Master Thesis Exposé

Life Cycle Sustainability Assessment of Products for Small Businesses – A Literature Review

Supervisor – Dr. Katrin Zulauf

Submitted by Rahul Suthar

ABSTRACT

Title – Life cycle sustainability assessment of products for small businesses – a literature review

Background - In present times, sustainability is becoming imperative for all types of business organizations, across all industries. Sustainability in business organizations is associated with creating long-term value by having positive impacts on society and the environment. To reach sustainability goals, first businesses must assess their current operations. Sustainability assessment in business organizations can be performed in a variety of ways but focusing on products has proved to be a good start for these types of organizations. Products throughout their entire life cycle – from the extraction of raw material, production, usage to ultimate disposal have a profound impact on society and the environment. Life cycle sustainability assessment (LCSA) is an evaluation framework that assesses product sustainability performance along the product's entire life cycle journey. This framework is comprehensive and reliable because it considers all three sustainability dimensions of the triple bottom line approach i.e. environmental, social, and economic dimensions along the product's total life cycle. LCSA (Life Cycle Sustainability Assessment) consists of three components viz. LCEA (Life Cycle Environment Assessment), SLCA (Social Life Cycle Assessment), and LCCA (Life Cycle Costing Assessment).

Aim – LCSA is a broad and complex topic. Different aspects related to LCSA are studied in the past but there is not enough concise literature available about LCSA for small businesses. The primary research questions of this review are what kind of issues are faced by small businesses in applying the LCSA framework and how can they simplify and successfully implement LCSA in real life. The key aim of this thesis is to provide a synthesized review of existing literature to find answers to the research questions.

Methodology – This literature review is a systematic type of analysis of extant literature. The research methodology is primarily based on a research paper published by Snyder, H. (2019). The overall methodology consists of four phases viz. design phase, conduct phase, analysis phase, and writing the review phase. The relevant literature is obtained from the Web of Science database by inserting suitable queries in the search bar of the database. Then, given literature is filtered out using relevant factors, and only relevant literature related to this research topic is

selected. Finally, selected research papers are analyzed and useful information is extracted from these papers.

Contributions – This literature review will have significant academic, practical, and social contributions. The review aims to synthesize previously studied literature in such a way that it creates unique value for business owners and potential researchers. The research will not only benefit small business owners in identifying sustainable issues but also their respective stakeholders throughout the product value chain.

Keywords – Life Cycle Sustainability Assessment, Life Cycle Assessment, Life Cycle Costing Assessment, Social Life Cycle Assessment, Small Businesses

TABLE OF CONTENTS

List of Abbreviations

LCA – Life Cycle Assessment

LCC – Life Cycle Costing

LCCA – Life Cycle Costing Assessment

LCEA – Life Cycle Environment Assessment

LCSA – Life Cycle Sustainability Assessment

SLCA – Social Life Cycle Assessment

TBL – Triple Bottom Line

WoS – Web of Science

List of Figures

List of Tables

1. INTRODUCTION

Our common future, also known as Brundtland Report published in 1987 by the World Commission on Environment and Development introduced the concept of sustainable development and proposed long-term strategies about how sustainability could be achieved. According to the report, "Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland et al. 1987). Sustainability and sustainable development are seen in different ways by different people (Johnston et al. 2007) but sustainability in general from a business point of view is a holistic approach that considers three interdependent dimensions: environmental, economic, and social (Dyllick et al. 2002). Increasing population along with a tremendous rise in anthropogenic activities like rapid urbanization, deforestation, inefficient land use, industrialization, etc has raised serious sustainability questions in front of us (Kumar et al. 2020; Arora et al. 2020). In response to this urgent call for sustainability, the United Nations in 2015 introduced "The Sustainable Development Goals" comprising 17 key goals and 169 specific targets designed to achieve a better and more sustainable future for all (Salvia et al. 2019). The 17 goals are at the heart of the 2030 Agenda for sustainable development, adopted by all UN member states for global peace and prosperity. To achieve sustainable goals, governments, businesses, civil societies, and individuals must come and work together (United Nations. 2020).

It is well recognized that sustainable development would only be successful if there are strong commitment and contribution from the business sector side (Pedersen et al. 2018) and the importance of sustainability in business organizations is growing day by day (Bergquist et al. 2017). Small businesses play a critical role in the economic and social development of countries (Edmiston et al. 2007; Ribeiro-Soriano et al. 2017) and they have an important role to play in achieving sustainability by promoting sustainable growth, providing employment opportunities and good work-life to all, reducing income inequalities, innovating and developing value-based solutions for society (OECD. 2017). Sustainability assessment is a methodology that helps decision-makers decide which set of actions they should take to make their organizations more sustainable (Devuyst et al. 2001; Sala et al. 2015). There are various assessment tools available for businesses to measure sustainability performance (Singh et al. 2009) and one important way

through which small businesses can assess their sustainability is focusing on their products (Moreno et al. 2011). Consumers are nowadays becoming more responsible and are demanding more sustainable products (Zamagni et al. 2013). Products throughout their entire life cycle – from the extraction of raw material, production, usage to ultimate disposal have a profound impact on society and environment (Bevilacqua et al. 2017; Valdivia et al. 2013) and sustainability can be measured along the whole life cycle of a product taking into consideration various indicators (He et al. 2019).

The triple bottom line (TBL) approach is an excellent framework that incorporates three dimensions of sustainability performance: environmental, social, and financial (Slaper et al. 2011). Sustainability of products can be assessed through a variety of ways, and one of them is Life Cycle Sustainability Assessment (LCSA), which studies environmental, economic, and social dimensions of products through products' entire life cycle journey (Finkbeiner et al. 2010). LCSA consists of three major assessment tools i.e. LCEA (Life Cycle Environment Assessment), LCCA (Life Cycle Costing Assessment), and SLCA (Social Life Cycle Assessment). LCEA assesses the environmental impact of the product, LCCA is an assessment tool for the economic evaluation of the product and SLCA evaluates the societal impacts of the product throughout its total life cycle (Kloepffer et al. 2008). It is stated that when three tools are simultaneously applied to products, these tools can provide more relevant results in the overall context of sustainability (Parent et al. 2013).

Life cycle thinking has gained significant importance over the past years (Azapagic et al. 2004). "The International Journal of Life Cycle Assessment" (Int J Life Cycle Assess) is a dedicated journal devoted entirely to life cycle assessment and its related topics. A research paper published by (Fauzi et al. 2019) shows that publications related to LCSA are steadily growing in the past years. From 2007 to 2018, the Authors found 124 papers by putting the keywords "Life Cycle Sustainability Assessment" and/or "LCSA", into both the Scopus database and Google Scholar. Also, one research article by (Zamagni, 2012) shows that between 1974 and 2010, around 600 articles were published that included the terms "sustainability" and "LCA". This shows that LCSA as a concept has been widely studied and applied.

The concept is broad and has large implications, and in the last decade, various researchers studied different aspects related to LCSA. Different aspects include a brief introduction of LCSA and its related topics (Kloepffer, W. 2008; Zamagni et al. 2012), an In-depth elaborative study of LCA methodology (Heijungs et al. 2002), a study of the specific part of LCSA (Jørgensen et al. 2008; Rebitzer et al. 2003; Rebitzer et al. 2004), application prospects of LCSA for different types of products (Cabeza et al. 2014; Zhou et al. 2007; Atilgan et al. 2016; Stamford et al. 2004), historical & current developments of LCSA, anticipated future developments of LCSA (Finnveden et al. 2009; Guinee et al. 2011; Onat et al. 2017), and possible limitations related to LCSA (Reap et al. 2008; Pizzirani et al. 2014).

LCSA in small businesses, as compared to large businesses has not been popular despite increasing interest and importance of sustainability in small businesses (Baumann et al. 2012; Frankl et al. 1999; Rex et al. 2004). The research paper by (Kurczewski et al. 2014) shows reasons why small businesses are unable to apply life cycle thinking and LCA-related approaches in their strategy and operations. Reasons include costs of LCA assessment, costs of change in routine practices, complicated methodological assessment tools, shortage of qualified staff to carry out actual LCSA, and related assessments. In a research publication by (Rubik et al. 2000), the authors concluded that large businesses as compared to small businesses have strong resources (financial, human, research and development) to apply LCSA and related tools in their organizations. LCSA and related techniques are not that much widely used in small businesses, but their use is becoming popular and common nowadays (Schischke et al. 2012; Ansems et al. 2005).

This research paper aims at finding out issues faced by small businesses while applying LCSA related principles and how can they simplify and successfully implement LCSA. This research will not only benefit small businesses but also their different stakeholders throughout the product value chain.

The Exposé is divided into eight chapters as follows:

1. Introduction – Introducing the research context and thesis overview
2. Theoretical framing – Theories fundamental to conduct this review.

3. Research propositions – Research propositions related to this literature review
4. Methodology – Methodology which is applied to carry out this review
5. Expected contributions – Expected academic, practical, and social contributions of this review
6. Thesis chapters overview – Overall structure of the actual thesis
7. Workplan – The work plan of the thesis until its submission
8. References – References used in conducting this Exposé

2. THEORETICAL FRAMING

The purpose of this section is to introduce theoretical frameworks, which will form the foundation of this research paper. There will be three key theoretical models viz. TBL framework, Stakeholder theory of Corporate Social Responsibility, and Discounting theory. There will be no alternative theories, but since this research topic is broad and complex while conducting the actual research, any other alternative theory can be found in the future. First, each of the theoretical frameworks will be introduced, then their justification of choices will be presented, then their relationship with the actual research paper and how they will be implemented in the research paper will be established.

2.1. Triple Bottom Line (TBL) Framework

TBL is an accounting framework that considers financial, environmental, and social factors to evaluate a firm's sustainability performance. It is also called PPP (People, Planet, Profit) model (Slaper et al. 2011). Sustainability in business shows that apart from profit maximization, firms have social and environmental obligations (Dyllick et al. 2002). Freer Spreckley (1981) introduced the idea of TBL in a paper in which he specified what organizations should incorporate in their performance evaluation. He said firms should measure and report on financial performance, social wealth creation, and environmental responsibility. John Elkington (1997) in his book said It's a bottom line that continues to measure profits, but also measures the organization's impact on people and the planet. TBL is a way of expressing a company's impact

and sustainability on both a local and a global scale. The United Nations 2005 World Summit Outcome Document clarifies sustainability. It refers to the "interdependent and mutually reinforcing pillars" of sustainable development as economic development, social development, and environmental protection.

The TBL approach forms the foundation of the sustainability of business operations (Gimenez et al. 2012).

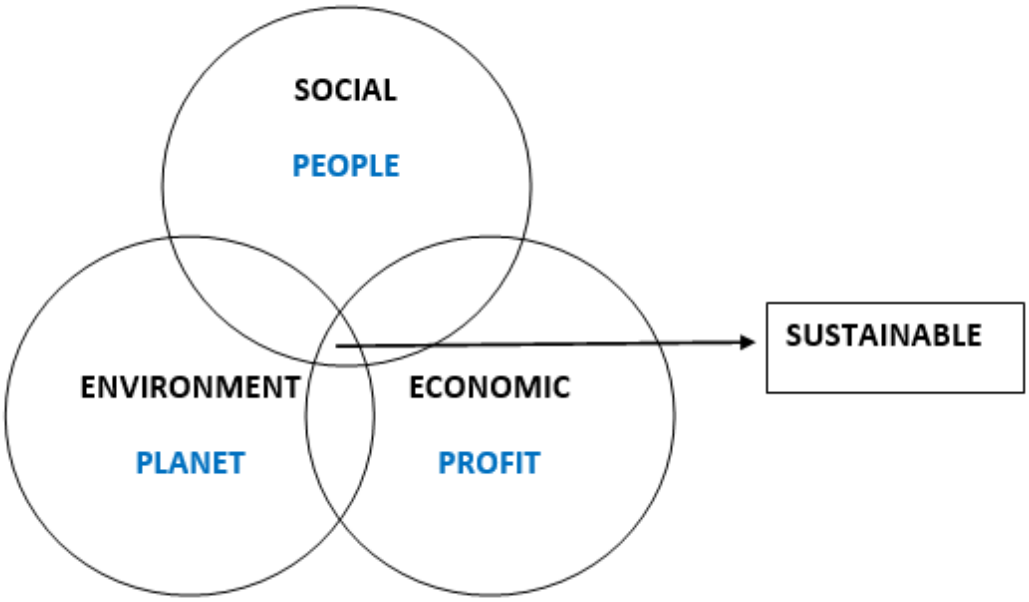

Figure 1. TBL framework. Adapted from (Chen et al. 2014).

LCSA = LCEA + SLCA + LCCA……equation 1.

Equation 1. is a standard equation of Life cycle sustainability assessment. LCSA consists of three components viz. LCEA (Life Cycle Environment Assessment), SLCA (Social Life Cycle Assessment), and LCCA (Life Cycle Costing Assessment). This integrated assessment framework is based on three sustainability pillars (environment, social, and economic) and each component is constructed on each sustainable pillar of the TBL (Sala et al. 2013).

2.1.1. Life Cycle Environment Assessment (LCEA)

Also known as Life Cycle Assessment (LCA), LCEA is an assessment framework that analyses the environmental impacts and resources used along a product's entire life cycle, i.e. from raw material extraction, production, usage to disposal of the product (Finnveden et al. 2009). It represents the environmental dimension of sustainability in LCSA.

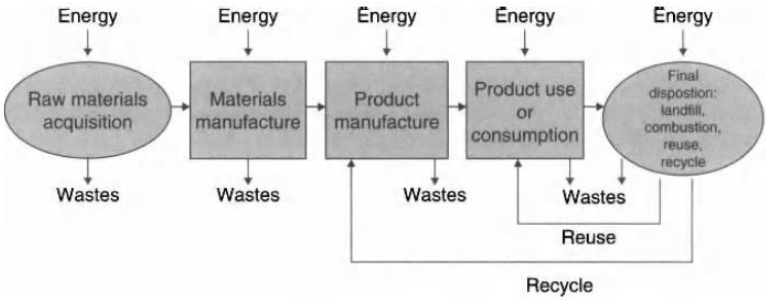

Figure 2. The simple life cycle of a product. Retrieved from (Curran et al. 2012).

Figure 2. represents a simple diagram of the life cycle of a product. A product passes through a variety of processes before it is ready for use to the final consumer. A consumer uses the product until the useful life of the product, and finally, he disposes of it. In all the processes, there is either consumption of resources (it can be in form like raw material, energy, etc) or emissions of waste (like the release of toxic water, release of harmful gases) or both at the same time. These emissions and consumptions contribute to a wide range of impacts, such as climate change, pollution, eutrophication, acidification, human toxicity, depletion of resources, water use, land use, noise, and radiation among others (Rebitzer et al. 2004).

2.1.2. Social Life Cycle Assessment (SLCA)

SLCA integrates the societal aspects of LCSA. It is based on the social pillar of the TBL. There are various stakeholders involved in the life cycle journey of a product and this assessment tool collects data on social issues associated with different stakeholders and reports on the overall social aspects of sustainability (Wu et al. 2014). According to (UNEP et al. 2009), there are five key stakeholder categories, which include workers, local community, society, consumer, and other value chain actors.

Worker	Other value chain actors
• Freedom of association and collective bargaining • Child labor • Fair salary • Working hours • Forced labor • Equality/ discrimination • Health and safety • Social benefits and social security	• Respect for intellectual property rights • Promoting corporate social responsibility • Healthy competition • Suppliers relations • End-of-life • Feedback mechanism
Local Community	
• Access to material resources • Access to immaterial resources • Delocalization and migration • Cultural heritage • Safe and healthy living conditions	• Indigenous people's rights • Community engagement • Local employment • Secure living
Society	**Consumers**
• Public commitment on sustainable development issues • Contribution to economic development • Prevention and mediation of armed conflict • Corruption • Technological development	• Health and safety • Feedback mechanism • Consumer privacy • Transparency • End-of-life responsibility

Figure 3. Considered stakeholder groups and subcategories in SLCA recommended by the UNEP/SETAC (2009) guidelines for S-LCA. Adapted from (Mair-Bauernfeind et al. 2020).

In figure 3., each stakeholder has various impact subcategories through which social positive and negative data can be gathered. Information provided from subcategories can be used to assess the overall social impact using various methods (Benoît et al. 2010). In SLCA, data types and collection methods always remain questionable (Dreyer et al. 2006; Wu et al. 2004).

2.1.3. Life Cycle Costing Assessment (LCCA)

LCCA is a framework that evaluates economic burdens derived from a product during its life cycle. The cost evaluation can be done from point of view of two players i.e. producer and consumer. From a producer's point of view, it involves the total manufacturing costs and from a consumer point of view, it means how costly is the product to the consumer during its total life until it is finally disposed of (Finkbeiner et al. 2010). LCCA is concerned with reducing the

overall cost of acquiring, ownership, and disposal of the products from the consumer point of view so that manufacturer can disclose cost savings benefits arising from it to the consumer (Asiedu et al. 1998).

2.2. Stakeholder Theory of Corporate Social Responsibility

Stakeholder theory states that a firm should create value for all stakeholders, not just shareholders (Freeman et al. 2010). Stakeholders are the ones who have a direct or indirect stake in the business. Stakeholders can be divided into two groups: 1. *Internal stakeholders* are the ones who are directly involved in the firm's operations. Examples include shareholders, employees, managers, etc. 2. *External stakeholders* are the ones who are indirectly involved in the firm's operations. Examples include customers, society, government, suppliers, media, creditors, media, pressure groups, etc (Freeman et al. 2001).

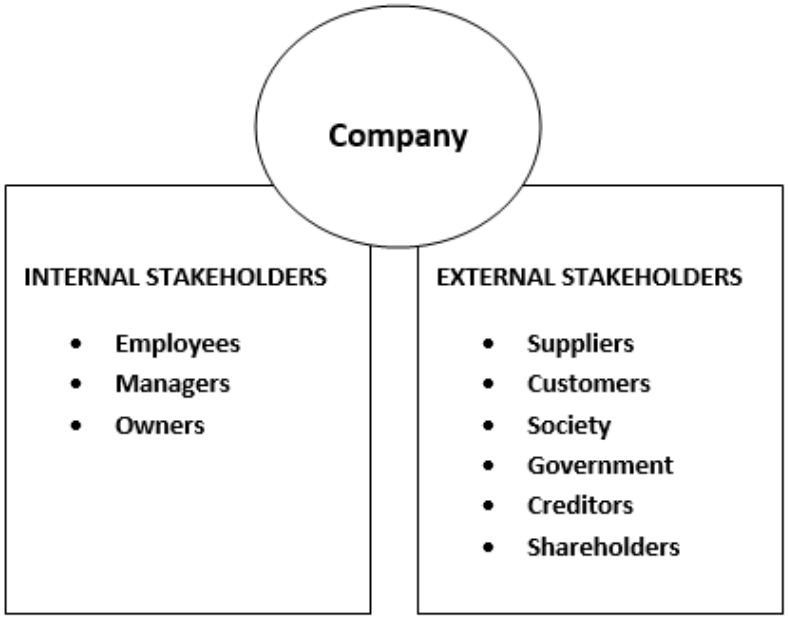

Figure 4. Various stakeholders of a company. Adapted from (Gurzawska et al. 2017)

R. Edward Freeman's Stakeholder theory

R. Edward Freeman (1984) in his famous book "*Strategic management: A Stakeholder Approach*" introduced the concept of stakeholders, emphasized the importance of stakeholders, and gave ideas on how a firm can achieve long term goals considering various stakeholders.

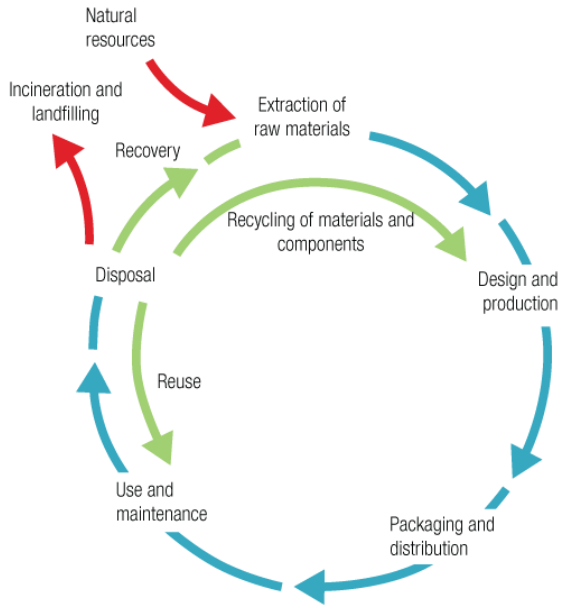

Figure 5. Product life cycle diagram. Obtained from (UNEP. 2019)

Stakeholder theory is at the center of the life cycle sustainability assessment of products (Kozlowski et al. 2012). In LCSA of small businesses, the process starts from raw material extraction, where the assessing firm has to collect data from the raw material producers (suppliers), incoming raw materials are transformed into the intended product through a production process (producer), then the final product is transported to distributors and retailers, and then it is finally sent to the customer. The customer uses the product and then disposes of it. In the whole process, there are a lot of stakeholders involved and conducting the assessment requires inputs from respective stakeholders (Halog et al. 2011).

LCEA aims at collecting input data from various stakeholders that are directly or indirectly concerned with environmental impacts, but challenges always remain about the quality and reliability of data (Guinée et al. 2002). Although various dedicated databases of Life cycle assessment are available, it is still insufficient, and global alliances are emerging to solve problems related to databases (Curran, M. A. 2012). LCCA helps in estimating the overall cost

of ownership from consumers or producers' point of view. There are a lot of methods already available to estimate the costs and revenues of products (Heinzle et al. 2007). As compared to LCEA, LCCA is less costly. SLCA accounts for assessing the impact of products on society. The societal impacts can be measured by analyzing the effects of stakeholders at local, national, and global levels (GRI, 2002). Measuring social impacts involves different dimensions to choose from and which dimensions to include in the assessment always remain a question and depend on a lot of factors (Petti et al. 2018).

2.3. Discounting

Discounting is a process to determine the present value of a payment that is to be received or to be paid in the future (Boardman et al. 2017).

Present Value of Discounted Cash Flows

$$PV = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \frac{CF_3}{(1+r)^3} + \cdots + \frac{CF_n}{(1+r)^n} \quad \text{.....equation 2.}$$

Where CF equals cash flow for a period

r equals the discount rate

n equals the number of periods

The future cash flows *(CF_n)* are discounted at interest rate *r* till period *n* to get the present value. This concept is also called the Time value of money. Money has time value, which means that *x* amount is more valuable now than *x* amount in the future if *r*>0.

In the context of the LCSA of products, discounting is used in LCCA. LCCA seeks to optimize the cost of acquiring, owning, and operating the product over its useful life by attempting to identify and quantify all the significant costs involved in the life cycle, using the present value technique. LCCA aims to minimize the overall costs (Woodward et al. 1997).

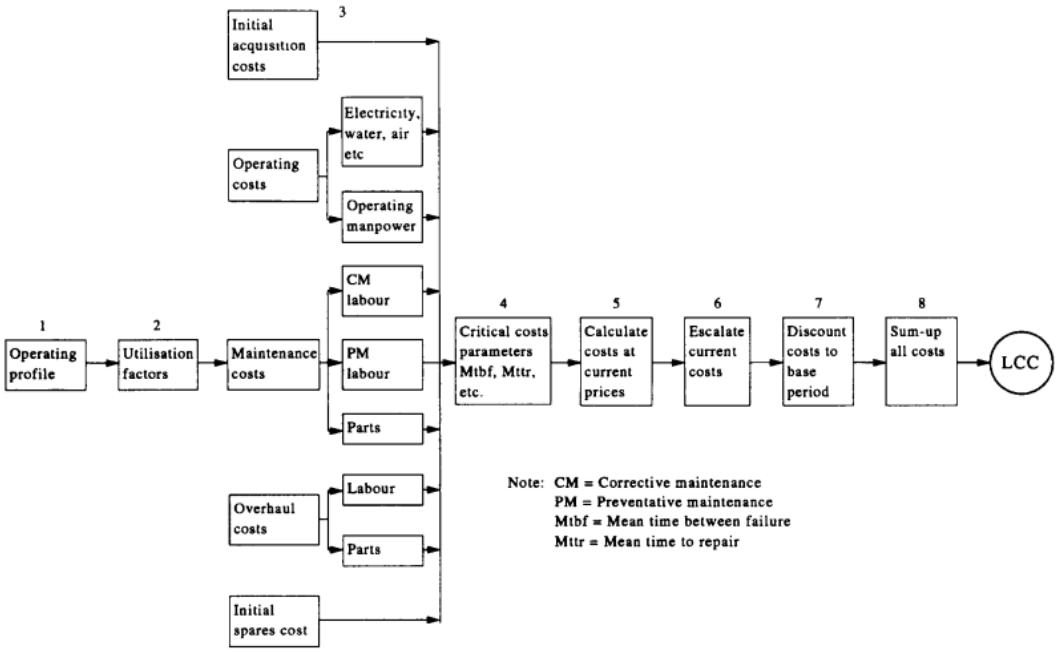

Figure 6. Life Cycle Costing Formulation. Adapted from (Kaufman et al. 1969)

In the research paper published by (Kaufman et al. 1969), researchers significantly contributed to the LCC methodology, whereby they developed a systematic framework. The framework consists of eight key steps – 1. Establishing the profile, 2. Establishing the utilization factors, 3. Identify all cost elements, 4. Determine the critical cost parameters, 5. Calculate all costs at current prices, 6. Increase current costs at estimated inflation rates, 7. Discount all costs to the present base time and 8. Add up all discounted costs to get a total present value. In figure 5. All steps can be seen and different costs that can occur in the life cycle are also presented. The framework was primarily developed to evaluate different capital asset options for the purchasing department of the organization.

There are a variety of ways to conduct an LCCA depending on industry type and are firm specific (Korpi et al. 2008). LCCA attempts to identify total costs across the life cycle, and some costs are borne by different stakeholders with very different perspectives of the costs and potentially conflicting goals. It is conducted to inform decision making to one specific actor, but data can be used by different actors as well (Swarr et al. 2011). The main problem in LCCA evaluation is data estimation and allocation of costs to different activities in the life cycle. This topic is widely studied in LC related methods (Schaltegger et al. 2017). Discounting in the

context of small businesses seems practical and easy to implement. LCCA can be conducted from the producer's point of view and consumer point of view. LCCA from the producer point of view analyses whether any project/product is economically sustainable or not (US EPA, 2010). In this analysis, in period t_0 (initial period), the initial cash flow is negative, meaning the producer will be spending money for the production, but in future periods, the producer will receive revenue (positive cash flows) from customers. If the sum of positive discounted cash flows is greater than the sum of negative discounted cash flow, then it can be said that the product is sustainable. Here the objective of the producer is to maximize the difference to get more profits.

LCCA from a consumer point of view has a different purpose. Here the purpose is to communicate to the customer how much the product will cost from the entire life cycle approach (Elsayed, E. A. 2014; Woodward et al. 1997). Here the objective of the producer is to minimize life cycle total costs (from the consumer point of view) so that producers can communicate cost savings ideas to consumers. The producer can minimize the cost in two ways - first by increasing the time for which the product will last (durability), the other is by reducing the related costs of products in its usage and disposal phase. LCC is used as a marketing tool for producers, producers communicate to the buyers that their products are more sustainable in economic terms (after doing LCCA of their products). It becomes simpler and more practical for buyers to evaluate and make informed decision making while choosing products from various other product alternatives (Brown et al. 1979).

3. RESEARCH PROPOSITIONS

A research proposition is a statement about topics that may be judged as true or false in an observable situation (Cooper et al. 2014). This thesis is supported by several key propositions.

Several researchers in the past convincingly argued that sustainability is critical for business organizations in current times (Schaltegger et al. 2017). A recent study by (Bonini et al. 2014) argues that global corporate trends towards sustainability are changing rapidly and sustainability is becoming a more integral and strategic part of the businesses. Implementation of sustainable strategies in business provides not only competitive advantages to firms but also better financial

returns (Sharma et al. 2010; Engardio et al.2007; Esty et al. 2009; Hart et al. 1995). This seems that business organizations in the future will move towards more sustainable strategies and will adopt green practices. This leads to the formulation of this proposition:

P1: Sustainability is critical for business in present times

Consumers in all parts of the world are becoming more aware of their environmental impacts. They are demanding more green products than before, moreover, studies conducted in several regions of the world suggest that they are willing to pay more for green products (Laroche et al. 2001; Kang et al. 2012; Nomura et al. 2004). This explains that the demand for green products is going to increase in near future, and to take advantage of that, businesses have to make their products greener. This leads to the following proposition:

P2: Customers are demanding greener products

Small businesses face various resource constraints as compared to large firms and do not take proactive steps towards sustainability (Del Brìo et al. 2003). In the short run, a small business faces risks of survival (Ye et al. 2013), but in the long run, integrating sustainable policies gives more edge to these types of firms (Dillard et al. 2010). This conveys that more and more businesses are adopting long term strategic business models, in which sustainability plays a central role. For this reason, the following proposition is formulated:

P3: Sustainability creates long term value for small businesses

LCSA as compared to other sustainability assessment frameworks is more comprehensive because it considers all three sustainability dimensions throughout the product's total life cycle (Kloepffer et al. 2008). The assessment of the entire life cycle implies that no processes connected with the product system boundary directly or indirectly are missed out during the evaluation process. Governments all around the world are recommending the use of LCSA and are adopting LCSA related principles in their environment policies (Guinee et al. 2011). Although there are various limitations of LCSA, effective LCSA within a defined goal and scope of the study can yield impressive results. The following proposition is established in the context of the above information:

P4: LCSA is a more comprehensive sustainability assessment framework than other sustainability assessment frameworks

There are various reasons why LCSA despite being a holistic sustainability assessment framework, is not being used that much in small businesses (Kurczewski et al. 2014). One of the reasons is its complexity. LCSA involves gathering data of various sub-product systems or product-processes along the product life cycle. Primary data collection is too costly and secondary data collection has a higher degree of risk of incorrect allocation to the product that needs to be studied (Curran et al. 2012). Also, there is a lack of guidance for small business owners to implement LCSA into their businesses (Suhariyanto et al. 2017; Kurczewski et al. 2014). It is argued by researchers in a paper published by (Witczak et al. 2014) that LCSA application in small businesses requires a special approach taking into consideration various factors that are specific to small businesses. Therefore, it can be argued that the critical problem in the application of LCSA is its complexity, if LCSA becomes simpler then it can be said that its usage will increase proportionately. This leads to the following proposition:

P5: Simplified version of LCSA in the context of small businesses can significantly increase the use of LCSA among small businesses

3.1. Relevant Literature Review

The table consists of the most important literature to be used in this thesis.

Table 1. Literature Review Table

Title	**Author(s)**	**Year of Publication**	**Journal/ Textbook**	**Content/ Relevance**
Life cycle sustainability assessment of products	Walter Kloepffer	2008	The International Journal of Life Cycle Assessment	A concise introduction of LCSA as a topic and its relevance
Towards Life	Matthias	2010	Sustainability	In depth

Cycle Sustainability Assessment	Finkbeiner, Erwin M. Schau, Annekatrin Lehmann, Marzia Traverso			discussion of each components of LCSA
Life Cycle Assessment: Theory and Practice	Michael Z. Hauschild, Ralph K. Rosenbaum, Stig Irving Olsen	2018	The International Journal of Life Cycle Assessment	In-depth theory and practice aspects of LCEA/LCA
Life Cycle Assessment Handbook: A Guide for Environmentally Sustainable Products	Mary Ann Curran	2012	Textbook	LCA in the context of product sustainability
Social Life Cycle Assessment: An Insight	Muthu, Subramanian Senthilkannan	2015	Textbook	In-depth study of SLCA
Life cycle thinking in small and medium enterprises: the results of research on the implementation of life cycle tools in Polish SMEs—part 1: background and	Przemyslaw Kurczewski	2013	The International Journal of Life Cycle Assessment	Study of Life cycle thinking in SMEs

framework				
Life Cycle Assessment: Past, Present, and Future	Jeroen B. Guinée, Reinout Heijungs, Gjalt Huppes, Alessandra Zamagni, Paolo Masoni, Roberto Buonamici, Tomas Ekvall, Tomas Rydberg	2011	Environment Science & Technology	Historical background of LCSA, its present application, and future prospects
Life Cycle Management	Guido Sonnemann, Manuele Margini	2015	The International Journal of Life Cycle Assessment	Improving products and services while enhancing the overall sustainability performance of a business and its value chains
Determinants of a sustainable new product development	Harald Gmelin, Stefan Seuring	2014	Journal of Cleaner Production	Linking sustainability and new product development by providing a conceptual framework

4. METHODOLOGY

Literature reviews are fundamental for knowledge building and help identify areas in which further research would be beneficial (Rowley et al. 2004). LCSA as a concept is broad and complex, and a considerable amount of literature is available in this field. This literature review will be systematic type, which means existing literature will be synthesized in a systematic way (Davis et al. 2014). The primary research questions of this review as identified earlier are "what kind of issues are faced by small businesses in applying LCSA framework" and "how can they simplify and successfully implement LCSA in real life".

The methodology of this literature review is primarily based on a research article published by (Snyder et al. 2019). In the paper, the authors gave an overview and guidelines for conducting a literature review in studies related to business context. The process of conducting a literature review is divided into four phases viz. 1. Design phase, 2. Conduct phase, 3. Analysis phase, 4. Writing phase. Each phase is discussed in detail below:

1. **Design Phase -** The design phase is the first and preliminary step of the process. The topics that need to be answered in this phase are identifying the needs and potential contributions of the review, recognizing the potential audience of the review, finding a specific purpose, selecting an appropriate method to use, defining the search strategy for the review.
2. **Conduct Phase** – The questions that need to be answered in this phase are developing a search plan, creating a strategy of selecting relevant articles, assessing the quality of selected articles.
3. **Analysis Phase** – This phase is concerned with analyzing the data previously collected. The key areas to focus on here are abstracting useful information from selected articles to fulfill the specific objective, documenting, and reporting the overall procedure in the review.
4. **Writing Phase** – The final phase is all about structuring and writing the actual review. The key points to be answered here is establishing enough motivation for the reader, drawing standards of reporting, filtering the information that needs to be documented on the final review and communicating the conclusion and results.

4.1. Search Strategy and Data Collection

Collecting data in the literature review is a complicated and long process. It starts from searching the extant literature, screening for inclusion and exclusion of articles, assessing the quality based on various indicators, extracting data into a well-managed database, and finally analyzing the data (Templier et al. 2015). In this review, the "Web of Science" database is chosen as a reliable source for the data collection process. The search strategy of the literature review is established on basis of the research questions, relevant keywords are identified from research questions, from relevant keywords, search queries are constructed and tested in the journal search engine to look for suitable literature.

Research questions of this literature review are as follows:
Q1. What kind of issues are faced by small businesses in applying the LCSA framework?
Q2. How small businesses can simplify and successfully implement the LCSA framework in real life?

Relevant keywords identified from research questions include "issues", "small businesses", "LCSA". Constructing effective search query is difficult since different researchers define different concepts in different ways, e.g. researchers studying issues encountered in applying LCSA in a small firm and researchers studying problems faced by small businesses in applying LCA are the same. Therefore, search queries must be carefully composed. To figure out these kinds of problems, a conceptual framework is developed. The conceptual framework essentially presents different concepts determined from the research question and looking for related terms of concepts. The conceptual framework of this review is below:

Related terms	**Concept 1 (LCSA)**	**Concept 2 (Issues)**	**Concept 3 (Small businesses)**
1.	Life Cycle Sustainability Assessment	Problems	SMEs
2.	Life Cycle Assessment	Concerns	Small and Medium Enterprises
3.	Life Cycle Thinking	Complications	Small Firms

4.	Life Cycle Analysis	Obstacles	Small Companies
5.	Life Cycle Evaluation	Troubles	Small Corporations
6.	Social Life Cycle Assessment	Challenges	Small Organizations
7.	Life Cycle Costing Assessment	Limitations	Small and Medium Sized
8.	Environment Assessment	Drawbacks	
9.	Life Cycle Management	Hurdles	
10.	Product Life Cycle		

Table 2. The Conceptual Framework

In Table 2. The conceptual framework exhibits three key concepts and related terms of each concept.

Search queries are fundamentally based on the conceptual framework. Different databases have different search rules, and in this specific case, the search rules (Capitalization, Boolean search operators, Phrase searching, Limiters, Parentheses, etc.) and recommendations (Truncation, Wildcards, Plural terms, etc) provided by the WoS database were taken into consideration while constructing search queries.

Initially, it was thought that there would be only one search query for this review, but after initial trials and errors, it was found that a single search query can't deliver the required outcomes. Therefore, two different search queries were designed. The first query focuses on LCSA and its related issues and the second query concentrates on LCSA and small business prospects.

The first query after several trials is identified as below:

[("Life cycle sustainability assessment" or "life cycle assessment" or "life cycle thinking" or "life cycle evaluation" or "life cycle analysis" or "social life cycle assessment" or "life cycle costing assessment" or " environment assessment" or "life cycle management") AND ("problem$" or "concern$" or "complication$" or "obstacle$" or "trouble$" or "challenge$" or "limitation$" or "drawback$" or "hurdle$" or "issue$")]

In this review process, the basic search function of the WoS is adopted. Search query related to concept 1 (LCSA) was inserted in the first row of the database and it was searched using the

topic field (Title, Abstract, Author Keywords, Keywords Plus) function. The search query related to concept 2 (Issues) was inserted in the second row and it was searched using the Title field function. Both concept 1 and concept 2 were joined using “AND” as a Boolean operator.

The initial search query inserted in the database gave a total of 702 results. Only research literature from 2005 onwards was selected, the amount of literature reduced to 640 results. The majority of the literature was in the English language, literature in other languages (5 results) was also excluded. Filtering out using “WoS Categories” function, literature which was not at all relevant to this research topic, for instance, literature in the category of optics, microbiology, mathematics, international relations, etc. and filtering out using “Document Types” function, letters, meeting abstract, correction were also excluded giving a total of 460 results. Further, filtering out using the “Research Areas” function, literature related to material sciences was ignored giving a total of 452 results. Refining the literature using “Source Titles” function, all remaining literature was analyzed after going through their titles, abstracts, and keywords. Literature not relevant to this research field was excluded and the results were reduced to 216. Further refining literature using Source Titles was not possible, because several source titles had few articles relevant to this topic but also at the same time, several articles were irrelevant. Finally, the literature was filtered using the “Organizations Enhanced” function, irrelevant articles were removed after analysis and the results dropped down to 46 results. The results were consistent with the research objective and all those final results were exported in an Excel file.

The second query after several trials and errors is described as follow:

[("Life cycle sustainability assessment" or "life cycle assessment" or "life cycle thinking" or "life cycle evaluation" or "life cycle analysis" or "social life cycle" or "life cycle costing" or "environment assessment" or "life cycle management" or "product life cycle") AND (SME$ or "small and medium enterprise$" or small firm$ or small compan or small corporation$ or small organi?ation$ or small business* or "small and medium sized")]*

In the basic search bar of the WoS database, a search query related to concept 1 (LCSA) was inserted in the first row and a search query related to concept 3 (small businesses) was entered in the second row. Both search queries (concept 1 and concept 3) were searched using the topic field and joined using “AND” as a Boolean operator.

The introductory search query yielded a total of 452 results. Only literature of the past 15 years (from 2005 onwards) were included, the amount of literature reduced to a total of 403 results. Literature in languages other than the English language was excluded, giving a total of 400 results. Filtering out using the "Document Types" function, editorial materials, and book chapters were omitted, reducing the amount of remaining literature to 393 results. Literature in categories irrelevant to the research topic like medicine general internal, statistics & probability, sociology, soil science, etc. were removed, presenting a total of 322 results. Filtering out using the "Research Areas" function, literature results related to material sciences were excluded, giving a total of 314 results. Further, filtering out using "Source Titles" and "Organizations Enhanced" functions, all literature was analyzed by their titles, abstracts, and keywords. Irrelevant literature was excluded, the amount of literature decreased to a total of 80 results. The outcomes (80 results) were exported in an Excel file as well.

4.2. Analysis

Selected research papers are analyzed by extracting useful information from the selected articles database. The final database consists of results from the first query (46 results), second query (80 results), and results of relevant literature as identified in the relevant literature table (9 results) giving an aggregate total of 135 results. Results from relevant literature are included because they form the foundation of this research and they are of utmost importance, especially in introducing the general topics and underlying principles related to LCSA for this thesis.

For the analysis process, "Citavi 6" software is used. First, a new project is created for this thesis and hypothetical categories and subcategories are established. Second, final research papers (135 results) are downloaded from respective sources and imported into the Citavi 6 software. Reference research papers from final research papers are vital for this thesis. These papers can be either imported from the local computer or can be searched and imported directly through the software. Third, the available text is analyzed and evaluated through various means including annotating and highlighting important sections, quoting relevant ideas, commenting on the selected text, and developing own ideas. Finally, actual writing with the help of the "Citavi Add-in" function for Microsoft Word and other functionalities is performed.

5. EXPECTED CONTRIBUTIONS

5.1. Academic Contributions

As discussed above, the key aim of this thesis is to systematically synthesize existing scattered literature in a way that produces a unique value to the audience. The intended audience of this thesis is small business owners, managers, and employees. Small firms are less likely to perform sustainability assessments as compared to big firms because of a lack of knowledge and financial constraints (Labonne et al. 2006). Also, small business organizations have a reactive attitude towards sustainability, they tend to care less about sustainability unless pressure is applied from stakeholders (Bianchi et al. 1999). This trend is changing, more and more small businesses are applying sustainability principles, moreover, a new breed of entrepreneurs is emerging called "sustainable entrepreneurs" (Gibbs et al. 2009). To apply sustainability principles, sustainability assessments must be made. In the context of LCSA, there is no concise and comprehensive (at the same time) research paper available for small businesses. The thesis will significantly contribute to concisely organizing relevant information so that it can be beneficial for not only small businesses but also for potential researchers.

5.2. Practical Contributions

Customers are increasingly becoming aware of environmental and sustainability issues. They are demanding more green and sustainable products, hence opportunities are arising for small businesses to take advantage of it (Belz et al. 2010). Various sustainability assessment tools have been designed, but they were mostly developed for large-sized firms (Jones et al. 2003; Bradford et al. 2008). LCSA requires a vast amount of reliable data and expert guidance. Moreover, it is time-consuming and costly (Lu et al. 2007; Kim et al. 2010). Small businesses cannot perform primary data collection process for each functional unit of product, they rely on secondary data. In one study of LCA of windmill turbine, 3931 functional units of product that needs to be individually assessed were found (Wiedmann et al. 2011). One of the key problems small businesses face in the LCA context is the availability of reliable data (Heidrich et al. 2013). Various initiatives have been taken on the global, regional, and local levels to create interconnected public databases related to LCA so that small businesses in their respective category of products can obtain data according to product type (Curran et al. 2012). This thesis

aims at simplifying and making LCSA more practical to use for small businesses. The thesis will discuss basic problems which small businesses face in applying LCSA in their organizations and what small businesses can do about it.

5.3. Societal Contributions

Small businesses contribute significantly to the global economy, not only in terms of GDP but also in terms of employment generation (Ye et al. 2013). Sustainability drives innovation, ethics, long term profitability, and gives a competitive advantage to firms (Wilshusen et al. 2017; Dyllick et al. 2016). LCSA helps businesses to find out sustainability issues in the product life cycle. The feedback generated from the assessment not only helps the firm itself but also helps its stakeholders along the value chain. Suppliers will be encouraged to produce greener and environmentally friendly raw materials; customers will be provided with more sustainable friendly choices. LCSA will not only help businesses to design existing products more environmentally friendly and sustainable but will also contribute significantly towards green research & development ideas for new products.

6. THESIS CHAPTERS OVERVIEW

The literature review will be divided into three chapters namely:

1. Introduction, 2. Body, 3. Conclusion.

6.1. Introduction

The introduction part is the first part of the thesis. This part includes discussing LCSA as a topic in brief and giving background information related to the topic.

6.2. Body

The body part consists of the majority of the thesis. This part will be divided into four parts according to the components of LCSA.

LCSA – Life cycle sustainability assessment

LCEA – Life cycle environment assessment

SLCA – Social life cycle assessment

LCCA – Life cycle costing assessment

Each chapter will be studied in detail.

6.3. Conclusion

This is the final part of the thesis. This part includes conclusion remarks, possible limitations of the study, future research opportunities related to this topic.

References

All references used in the study will be systematically displayed according to relevant standards.

7. WORKPLAN

01.10.20 – 13.10.20 – Preliminary broad study of all related aspects of LCSA, primarily all three components

14.10.20 – 20.10.20 – Searching for relevant literature according to the criteria identified in the methodology section

20.10.20 – 20.11.20 – Analysis of literature, transferring literature idea into the thesis

20.11.20 – 10.12.20 – Writing the thesis

13.01.21– 31.12.20 – Refinement and correction
13.01.21– Final submission

8. REFERENCES

- Ansems, A., Van Leeuwen, S., Guinée, J., & Frankl, P. (2005). Making life-cycle information and interpretative tools available. TNO report B&O-A, 2005, 326.
- Arora, N. K. (2018). Environmental Sustainability—necessary for survival.
- Asiedu, Y., & Gu, P. (1998). Product life cycle cost analysis: state of the art review. International journal of production research, 36(4), 883-908.
- Atilgan, B., & Azapagic, A. (2016). An integrated life cycle sustainability assessment of electricity generation in Turkey. Energy Policy, 93, 168-186.
- Azapagic, A. (2004). Life cycle thinking and life cycle assessment (LCA). Sustainable Development in Practice: Case Studies for Engineers and Scientists, 426.
- Baumann, M., Held, M., Herrmann, C., Saraev, A., Riese, O., & Steininger, H. (2012, September). Ecodesign tool for SMEs in the electronics sector. In 2012 Electronics Goes Green 2012+ (pp. 1-8). IEEE.
- Belz, F. M., & Schmidt-Riediger, B. (2010). Marketing strategies in the age of sustainable development: evidence from the food industry. Business strategy and the environment, 19(7), 401-416.
- Benoît, C., Norris, G. A., Valdivia, S., Ciroth, A., Moberg, A., Bos, U., ... & Beck, T. (2010). The guidelines for social life cycle assessment of products: just in time!. The international journal of life cycle assessment, 15(2), 156-163.
- Bergquist, A. K. (2017). Business and sustainability: new business history perspectives. Harvard Business School General Management Unit Working Paper, (18-034).
- Bevilacqua, M., Ciarapica, F. E., & Giacchetta, G. (2007). Development of a sustainable product lifecycle in manufacturing firms: a case study. International Journal of Production Research, 45(18-19), 4073-4098.

- Bianchi, R., & Noci, G. (1998). " Greening" SMEs' Competitiveness. Small Business Economics, 11(3), 269-281.
- Boardman, A. E., Greenberg, D. H., Vining, A. R., & Weimer, D. L. (2017). Cost-benefit analysis: concepts and practice. Cambridge University Press.
- Bonini, S., & Swartz, S. (2014). Profits with purpose: How organizing for sustainability can benefit the bottom line. McKinsey on Sustainability & Resource Productivity, 2, 1-15.
- Bradford, J., & Fraser, E. D. (2008). Local authorities, climate change, and small and medium enterprises: identifying effective policy instruments to reduce energy use and carbon emissions. Corporate Social Responsibility and Environmental Management, 15(3), 156-172.
- Brown, R. J. (1979). A new marketing tool: Life-cycle costing. Industrial Marketing Management, 8(2), 109-113.
- Brundtland, G. H., Khalid, M., Agnelli, S., Al-Athel, S., & Chidzero, B. J. N. Y. (1987). Our common future. New York, 8.
- Cabeza, L. F., Rincón, L., Vilariño, V., Pérez, G., & Castell, A. (2014). Life cycle assessment (LCA) and life cycle energy analysis (LCEA) of buildings and the building sector: A review. Renewable and sustainable energy reviews, 29, 394-416.
- Chen, Z., & Andresen, S. (2014). A multi-objective optimization model of production-sourcing for sustainable supply chain with consideration of social, environmental, and economic factors. *Mathematical Problems in Engineering*, *2014*.
- Cooper, D. R., & Schindler, P. S. (2014). Business research methods. McGraw-Hil.
- Curran, M. A. (Ed.). (2012). Life cycle assessment handbook: a guide for environmentally sustainable products. John Wiley & Sons.

- Davis, J., Mengersen, K., Bennett, S., & Mazerolle, L. (2014). Viewing systematic reviews and meta-analysis in social research through different lenses. SpringerPlus, 3(1), 511.
- Del Brìo, J. A., & Junquera, B. (2003). A review of the literature on environmental innovation management in SMEs: implications for public policies. Technovation, 23(12), 939-948.
- Devuyst, D., Hens, L., De Lannoy, W., & de Lannoy, W. (Eds.). (2001). How green is the city?: sustainability assessment and the management of urban environments. Columbia University Press.
- Dillard, J., Pullman, M. E., Loucks, E. S., Martens, M. L., & Cho, C. H. (2010). Engaging small-and medium-sized businesses in sustainability. Sustainability Accounting, Management and Policy Journal.
- Dreyer, L., Hauschild, M., & Schierbeck, J. (2006). A framework for social life cycle impact assessment (10 pp). The International Journal of Life Cycle Assessment, 11(2), 88-97.
- Dyllick, T., & Hockerts, K. (2002). Beyond the business case for corporate sustainability. Business strategy and the environment, 11(2), 130-141.
- Edmiston, K. D. (2007). The role of small and large businesses in economic development. Available at SSRN 993821.
- Elsayed, E. A. (2014). Life Cycle Costs and Reliability Engineering. Wiley StatsRef: Statistics Reference Online.
- Engardio, P., Capell, K., Carey, J., & Hall, K. (2007). Beyond the green corporation. Business Week, 29, 50-64.
- Esty, D. C., & Winston, A. (2009). Green to gold: How smart companies use environmental strategy to innovate, create value, and build competitive advantage. John Wiley & Sons.

- Fair labor association (2018). Supply chain mapping and traceability glossary.
- Fauzi, R. T., Lavoie, P., Sorelli, L., Heidari, M. D., & Amor, B. (2019). Exploring the current challenges and opportunities of life cycle sustainability assessment. Sustainability, 11(3), 636.
- Finkbeiner, M., Schau, E. M., Lehmann, A., & Traverso, M. (2010). Towards life cycle sustainability assessment. Sustainability, 2(10), 3309-3322.
- Finnveden, G., Hauschild, M. Z., Ekvall, T., Guinée, J., Heijungs, R., Hellweg, S., ... & Suh, S. (2009). Recent developments in life cycle assessment. Journal of environmental management, 91(1), 1-21.
- Frankl, P., & Rubik, F. (1999). Life cycle assessment in industry and business: adoption patterns, applications and implications. Springer Science & Business Media.
- Freeman, R. E. (2001). A stakeholder theory of the modern corporation. Perspectives in Business Ethics Sie, 3(144), 38-48.
- Freeman, R. E., Harrison, J. S., Wicks, A. C., Parmar, B. L., & De Colle, S. (2010). Stakeholder theory: The state of the art. Cambridge University Press.
- Gibbs, D. (2009). Sustainability entrepreneurs, ecopreneurs and the development of a sustainable economy. Greener Management International, (55).
- Gimenez, C., Sierra, V., & Rodon, J. (2012). Sustainable operations: Their impact on the triple bottom line. International Journal of Production Economics, 140(1), 149-159.
- Global Reporting Initiative (GRI): Sustainability Reporting Guidelines; GRI: Boston, MA, USA,
- Gmelin, H., & Seuring, S. (2014). Determinants of a sustainable new product development. Journal of Cleaner production, 69, 1-9.
- Guinée, J. B., & Lindeijer, E. (Eds.). (2002). Handbook on life cycle assessment: operational guide to the ISO standards (Vol. 7). Springer Science & Business Media.

- Guinee, J. B., Heijungs, R., Huppes, G., Zamagni, A., Masoni, P., Buonamici, R., ... & Rydberg, T. (2011). Life cycle assessment: past, present, and future.
- Gurzawska, A., Mäkinen, M., & Brey, P. (2017). Implementation of Responsible Research and Innovation (RRI) practices in industry: Providing the right incentives. *Sustainability*, *9*(10), 1759.
- Halog, A., & Manik, Y. (2011). Advancing integrated systems modelling framework for life cycle sustainability assessment. Sustainability, 3(2), 469-499.
- Hart, S. L. (1995). A natural-resource-based view of the firm. Academy of management review, 20(4), 986-1014.
- Hauschild, M. Z., Rosenbaum, R. K., & Olsen, S. (2018). Life cycle assessment. Springer.
- He, B., Luo, T., & Huang, S. (2019). Product sustainability assessment for product life cycle. Journal of cleaner production, 206, 238-250.
- Heidrich, O., & Tiwary, A. (2013). Environmental appraisal of green production systems: Challenges faced by small companies using life cycle assessment. International Journal of Production Research, 51(19), 5884-5896.
- Heijungs, R., & Suh, S. (2002). The computational structure of life cycle assessment (Vol. 11). Springer Science & Business Media.
- Heinzle, E., Biwer, A. P., & Cooney, C. L. (2007). Development of sustainable bioprocesses: modeling and assessment. John Wiley & Sons.
- Johnston, P., Everard, M., Santillo, D., & Robèrt, K. H. (2007). Reclaiming the definition of sustainability. Environmental science and pollution research international, 14(1), 60-66.
- Jones, O. (2003). Competitive advantage in SMEs: towards a conceptual framework. Competitive advantage in SMEs: Organising for innovation and change, 15-33.

- Jørgensen, A., Dreyer, L. C., & Wangel, A. (2012). Addressing the effect of social life cycle assessments. The International Journal of Life Cycle Assessment, 17(6), 828-839.
- Jørgensen, A., Le Bocq, A., Nazarkina, L., & Hauschild, M. (2008). Methodologies for social life cycle assessment. The international journal of life cycle assessment, 13(2), 96.
- Kang, K. H., Stein, L., Heo, C. Y., & Lee, S. (2012). Consumers' willingness to pay for green initiatives of the hotel industry. International Journal of Hospitality Management, 31(2), 564-572.
- Kaufman, R. J. (1969). Life cycle costing: decision making tool for capital equipment acquisitions. Journal of Purchasing, 5(3), 16-31.
- Kim, J., Park, K., Hwang, Y., & Park, I. (2010). Sustainable manufacturing: a case study of the forklift painting process. International Journal of Production Research, 48(10), 3061-3078.
- Kloepffer, W. (2008). Life cycle sustainability assessment of products. The International Journal of Life Cycle Assessment, 13(2), 89.
- Kocmanova, A., & Nemecek, P. (2009). Social aspects in life cycle management. Economics and Management, (14), 289-293.
- Korpi, E., & Ala-Risku, T. (2008). Life cycle costing: a review of published case studies. Managerial auditing journal.
- Kozlowski, A., Bardecki, M., & Searcy, C. (2012). Environmental impacts in the fashion industry: A life-cycle and stakeholder framework. Journal of Corporate Citizenship, (45), 17-36.
- Kumar, M., Rathour, R., Gupta, J., Pandey, A., Gnansounou, E., & Thakur, I. S. (2020). Bacterial production of fatty acid and biodiesel: opportunity and challenges. In Refining Biomass Residues for Sustainable Energy and Bioproducts (pp. 21-49). Academic Press.

- Kurczewski, P. (2014). Life cycle thinking in small and medium enterprises: the results of research on the implementation of life cycle tools in Polish SMEs—part 1: background and framework. The International Journal of Life Cycle Assessment, 19(3), 593-600.
- Labonne, J. (2006). A comparative analysis of the environmental management, performance and innovation of SMEs and larger firms. for the European Commission, Directorate-General Environment, CL Conseil, Saint Michel Sur Orge, 1-44.
- Laroche, M., Bergeron, J., & Barbaro-Forleo, G. (2001). Targeting consumers who are willing to pay more for environmentally friendly products. Journal of consumer marketing.
- Lu, L. Y., Wu, C. H., & Kuo, T. C. (2007). Environmental principles applicable to green supplier evaluation by using multi-objective decision analysis. International journal of production research, 45(18-19), 4317-4331.
- Mair-Bauernfeind, C., Zimek, M., Lettner, M., Hesser, F., Baumgartner, R. J., & Stern, T. (2020). Comparing the incomparable? A review of methodical aspects in the sustainability assessment of wood in vehicles. The International Journal of Life Cycle Assessment, 1-24.
- Muthu, S. S. (Ed.). (2014). Social life cycle assessment: an insight. Springer.
- Nomura, N., & Akai, M. (2004). Willingness to pay for green electricity in Japan as estimated through contingent valuation method. Applied Energy, 78(4), 453-463.
- Onat, N. C., Kucukvar, M., Halog, A., & Cloutier, S. (2017). Systems thinking for life cycle sustainability assessment: A review of recent developments, applications, and future perspectives. Sustainability, 9(5), 706.
- Parent, J., Cucuzzella, C., & Revéret, J. P. (2013). Revisiting the role of LCA and SLCA in the transition towards sustainable production and consumption. The International Journal of Life Cycle Assessment, 18(9), 1642-1652.

- Pedersen, C. S. (2018). The UN sustainable development goals (SDGs) are a great gift to business!. Procedia CIRP, 69, 21-24.
- Petti, L., Serreli, M., & Di Cesare, S. (2018). Systematic literature review in social life cycle assessment. The International Journal of Life Cycle Assessment, 23(3), 422-431.
- Pizzirani, S., McLaren, S. J., & Seadon, J. K. (2014). Is there a place for culture in life cycle sustainability assessment?. The International Journal of Life Cycle Assessment, 19(6), 1316-1330.
- Reap, J., Roman, F., Duncan, S., & Bras, B. (2008). A survey of unresolved problems in life cycle assessment. The International Journal of Life Cycle Assessment, 13(5), 374.
- Rebitzer, G., & Buxmann, K. (2005). The role and implementation of LCA within life cycle management at Alcan. Journal of Cleaner Production, 13(13-14), 1327-1335.
- Rebitzer, G., & Seuring, S. (2003). Methodology and application of life cycle costing. The International Journal of Life Cycle Assessment, 8(ARTICLE), 110-111.
- Rebitzer, G., Ekvall, T., Frischknecht, R., Hunkeler, D., Norris, G., Rydberg, T., ... & Pennington, D. W. (2004). Life cycle assessment: Part 1: Framework, goal and scope definition, inventory analysis, and applications. Environment international, 30(5), 701-720.

- Rebitzer, G., Ekvall, T., Frischknecht, R., Hunkeler, D., Norris, G., Rydberg, T., ... & Pennington, D. W. (2004). Life cycle assessment: Part 1: Framework, goal and scope definition, inventory analysis, and applications. Environment international, 30(5), 701-720.

- Rex, E., & Baumann, H. (2004). Expanding the green practice of LCA. The first decade of life cycle assessment activity in the Swedish forest products industry CPM-report, 1.
- Ribeiro-Soriano, D. (2017). Small business and entrepreneurship: their role in economic and social development.

- Rowley, J., & Slack, F. (2004). Conducting a literature review. Management research news.
- Rubik, F., & Frankl, P. (2000). Life Cycle Assessment in Industry and Business: Adoption Patterns, Applications and Implications. Springer.
- Sala, S., Ciuffo, B., & Nijkamp, P. (2015). A systemic framework for sustainability assessment. Ecological Economics, 119, 314-325.
- Sala, S., Farioli, F., & Zamagni, A. (2013). Life cycle sustainability assessment in the context of sustainability science progress (part 2). The International Journal of Life Cycle Assessment, 18(9), 1686-1697.
- Salvia, A. L., Leal Filho, W., Brandli, L. L., & Griebeler, J. S. (2019). Assessing research trends related to Sustainable Development Goals: Local and global issues. Journal of cleaner production, 208, 841-849.
- Schaltegger, S., & Burritt, R. (2017). Contemporary environmental accounting: issues, concepts and practice. Routledge.
- Schischke, K., Nissen, N. F., Sherry, J., O'Rafferty, S., O'Connor, F., Sitek, J., ... & Wimmer, W. (2012, September). Life cycle thinking in small and medium sized enterprises-Status quo and strategic needs in the electronics sector. In 2012 Electronics Goes Green 2012+ (pp. 1-6). IEEE.
- Sharma, A., Iyer, G. R., Mehrotra, A., & Krishnan, R. (2010). Sustainability and business-to-business marketing: A framework and implications. Industrial marketing management, 39(2), 330-341.
- Singh, R. K., Murty, H. R., Gupta, S. K., & Dikshit, A. K. (2009). An overview of sustainability assessment methodologies. Ecological indicators, 9(2), 189-212.
- Slaper, T. F., & Hall, T. J. (2011). The triple bottom line: What is it and how does it work. Indiana business review, 86(1), 4-8.

- Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. Journal of Business Research, 104, 333-339.
- Sonnemann, G., & Margni, M. (2015). Life cycle management (p. 353). Springer Nature.
- Stamford, L., & Azapagic, A. (2012). Life cycle sustainability assessment of electricity options for the UK. International Journal of Energy Research, 36(14), 1263-1290.
- Suhariyanto, T. T., Wahab, D. A., & Rahman, M. A. (2017). Multi-Life Cycle Assessment for sustainable products: A systematic review. Journal of Cleaner Production, 165, 677-696.
- Swarr, T. E., Hunkeler, D., Klöpffer, W., Pesonen, H. L., Ciroth, A., Brent, A. C., & Pagan, R. (2011). Environmental life-cycle costing: a code of practice.
- Templier, M., & Paré, G. (2015). A framework for guiding and evaluating literature reviews. Communications of the Association for Information Systems, 37(1), 6.
- UNEP. (2019). The Business case for life cycle thinking.
- UNEP/SETAC. (2009). Guidelines for social life cycle assessment of products. UNEP
- United Nations. (2020). *Sustainable Development Report 2020*. Cambridge University Press.
- United Nations. (2020). *The Sustainable Development Goals Report*. https://unstats.un.org/sdgs/report/2020/The-Sustainable-Development-Goals-Report-2020.pdf
- United States Environmental Protection Agency. (2010). Discounting future benefits and costs. US EPA.
- Valdivia, S., Ugaya, C. M., Hildenbrand, J., Traverso, M., Mazijn, B., & Sonnemann, G. (2013). A UNEP/SETAC approach towards a life cycle sustainability assessment—our contribution to Rio+ 20. The International Journal of Life Cycle Assessment, 18(9), 1673-1685.

- Wiedmann, T. O., Suh, S., Feng, K., Lenzen, M., Acquaye, A., Scott, K., & Barrett, J. R. (2011). Application of hybrid life cycle approaches to emerging energy technologies–the case of wind power in the UK. Environmental science & technology, 45(13), 5900-5907.

- Wilshusen, P. R., & MacDonald, K. I. (2017). Fields of green: Corporate sustainability and the production of economistic environmental governance. Environment and Planning A: Economy and Space, 49(8), 1824-1845.

- Witczak, J., Kasprzak, J., Klos, Z., Kurczewski, P., Lewandowska, A., & Lewicki, R. (2014). Life cycle thinking in small and medium enterprises: the results of research on the implementation of life cycle tools in Polish SMEs—part 2: LCA related aspects. The International Journal of Life Cycle Assessment, 19(4), 891-900.

- Woodward, D. G. (1997). Life cycle costing—theory, information acquisition and application. International journal of project management, 15(6), 335-344.

- Wu, R., Yang, D., & Chen, J. (2014). Social life cycle assessment revisited. Sustainability, 6(7), 4200-4226.

- Ye, X., & Leipnik, M. (2013). Comparison of the characteristics of small business in China and the US. Perspectives on Global Development and Technology, 12(5-6), 661-679.

- Zamagni, A., Pesonen, H. L., & Swarr, T. (2013). From LCA to Life Cycle Sustainability Assessment: concept, practice and future directions. The international journal of life cycle assessment, 18(9), 1637-1641.

- Zhou, Z., Jiang, H., & Qin, L. (2007). Life cycle sustainability assessment of fuels. Fuel, 86(1-2), 256-263.