category in the pair is more important for measuring liveability of Colombo under, "balanced socio-economics aspects"**. Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE				
A	**Vs**	**B**							
Culture	Vs	Political environment	A	B	**1**	**3**	**5**	**7**	**9**
Culture	Vs	Safety/ Crime	A	B	**1**	**3**	**5**	**7**	**9**
Culture	Vs	Working Environment	A	B	**1**	**3**	**5**	**7**	**9**
Culture	Vs	Cost of Living	A	B	**1**	**3**	**5**	**7**	**9**
Culture	Vs	Well-Being	A	B	**1**	**3**	**5**	**7**	**9**
Culture	Vs	Welfare	A	B	**1**	**3**	**5**	**7**	**9**
Political environment	Vs	Safety/ Crime	A	B	**1**	**3**	**5**	**7**	**9**
Political environment	Vs	Working Environment	A	B	**1**	**3**	**5**	**7**	**9**
Political environment	Vs	Cost of Living	A	B	**1**	**3**	**5**	**7**	**9**
Political environment	Vs	Well-Being	A	B	**1**	**3**	**5**	**7**	**9**
Political environment	Vs	Welfare	A	B	**1**	**3**	**5**	**7**	**9**
Safety/ Crime	Vs	Working Environment	A	B	**1**	**3**	**5**	**7**	**9**
Safety/ Crime	Vs	Cost of Living	A	B	**1**	**3**	**5**	**7**	**9**
Safety/ Crime	Vs	Well-Being	A	B	**1**	**3**	**5**	**7**	**9**
Safety/ Crime	Vs	Welfare	A	B	**1**	**3**	**5**	**7**	**9**
Working Environment	Vs	Cost of Living	A	B	**1**	**3**	**5**	**7**	**9**
Working Environment	Vs	Well-Being	A	B	**1**	**3**	**5**	**7**	**9**
Working Environment	Vs	Welfare	A	B	**1**	**3**	**5**	**7**	**9**
Cost of Living	Vs	Well-Being	A	B	**1**	**3**	**5**	**7**	**9**
Cost of Living	Vs	Welfare	A	B	**1**	**3**	**5**	**7**	**9**
Well-Being	Vs	Welfare	A	B	**1**	**3**	**5**	**7**	**9**

4. Please indicate **which category in the pair is more important for measuring liveability of Colombo under, "environment and character of the city"**. Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE				
A	**Vs**	**B**							
Natural environment	Vs	Community cohesion	A	B	**1**	**3**	**5**	**7**	**9**
Natural environment	Vs	Quality of architecture	A	B	**1**	**3**	**5**	**7**	**9**
Natural environment	Vs	Climate	A	B	**1**	**3**	**5**	**7**	**9**
Community cohesion	Vs	Quality of architecture	A	B	**1**	**3**	**5**	**7**	**9**
Community cohesion	Vs	Climate	A	B	**1**	**3**	**5**	**7**	**9**
Quality of architecture	Vs	Climate	A	B	**1**	**3**	**5**	**7**	**9**

5.Please indicate **which category in the pair is more important for measuring liveability of Colombo under, "quality and availability of services".** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE				
A	**Vs**	**B**							
Healthcare	Vs	Education	A	B	**1**	**3**	**5**	**7**	**9**
Healthcare	Vs	Recreation	A	B	**1**	**3**	**5**	**7**	**9**
Healthcare	Vs	Consumer goods	A	B	**1**	**3**	**5**	**7**	**9**
Healthcare	Vs	Sanitation	A	B	**1**	**3**	**5**	**7**	**9**
Healthcare	Vs	Other public services	A	B	**1**	**3**	**5**	**7**	**9**
Education	Vs	Recreation	A	B	**1**	**3**	**5**	**7**	**9**
Education	Vs	Consumer goods	A	B	**1**	**3**	**5**	**7**	**9**
Education	Vs	Sanitation	A	B	**1**	**3**	**5**	**7**	**9**
Education	Vs	Other public services	A	B	**1**	**3**	**5**	**7**	**9**
Recreation	Vs	Consumer goods	A	B	**1**	**3**	**5**	**7**	**9**
Recreation	Vs	Sanitation	A	B	**1**	**3**	**5**	**7**	**9**
Recreation	Vs	Other public services	A	B	**1**	**3**	**5**	**7**	**9**
Consumer goods	Vs	Sanitation	A	B	**1**	**3**	**5**	**7**	**9**
Consumer goods	Vs	Other public services	A	B	**1**	**3**	**5**	**7**	**9**
Sanitation	Vs	Other public services	A	B	**1**	**3**	**5**	**7**	**9**

6. Please indicate **which category in the pair is more important for measuring liveability of Colombo under, "proximity and connectivity to the local level services and location based attributes".** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE				
A	**Vs**	**B**							
Infrastructure	Vs	Transportation	A	B	**1**	**3**	**5**	**7**	**9**

7. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "housing" attribute.** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE				
A	**Vs**	**B**							
Availability of affordable housing	Vs	Availability of choice of housing	A	B	**1**	**3**	**5**	**7**	**9**

8. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "use of underutilized land" attribute.** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE				
A	**Vs**	**B**							
Services development in slum areas	Vs	Resettlement of shanty dwellers	A	B	**1**	**3**	**5**	**7**	**9**

9. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "proactive policy development" attribute.** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B	LEVEL OF IMPORTANCE
A	**Vs**	**B**		
Number of acts passed annually for urban development	Vs	Budgetary allocations for urban development	A B	**1 3 5 7 9**

10. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "culture" attribute.** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B	LEVEL OF IMPORTANCE
A	**Vs**	**B**		
Allocation towards cultural celebrations	Vs	Facilities to engage in religious and cultural activities	A B	**1 3 5 7 9**

11. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "political environment" attribute.** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B	LEVEL OF IMPORTANCE
A	**Vs**	**B**		
Relationship with other countries	Vs	Internal political stability	A B	**1 3 5 7 9**
Relationship with other countries	Vs	Law enforcement		
Internal political stability	Vs	Law enforcement		

12. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "Safety / Crimes" attribute.** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B	LEVEL OF IMPORTANCE
A	**Vs**	**B**		
Prevalence of Threats of Terrorism	Vs	Number of recorded crimes	A B	**1 3 5 7 9**

13. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "working environment" attribute.** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B	LEVEL OF IMPORTANCE
A	**Vs**	**B**		
Total unemployment rate	Vs	Total working hours	A B	**1 3 5 7 9**

14. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "cost of living" attribute.** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE
A	**Vs**	**B**			
Housing rent	Vs	General inflation	A	B	**1 3 5 7 9**

15. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "well being" attribute.** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE
A	**Vs**	**B**			
Life expectancy at birth	Vs	Risk to mental health	A	B	**1 3 5 7 9**

16. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "welfare" attribute.** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE
A	**Vs**	**B**			
Concessionaries to low income families	Vs	Welfare for elderly people	A	B	**1 3 5 7 9**
Concessionaries to low income families	Vs	Orphanages	A	B	**1 3 5 7 9**
Welfare for elderly people	Vs	Orphanages	A	B	**1 3 5 7 9**

17. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "natural environment" attribute.** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE
A	**Vs**	**B**			
Air quality	Vs	Noise pollution	A	B	**1 3 5 7 9**
Air quality	Vs	Restoration of ecologically significant areas	A	B	**1 3 5 7 9**
Air quality	Vs	Availability of urban green spaces	A	B	**1 3 5 7 9**
Air quality	Vs	Need for obtain LEED certification for new buildings	A	B	**1 3 5 7 9**
Noise pollution	Vs	Restoration of ecologically significant areas	A	B	**1 3 5 7 9**
Noise pollution	Vs	Availability of urban green spaces	A	B	**1 3 5 7 9**
Noise pollution	Vs	Need for obtain LEED certification for new	A	B	**1 3 5 7 9**

		buildings							
Restoration of ecologically significant areas	Vs	Availability of urban green spaces	A	B	**1**	**3**	**5**	**7**	**9**
Restoration of ecologically significant areas	Vs	Need for obtain LEED certification for new buildings	A	B	**1**	**3**	**5**	**7**	**9**
Availability of urban green spaces	Vs	Need for obtain LEED certification for new buildings	A	B	**1**	**3**	**5**	**7**	**9**

18. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "Healthcare" attribute.** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			**MORE IMPORTANT A OR B**		**LEVEL OF IMPORTANCE**				
A	**Vs**	**B**							
Availability of emergency medical services	Vs	Adequacy of in- patient beds	A	B	**1**	**3**	**5**	**7**	**9**
Availability of emergency medical services	Vs	Adequacy of healthcare professionals	A	B	**1**	**3**	**5**	**7**	**9**
Adequacy of in- patient beds	Vs	Adequacy of healthcare professionals	A	B	**1**	**3**	**5**	**7**	**9**

19. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "education" attribute.** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			**MORE IMPORTANT A OR B**		**LEVEL OF IMPORTANCE**				
A	**Vs**	**B**							
Availability of primary schools	Vs	Availability of secondary schools	A	B	**1**	**3**	**5**	**7**	**9**
Availability of primary schools	Vs	School aged population enrolled in schools	A	B	**1**	**3**	**5**	**7**	**9**
Availability of primary schools	Vs	Student- teacher ratio	A	B	**1**	**3**	**5**	**7**	**9**
Availability of primary schools	Vs	Accessibility to digital education	A	B	**1**	**3**	**5**	**7**	**9**
Availability of secondary schools	Vs	School aged population enrolled in schools	A	B	**1**	**3**	**5**	**7**	**9**
Availability of secondary schools	Vs	Student- teacher ratio	A	B	**1**	**3**	**5**	**7**	**9**
Availability of secondary schools	Vs	Accessibility to digital education	A	B	**1**	**3**	**5**	**7**	**9**
School aged population enrolled in schools	Vs	Student- teacher ratio	A	B	**1**	**3**	**5**	**7**	**9**
School aged population enrolled in schools	Vs	Accessibility to digital education	A	B	**1**	**3**	**5**	**7**	**9**
Student- teacher ratio	Vs	Accessibility to digital education	A	B	**1**	**3**	**5**	**7**	**9**

20. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "consumer goods".** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE				
A	**Vs**	**B**							
Accessibility to retail shops	Vs	Availability of restaurants and cafes	A	B	**1**	**3**	**5**	**7**	**9**

21. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "sanitation".** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE				
A	**Vs**	**B**							
Frequency of sewerage maintenance	Vs	Frequency of solid waste collection	A	B	**1**	**3**	**5**	**7**	**9**
Frequency of sewerage maintenance	Vs	Reuse and recycle of waste water	A	B	**1**	**3**	**5**	**7**	**9**
Frequency of sewerage maintenance	Vs	Prevalence of water borne diseases	A	B	**1**	**3**	**5**	**7**	**9**
Frequency of sewerage maintenance	Vs	Prevalence of vector borne diseases	A	B	**1**	**3**	**5**	**7**	**9**
Frequency of solid waste collection	Vs	Reuse and recycle of waste water	A	B	**1**	**3**	**5**	**7**	**9**
Frequency of solid waste collection	Vs	Prevalence of water borne diseases	A	B	**1**	**3**	**5**	**7**	**9**
Frequency of solid waste collection	Vs	Prevalence of vector borne diseases	A	B	**1**	**3**	**5**	**7**	**9**
Reuse and recycle of waste water	Vs	Prevalence of water borne diseases	A	B	**1**	**3**	**5**	**7**	**9**
Reuse and recycle of waste water	Vs	Prevalence of vector borne diseases	A	B	**1**	**3**	**5**	**7**	**9**
Prevalence of water borne diseases	Vs	Prevalence of vector borne diseases	A	B	**1**	**3**	**5**	**7**	**9**

22. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "public service".** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE				
A	**Vs**	**B**							
Quality pipe borne water supply	Vs	Prevalence of electricity interruptions	A	B	**1**	**3**	**5**	**7**	**9**

23. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "infrastructure".** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			MORE IMPORTANT A OR B		LEVEL OF IMPORTANCE				
A	**Vs**	**B**							
Walkability within the city	Vs	Coverage of sewerage network	A	B	**1**	**3**	**5**	**7**	**9**

Walkability within the city	Vs	Coverage of E,A,B,C roads	A	B	**1**	**3**	**5**	**7**	**9**
Walkability within the city	Vs	Solid waste treatment and disposal infrastructure	A	B	**1**	**3**	**5**	**7**	**9**
Walkability within the city	Vs	Energy requirement derived from the renewable sources	A	B	**1**	**3**	**5**	**7**	**9**
Coverage of sewerage network	Vs	Coverage of E,A,B,C roads	A	B	**1**	**3**	**5**	**7**	**9**
Coverage of sewerage network	Vs	Solid waste treatment and disposal infrastructure	A	B	**1**	**3**	**5**	**7**	**9**
Coverage of sewerage network	Vs	Energy requirement derived from the renewable sources	A	B	**1**	**3**	**5**	**7**	**9**
Coverage of E,A,B,C roads	Vs	Solid waste treatment and disposal infrastructure	A	B	**1**	**3**	**5**	**7**	**9**
Coverage of E,A,B,C roads	Vs	Energy requirement derived from the renewable sources	A	B	**1**	**3**	**5**	**7**	**9**
Solid waste treatment and disposal infrastructure	Vs	Energy requirement derived from the renewable sources	A	B	**1**	**3**	**5**	**7**	**9**

24. Please indicate **which category in the pair is more important for measuring liveability of Colombo under "transportation".** Please indicate the magnitude of importance of each category.

COMPARISON PAIR			**MORE IMPORTANT A OR B**		**LEVEL OF IMPORTANCE**				
A	**Vs**	**B**							
Coverage from the public transportation	Vs	Coverage from the private transportation	A	B	**1**	**3**	**5**	**7**	**9**
Coverage from the public transportation	Vs	Adequacy of the choice of transportation method	A	B	**1**	**3**	**5**	**7**	**9**
Coverage from the public transportation	Vs	Availability of adequate parking spaces within the city	A	B	**1**	**3**	**5**	**7**	**9**
Coverage from the private transportation	Vs	Adequacy of the choice of transportation method	A	B	**1**	**3**	**5**	**7**	**9**
Coverage from the private transportation	Vs	Availability of adequate parking spaces within the city	A	B	**1**	**3**	**5**	**7**	**9**
Adequacy of the choice of transportation method	Vs	Availability of adequate parking spaces within the city	A	B	**1**	**3**	**5**	**7**	**9**

Annexure 04: Questionnaire for Validation

Dear Sir/Madam,

I am a Post Graduate Student of University of Moratuwa. I do my research on Liveability in Sri Lanka, particularly in Colombo. I have Identified 72 indicator that will measure the liveability of Sri Lanka.

I kindly request you to express your opinion of the current level of these indicators in Colombo.

Even though, you do not know of any solid figures to support your answer, you may have a general or personal view of these factors. You can use it when you answer those questions.

Firstly, we need some general information about you. Then instructions are given with three examples on how to answer the questions on liveability indicators.

Thank you very much for your time and consideration in advance.

Kind Regards,

Maheshi

Maheshi Tennakoon.

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(Bsc.(Hons.) QS, CIMA Adv.Dip)

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General Information

Mark “X” in the relevant field and fill in the blank where necessary

Age : …….

Gender:……..

What is your occupation?

Government	
Non-Governmental	
Entrepreneur	
Other (Specify……...)	

What is your avg. monthly income? LKR…….

What is your highest educational qualification?

Less than O/L	
O/L qualification	
A/L qualification	
Graduate level qualification	
Post Graduate level qualification	

What part of urban area you represent?

Colombo MC	
Dehiwala Mount Lavinia MC	
Boralesgamuwa UC	
Kolonnawa UC	
Peliyagoda UC	
Wattala – Mabola UC	
Wattala PS	
Kelaniya PS	

Instructions

Example 01

Most importantly when you answer, view this as a question regarding your liveability in the city of Colombo.

If you are very satisfied with the availability of public hospitals in your residential area and you think it has secured your quality of life, day to day activities for you it may be "Desirable"

#No	*Livability Indicator*	*Desirable*	*Acceptable*	*Tolerable*	*Unacceptable*	*Undesirable*
1	***Availability of public hospitals per residential area***	***X***				

Example 02

You might not know how many terrorist act were happened during last year, but through social media, news and through other modes of information you may have a personal idea of that.

Therefore, if the terrorist activities do not have an impact on your quality of life, day to day activities for you it may be "Tolerable"

#No	*Livability Indicator*	*Desirable*	*Acceptable*	*Tolerable*	*Unacceptabl*	*Undesirable*
1	***Percentage of terrorist activities***			***X***		

Example 03

Seeing this as a "liveability indicator", if the availability of public transport modes do not satisfy your day to day requirements, it has a very negative impact on your day today life (wasting time or money) you can response this as " Undesirable"

#No	*Livability Indicator*	*Desirable*	*Acceptabl*	*Tolerable*	*Unaccept*	*Undesirab*
1	***Percentage of the public transport modes***			***X***		

In your opinion, what is the current level of following 71 liveability indicators in terms of the liveability of CCC?

No	*Livability Indicator*	*Desirable*	*Acceptable*	*Tolerable*	*Unacceptable*	*Undesirable*
1	***Number of recorded crimes per 10,000 population***					
2	***Percentage of terrorist activities***					
3	***Percentage of violent crimes***					
4	***Percentage of crimes recorded against women and children per year***					
5	***Percentage of unauthorized drug related crimes***					
6	***Percentage of trivial crimes***					
7	***Percentage of public spaces covered by surveillance cameras***					
8	***Percentage of services integrated via government authorities***					
9	***Percentage of public services available online***					
10	***Percentage of public using online government services***					
11	***Percentage of tax collected out of billed***					
12	***Unemployment Rate***					
13	***Average percentage of paid leave***					
14	***Percentage of professionals charged with tax***					
15	***Restaurants per 5000 population***					
16	***Percentage of historical buildings restored and reused***					
17	***Percentage of budgetary allocations for culture/sport activities***					
18	***Percentage of ecologically significant areas restored per year***					
19	***Occupancy in Hotels***					
20	***Concessionaries for low income families***					
21	***Welfare for elderly people***					
22	***Life expectancy at birth***					
23	***Risk to mental health***					
24	***Orphanages***					
25	***Per capita supply of water***					
26	***Household level coverage of water supply connection***					
27	***Percentage of non-revenue water***					
28	***Number of electricity interruptions per year***					
29	***Percentage of population with metered connection***					
30	***Availability of public hospitals per residential area***					
31	***Availability of private hospitals per residential area***					
32	***Number of healthcare professionals per 5000 population***					
33	***Number of in- patient beds per 5000 population***					
34	***Average response time for emergencies***					
35	***Percentage prevalence of vector borne diseases***					
36	***Percentage prevalence of water borne diseases***					
37	***Student-teacher ratio***					
38	***Percentage of school with access to ICT***					
39	***Percentage of private education facilities***					
40	***Percentage of student completing secondary education***					
41	***Percentage of school aged population enrolled in schools***					
42	***Frequency of municipal solid waste collection***					

43	***Percentage of treatment and reuse of waste water***					
44	***Percentage of city area with adequate public toilets***					
45	***Percentage of coverage of storm water drains***					
46	***Percentage of services availability in 300m walking distance***					
47	***Percentage of non-motorized transport modes***					
48	***Percentage of roads with pedestrian pavements***					
49	***Percentage of roads with dedicated bicycle tracks***					
50	***Percentage of traffic intersections with pedestrian crossings***					
51	***Percentage of city area coverage from public transport***					
52	***Number of multimodal transport hubs***					
53	***Percentage of the public transport modes***					
54	***Distance to nearest airport***					
55	***Level of CO2 concentration***					
56	***Level of SO2 concentration***					
57	***Quality of surface water bodies***					
59	***Annual average rainfall***					
60	***Annual average temperature***					
61	***Level of noise pollution***					
62	***Social acceptance in the residential area***					
63	***Average design approvals from authorities***					
64	***Average housing rent per month (affordability of housing)***					
65	***Percentage of housing available in the market (Choice of housing)***					
66	***Per capita availability of public and recreational places***					
67	***Per capita availability of green spaces***					
68	***Net density (Population)***					
69	***Percentage of mix land use out of the total land use***					
70	***Percentage of slum areas covered by basic services***					
71	***Percentage of shanty dwellers resettle per year***					

Performance of the liveability index

Please identify the status of following criteria regarding the performance of the liveability index.

Criteria	Outstanding	Satisfactory	Moderate	Remarks
Applicability				
User friendliness				
Clarity of terms				
clarity of assessment criteria				
Readability				
Understandability				

Annexure 05: AHP Calculations

Table 1 : The final list of liveability characteristics, attributes and indicators selected to construct the liveability index

#	*Livability Characteristic*	#	*Liveability Attribute*	#	*Liveability Indicator*
A	Proper planning of land use and affordable housing	A1	Mix use of land	A1.1	Percentage of mix land use out of the total land use
				A1.2	Net density
		A2	Use of underutilized land	A2.1	Percentage of slum areas covered by basic services
				A2.2	Percentage of shanty dwellers resettle per year
		A3	Housing	A3.1	Average housing rent per month (affordability of housing)
				A3.2	Percentage of housing available in the market (Choice of housing)
		A4	Public open spaces	A4.1	Per capita availability of public and recreational places
				A4.2	Per capita availability of green spaces
B	Balanced socio-economic environment	B1	Culture	B1.1	Percentage of budgetary allocations for culture/sport activities
				B1.2	Percentage of ecologically significant areas restored per year
				B1.3	Percentage of historical buildings restored and reused
				B1.4	Occupancy in Hotels
				B1.5	Restaurants per 5000 population
		B2	Governance	B2.1	Percentage of tax collected out of billed
				B2.2	Percentage of public services available online
				B2.3	Percentage of services integrated via government authorities
				B2.4	Percentage of public using online government services
		B3	Safety	B3.1	Percentage of public spaces covered by surveillance cameras
				B3.2	Percentage of violent crimes
				B3.3	Percentage of terrorist activities
				B3.4	Percentage of trivial crimes
				B3.5	Percentage of unauthorized drug related crimes
				B3.6	Percentage of crimes recorded against women and children per year
				B3.7	Number of recorded crimes per 10,000 population
		B4	Working Environment	B4.1	Unemployment Rate
				B4.2	Average percentage of paid leave
				B4.3	Percentage of professionals charged with tax
		B5	Well-Being and welfare	B5.1	Life expectancy at birth
				B5.2	Risk to mental health

#	*Livability Characteristic*	#	*Liveability Attribute*	#	*Liveability Indicator*
				B5.3	Concessionaries for low income families
				B5.4	Welfare for elderly people
				B5.5	Orphanages
C	Environment and character of the city	C1	Air quality	C1.1	Level of CO2 concentration
				C1.2	Level of SO2 concentration
				C1.3	Level of PM10 concentration
		C2	Water quality	C2.1	Quality of surface water bodies
		C3	Climate	C3.1	Annual average rainfall
				C3.2	Annual average temperature
		C4	Quality of architecture	C4.1	Average design approvals from authorities
		C5	Community Cohesion	C5.1	Social acceptance in the residential area
		C6	Prevalence of noise pollution	C6.1	Level of noise pollution
D	Quality and availability of services	D1	Solid waste management	D1.1	Frequency of municipal solid waste collection
		D2	Waste water management	D2.1	Percentage of city area with adequate public toilets
				D2.2	Percentage of treatment and reuse of waste water
				D2.3	Percentage of coverage of storm water drains
		D3	Water supply	D3.1	Per capita supply of water
				D3.2	Household level coverage of water supply connection
				D3.3	Percentage of non-revenue water
		D4	Healthcare	D4.1	Average response time for emergencies
				D4.2	Number of in- patient beds per 5000 population
				D4.3	Availability of public hospitals per residential area
				D4.4	Availability of private hospitals per residential area
				D4.5	Percentage prevalence of water borne diseases
				D4.6	Percentage prevalence of vector borne diseases
				D4.7	Number of healthcare professionals per 5000 population
		D5	Power supply	D5.1	Number of electricity interruptions per year
				D5.2	Percentage of population with metered connection
		D6	Education	D6.1	Percentage of school-aged population enrolled in schools
				D6.2	Student-teacher ratio
				D6.3	Percentage of school with access to ICT

#	Livability Characteristic	#	Liveability Attribute	#	Liveability Indicator
				D6.4	Percentage of private education facilities
				D6.5	Percentage of student completing secondary education
E	Proximity to local level services	E1	Service availability	E1.1	Percentage of services availability in 300m walking distance
		E2	Non-motorized transport	E2.1	Percentage of roads with dedicated bicycle tracks
				E2.2	Percentage of non-motorized transport modes
				E2.3	Percentage of traffic intersections with pedestrian crossings
				E2.4	Percentage of roads with pedestrian pavements
F	The connectivity to amenities and location-based attributes	F1	Mobility	F1.1	Percentage of city area coverage from public transport
				F1.2	Percentage of the public transport modes
				F1.3	Number of multimodal transport hubs
				F1.4	Distance to nearest airport

AHP Calculations of the liveability characteristics

Table.0.1: Pairwise comparison of the liveability characteristics

Liveability Characteristics	*Proper planning of land use and affordable housing*	*Balanced socio-economic environment*	*Environment and character of the city*	*Quality and availability of services*	*Proximity to local level services*	*The connectivity to amenities and location-based attributes*
Proper planning of land use and affordable housing	1.0000	0.3872	0.3333	0.3872	0.3872	0.3872
Balanced socio-economic environment	2.5826	1.0000	2.4568	2.5826	2.5826	2.5826
Environment and character of the city	3.0000	0.4070	1.0000	0.3872	0.3872	0.3872
Quality and availability of services	2.5826	0.3872	2.5826	1.0000	2.5826	2.5826

Liveability Characteristics	*Proper planning of land use and affordable housing*	*Balanced socio-economic environment*	*Environment and character of the city*	*Quality and availability of services*	*Proximity to local level services*	*The connectivity to amenities and location-based attributes*
Proximity to local level services	2.5826	0.3872	2.5826	0.3872	1.0000	2.5826
The connectivity to amenities and location-based attributes	2.5826	0.3872	2.5826	0.3872	0.3872	1.0000
Sum	14.3305	2.9559	11.5380	5.1314	7.3268	9.5222

The performance score of the liveability characteristics at the end of normalization is given in Table 3

Table 3 : Normalization of the liveability characteristics

Normalization	*Proper planning of land use and affordable housing*	*Balanced socio-economic environment*	*Environment and character of the city*	*Quality and availability of services*	*Proximity to local level services*	*The connectivity to amenities and location-based attributes*	*Sum*	*Performance Score*
Proper planning of land use and affordable housing	0.0698	0.1310	0.0289	0.0755	0.0528	0.0407	0.3986	0.0664
Balanced socio-economic environment	0.1802	0.3383	0.2129	0.5033	0.3525	0.2712	1.8585	0.3097
Environment and character of the city	0.2093	0.1377	0.0867	0.0755	0.0528	0.0407	0.6027	0.1004

Normalization	*Proper planning of land use and affordable housing*	*Balanced socio-economic environment*	*Environment and character of the city*	*Quality and availability of services*	*Proximity to local level services*	*The connectivity to amenities and location-based attributes*	*Sum*	*Performance Score*
Quality and availability of services	0.1802	0.1310	0.2238	0.1949	0.3525	0.2712	1.3536	0.2256
Proximity to local level services	0.1802	0.1310	0.2238	0.0755	0.1365	0.2712	1.0182	0.1697
The connectivity to amenities and location-based attributes	0.1802	0.1310	0.2238	0.0755	0.0528	0.1050	0.7684	0.1281

The consistency calculation of the liveability characteristics is given in Table 4.

Table0.2: Consistency Calculation Liveability Characteristics

Liveability Characteristics	*Proper planning of land use and affordable housing*	*Environment and character of the city*	*Quality and availability of services*	*Proximity to local level services*	*Balanced socio-economic environment*	*The connectivity to amenities and location-based attributes*	*Sum*	*Sum/ performance score*
Proper planning of land use and affordable housing	0.0664	0.0335	0.0874	0.0657	0.1199	0.0496	0.4225	6.3593
Balanced socio-economic environment	0.1716	0.2468	0.5827	0.4383	0.3097	0.3307	2.0798	6.7145
Environment and character of the city	0.1993	0.1004	0.0874	0.0657	0.1261	0.0496	0.6285	6.2569

Liveability Characteristics	*Proper planning of land use and affordable housing*	*Environment and character of the city*	*Quality and availability of services*	*Proximity to local level services*	*Balanced socio-economic environment*	*The connectivity to amenities and location-based attributes*	*Sum*	*Sum/ performance score*
Quality and availability of services	0.1716	0.2594	0.2256	0.4383	0.1199	0.3307	1.5456	6.8507
Proximity to local level services	0.1716	0.2594	0.0874	0.1697	0.1199	0.3307	1.1387	6.7102
The connectivity to amenities and location-based attributes	0.1716	0.2594	0.0874	0.0657	0.1199	0.1281	0.8321	6.4974
							Sum	39.3889

λ max = 39.3889/6 = 6.5648

Consistency Index = (6.5648-6)/ (6-1) = 0.1130

n	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
R I	0.00	0.00	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

Consistency Ratio = Consistency Index/ Randomized Index = 0.1130/1.25= 0.0904

A response to be considered consistence the consistency ratio must be less than 0.1. Hence, in this scenario the findings are considered consistence and the value of the performance score hence used as the determinant of the priority of the liveability characteristic.

AHP Calculations of the liveability attributes under proper planning of land use and affordable housing

Table 6 : Pair wise comparison of liveability attributes under proper planning of land use and affordable housing

Liveability Attributes	*Mix use of land*	*Use of underutilized land*	*Housing*	*Public open spaces*
Mix use of land	1.0000	2.4568	0.2307	0.3516
Use of underutilized land	0.4070	1.0000	0.1910	0.3333
Housing	4.3346	5.2348	1.0000	3.0000
Public open spaces	2.8439	3.0000	0.3333	1.0000
Sum	8.5855	11.6916	1.7551	4.6850

Table 0.3: Normalization of liveability attributes under proper planning of land use and affordable housing

Liveability Attributes	*Mix use of land*	*Use of underutilized land*	*Housing*	*Public open spaces*	**Sum**	**Performance Score**
Mix use of land	0.1165	0.2101	0.1314	0.0751	0.5331	0.1333
Use of underutilized land	0.0474	0.0855	0.1088	0.0711	0.3129	0.0782
Housing	0.5049	0.4477	0.5698	0.6403	2.1627	0.5407
Public open spaces	0.3312	0.2566	0.1899	0.2134	0.9912	0.2478

Table 0.4: Consistency calculation liveability attributes under proper planning of land use and affordable housing

Liveability Attributes	*Mix use of land*	*Use of underutilized land*	*Housing*	*Public open spaces*	*Sum*	*Performance Score*
Mix use of land	0.1333	0.1922	0.1247	0.0871	0.5374	4.0318
Use of underutilized land	0.0542	0.0782	0.1033	0.0826	0.3184	4.0695
Housing	0.5777	0.4095	0.5407	0.7434	2.2713	4.2009
Public open spaces	0.3790	0.2347	0.1802	0.2478	1.0418	4.2040

λ max = 16.5062/4 = 4.1265

Consistency Index = (4.1265-4)/ (4-1) = 0.0422

Consistency Ratio = Consistency Index/ Randomized Index = 0.0422/0.89= 0.0474

Table 0.5: Priority ranks obtained by the liveability attributes under proper planning of land use and affordable housing

Liveability Attributes	*Performance score after normalizing*	*Rank*
Mix use of land	0.1333	3
Use of underutilized land	0.0782	4
Housing	0.5407	1
Public open spaces	0.2478	2

Table 0.6: Performance Scores of liveability characteristics, attributes and indicators using AHP method

Number	**Liveability Element**	**Performance Score**
1	Balanced socio- economic environment	0.3097
1.1	Safety	0.4176
1.1.1	Number of recorded crimes per 10,000 population	0.2337
1.1.2	Percentage of terrorist activities	0.1982
1.1.3	Percentage of violent crimes	0.1604
1.1.4	Percentage of crimes recorded against women and children per year	0.1439
1.1.5	Percentage of unauthorized drug related crimes	0.1203
1.1.6	Percentage of trivial crimes	0.0827
1.1.7	Percentage of public spaces covered by surveillance cameras	0.0607
1.2	Governance	0.2240
1.2.1	Percentage of services integrated via government authorities	0.4085
1.2.2	Percentage of public services available online	0.3682
1.2.3	Percentage of public using online government services	0.1167
1.2.4	Percentage of tax collected out of billed	0.1067
1.3	Working Environment	0.1805
1.3.1	Unemployment Rate	0.5007
1.3.2	Average percentage of paid leave	0.1890
1.3.3	Percentage of professionals charged with tax	0.3102
1.4	Culture	0.1022
1.4.1	Restaurants per 5000 population	0.3582
1.4.2	Percentage of historical buildings restored and reused	0.2894
1.4.3	Percentage of budgetary allocations for culture/sport activities	0.1758
1.4.4	Percentage of ecologically significant areas restored per year	0.0980
1.4.5	Occupancy in Hotels	0.0787
1.5	Well-Being and welfare	0.0758
1.5.1	Concessionaries for low income families	0.3993
1.5.2	Welfare for elderly people	0.2763
1.5.3	Life expectancy at birth	0.1666
1.5.4	Risk to mental health	0.0953
1.5.5	Orphanages	0.0625
2	Quality and availability of services	0.2256

Number	Liveability Element	Performance Score
2.1	Water supply	0.3494
2.1.1	Per capita supply of water	0.4673
2.1.2	Household level coverage of water supply connection	0.3117
2.1.3	Percentage of non-revenue water	0.2210
2.2	Power supply	0.1461
2.2.1	Number of electricity interruptions per year	0.6342
2.2.2	Percentage of population with metered connection	0.3658
2.3	Healthcare	0.1315
2.3.1	Availability of public hospitals per residential area	0.2156
2.3.2	Availability of private hospitals per residential area	0.1943
2.3.3	Number of healthcare professionals per 5000 population	0.1429
2.3.4	Number of in- patient beds per 5000 population	0.1245
2.3.5	Average response time for emergencies	0.1163
2.3.6	Percentage prevalence of vector borne diseases	0.1042
2.3.7	Percentage prevalence of water borne diseases	0.1022
2.4	Education	0.1303
2.4.1	Student-teacher ratio	0.3223
2.4.2	Percentage of school with access to ICT	0.2264
2.4.3	Percentage of private education facilities	0.2179
2.4.4	Percentage of student completing secondary education	0.1270
2.4.5	Percentage of school-aged population enrolled in schools	0.1064
2.5	Solid waste management	0.1281
2.5.1	Frequency of municipal solid waste collection	1.0000
2.6	Waste water management	0.1146
2.6.1	Percentage of treatment and reuse of waste water	0.4332
2.6.2	Percentage of city area with adequate public toilets	0.3144
2.6.3	Percentage of coverage of storm water drains	0.2524
3	Proximity to local level services	0.1697
3.1	Service availability	0.8095
3.1.1	Percentage of services availability in 300m walking distance	1.0000
3.2	Non-motorized transport	0.1905
3.2.1	Percentage of non-motorized transport modes	0.5342
3.2.2	Percentage of roads with pedestrian pavements	0.2134
3.2.3	Percentage of roads with dedicated bicycle tracks	0.1492
3.2.4	Percentage of traffic intersections with pedestrian crossings	0.1032
4	The connectivity to amenities and location-based attributes	0.1281
4.1	Mobility	1.0000
4.1.1	Percentage of city area coverage from public transport	0.4103
4.1.2	Number of multimodal transport hubs	0.2533
4.1.3	Percentage of the public transport modes	0.2150
4.1.4	Distance to nearest airport	0.1214
5	Environment and character of the city	0.1004
5.1	Air quality	0.3259
5.1.1	Level of CO2 concentration	0.5222
5.1.2	Level of SO2 concentration	0.2611
5.1.3	Level of PM10 concentration	0.2167
5.2	Water quality	0.2023
5.2.1	Quality of surface water bodies	1.0000
5.3	Climate	0.1707
5.3.1	Annual average rainfall	0.7236
5.3.2	Annual average temperature	0.2764
5.4	Prevalence of noise pollution	0.1325

Number	Liveability Element	Performance Score
5.4.1	Level of noise pollution	1.0000
5.5	Community Cohesion	0.1033
5.5.1	Social acceptance in the residential area	1.0000
5.6	Quality of architecture	0.0653
5.6.1	Average design approvals from authorities	1.0000
6	Proper planning of land use and affordable housing	0.0664
6.1	Housing	0.5407
6.1.1	Average housing rent per month (affordability of housing)	0.6097
6.1.2	Percentage of housing available in the market (Choice of housing)	0.3903
6.2	Public open spaces	0.2478
6.2.1	Per capita availability of public and recreational places	0.5743
6.2.2	Per capita availability of green spaces	0.4257
6.3	Mix use of land	0.1333
6.3.1	Net density	0.6974
6.3.2	Percentage of mix land use out of the total land use	0.3026
6.4	Use of underutilized land	0.0782
6.4.1	Percentage of slum areas covered by basic services	0.6385