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A framework for the systematic implementation of Green-Lean and sustainability in SMEs

Rebecca Siegel^a, Jiju Antony^b , Kannan Govindan^{c,d}, Jose Arturo Garza-Reyes^e , Bart Lameijer^f and Ashutosh Samadhiya^g 

^aSchool of Social Sciences, Edinburgh Business School, Heriot-Watt University, Edinburgh, Scotland, UK; ^bDepartment of Industrial and Systems Engineering, Khalifa University, Abu Dhabi, UAE; ^cChina Institute of FTZ Supply Chain, Shanghai Maritime University, China; ^dCenter for Sustainable Supply Chain Engineering, Department of Technology and Innovation, Danish Institute for Advanced Study, University of Southern Denmark, Denmark; ^eCentre for Supply Chain Improvement, The University of Derby, Derby, UK; ^fFaculty of Economics and Business, Amsterdam Business School, University of Amsterdam, Netherlands; ^gDepartment of Management Studies, Indian Institute of Technology Roorkee

ABSTRACT

Evidence suggests that smaller organisations find the implementation of combined operations- and environmental Sustainability improvement initiatives such as Green-Lean and Sustainability (GLS) challenging. This paper, therefore, develops a framework for the systematic implementation of Green-Lean and Sustainability in small and medium-sized enterprises (SMEs) to achieve long-term improvement of environmental, social and economic processes and performance. A literature assessment of theories, frameworks, and concepts was employed in the study to better comprehend the difficulties confronting the modern business world. In addition, the research employed expert perspectives from the lean, green-lean, and sustainability fields to propose, develop, test, and validate a framework for addressing business concerns. The research uncovers considerable implementation problems, such as employee motivation and integration, responsibilities, and measurements. It also underlines the success factors for the implementation process, such as management, firm- goals and strategy, reviews and audits, vision, and guidance by lean, green and sustainability frameworks. The novelty in this research lies in the approach where Green-Lean and Sustainability are combined and applied in an SME context. The presented framework offers the potential to be implemented in SMEs that operate in different sectors and contexts and are affected by different environmental and social considerations.

ARTICLE HISTORY

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Green-lean; lean green; sustainability; SMEs

1. Introduction

Over the last decades, there has been growing pressure on organisations from a variety of stakeholders to conduct their operations conscientiously to improve their environmental and social performance (Singh, Singh, and Khamba 2021; Choudhary et al. 2019). Growing customer demands for socially and environmentally responsible products and procedures have, in recent years, led to companies adopting new approaches in their processes and operations management to remain competitive (Abuulfaraa et al. 2020; Sony and Naik 2020; Cherrafi et al. 2017a; Garza-Reyes 2015a). Sustainability requirements were established as a new criterion for competitiveness (Cherrafi et al. 2016; Wong and Wong 2014).

To this effect, Green and Lean have been adopted as important tools for the implementation of Sustainability criteria, and therefore a means for companies to maintain their competitive advantage (Duarte and Cruz-Machado 2019; Cherrafi et al. 2018; Zhou 2016). The combination of the two paradigms is seen as a natural alignment through their similar operations management approach (Huo, Gu, and Wang

2019; Dieste et al. 2019). Lean as an approach for performance improvement identifies and eliminates waste through continuous improvement (Kovilage 2021). It was merged with the Green paradigm to incorporate further environmental concerns and improve environmental efficiency under the label Green-Lean (Singh, Singh, and Khamba 2021; Cherrafi et al. 2016; Garza-Reyes 2015a).

Many practical examples established in the scientific literature argue for the significance of Green-Lean. Implementing both approaches simultaneously stimulates process innovation (Huo, Gu, and Wang 2019; Fercoq, Lamouri, and Carbone 2016), which allows companies to accomplish sustainable performance with the highest efficiency and minimal resources (Huo, Gu, and Wang 2019; Farias et al. 2019b). For companies that are already Lean, simply implementing Green methods will allow them to see an improvement to their sustainable performance (Kuo and Lin 2020; Cherrafi et al. 2017a). Both Green and Lean concentrate on the reduction of waste and the increase of efficiency of production processes (Dieste et al. 2019; Cherrafi et al. 2017a). In their

research, Dieste et al. (2019) point out that measures such as energy use, materials use, air emissions, and toxic chemicals used can be positively affected when Green-Lean is applied.

In the last ten years, the business world has noted the significance of exchange among the daunting preferences of environmental protection, economic development, and social equality, with the pursuit for sustainability as a practical challenge rather than just a scientific or conceptual notion (Casula and Soneryd 2012). The main idea that has encouraged enterprises to adopt sustainable development is that a company hopes to gain significantly by exercising sustainability (Sy 2016). Also, there is a growing demand for businesses to focus from a boardroom sustainability strategy to the deployment and monitoring of these initiatives. Moore and Manring (2009) suggest that SMEs must reassess their corporate approach and seek a better sustainable solution for their operations. SMEs inability to incorporate sustainability into their organisations has been a significant hindrance to their development, and they are continually up against intense competition from local and foreign markets (Lee, Che-Ha, and Syed Alwi 2021).

In order to truly fulfil sustainability requirements, however, organisations must take into account and implement all three dimensions of sustainability. While the economic and environmental dimensions of Sustainability have been amply explored in literature and practice, thus far, the social dimension has been found to not be sufficiently science-based and operational and therefore requires subsequent development (Popovic et al. 2018; Missimer, Robèrt, and Broman 2017; Ahmadi, Kusi-Sarpong, and Rezaei 2017). Social sustainability occurs when formal and informal protocols, structures, affiliations, and encounters actively improve the potential of current and future generations to create healthy and lively communities (Masocha 2019).

Despite the increased interest in social sustainability, there is still a lack of information (Popovic et al. 2018; Mani, Gunasekaran, and Delgado 2018; Eizenberg and Jabareen 2017). The lack of theoretical and empirical studies concerning social sustainability demonstrates that the social dimension was incorporated late into debates on sustainable development (Eizenberg and Jabareen 2017; Missimer, Robèrt, and Broman 2017). The authors, therefore, see the need to further consolidate the social dimension within the concept of Sustainability as a means to improve competitiveness and to contribute to the strengthening of the scientific foundation of the social dimension within Sustainability.

This study takes a novel approach by joining Green-Lean and Sustainability as an improvement strategy to be implemented specifically in small and medium-sized enterprises. It attempts to answer the questions of how Green-Lean and Sustainability are defined in the literature, what linkages exist between them and what possible challenges and key success factors an implementation of both concepts poses. By interviewing practitioners, we expect to expose overlapping themes, and our framework will be guided by the question of how to integrate these themes into our core model. We also hope to gain more insight into necessary methods and mechanisms that must be employed for the framework to be

practical and ensure long-lasting success. In addition, we look to determine the existing limitations of Green-Lean frameworks in order to overcome them through our model.

It was found that only very few studies have focussed their Green-Lean research on small and medium-sized enterprises (Yadav et al. 2019; Verrier, Rose, and Caillaud 2016; Piercy and Rich 2015). It is mainly large organisations that are familiar with the implementation of Lean (Kumar, Antony, and Tiwari 2011), with a dearth of research into Lean in SMEs (Hu et al. 2015). Specific characteristics of SMEs, such as little spare human resources, a general lack of financial resources and an emphasis on short-term objectives to achieve quick results, aggravate the integration of improvement strategies (Yadav et al. 2019).

In more recent research, Siegel et al. (2019) conducted an extensive literature review on the relationship between Green-Lean and Sustainability and on the pre-existing models aimed at implementing both paradigms in practice. The study demonstrated that existing frameworks for Green-Lean are predominantly generic models that use predetermined tools, do not take into consideration the specific needs of SMEs and additionally lack long-term efforts to sustain an integration.

Some other past work in this area, e.g. Pampanelli, Found, and Bernardes (2014), offered an integrated green and lean method in global manufacturing firms to address, in particular, a firm's environmental sustainability performance. Cherrafi et al. (2017a) recommended combining Green, Lean, and Six Sigma methodologies to improve the sustainability performance of various businesses. Their research is primarily concerned with economic and environmental sustainability. They also did not reveal the industry's size (SMEs/large industries) in which the framework is used. Given this and the above-stated benefits of Green-Lean, we propose a framework that promotes the simultaneous integration of Green-Lean and Sustainability in SMEs in a comprehensive, simplified and systematic manner. Furthermore, the primary focus of this research is on social sustainability.

The remaining structure of the paper is as follows: [Section 2](#) reviews the past literature on green, lean, and sustainability, with particular emphasis on SMEs. [Section 3](#) presents the research methodology of the paper, followed by the results in [Section 4](#). Furthermore, [Section 5](#) provides the discussion and implications of the current study. Finally, [Section 6](#) offers the conclusions, limitations and further research directions drawn from this study.

2. Literature review

Due to a vastly competitive business environment and increased pressure to adapt to stakeholder demands for sustainable operations and products (Farias et al. 2019a; Cherrafi et al. 2017a), companies need to adjust their modus operandi (Kaswan and Rathi 2020; Sony and Naik 2020). As a result, the importance of Green-Lean as a supporting measure has increased (Abuelfaraa et al. 2020; Saetta and Caldarelli 2020). This section, therefore, focuses on key themes and motivating factors of GLS and SMEs. In this

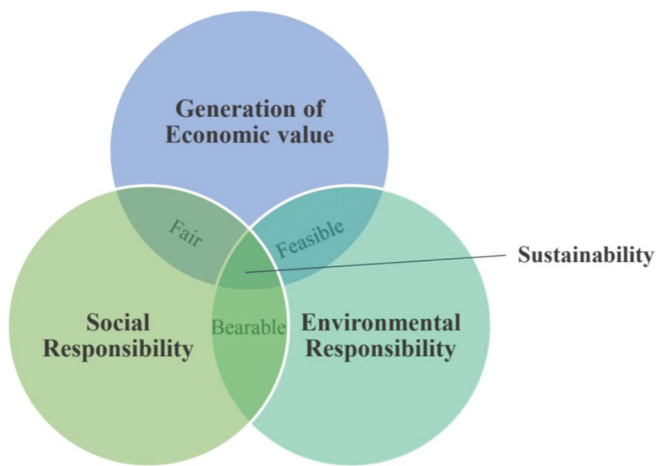


Figure 1. Pillars of sustainability. Source: Adapted from Oliveira et al. (2011), p. 73.

literature review, articles from different databases and sources were systematically selected and examined. Five search engines, namely Elsevier, Taylor & Francis Online, Wiley Online Library, Emerald Insight and Springer were used to locate relevant journal articles. Search strings included (Lean), (Green), (Green Lean), (Lean Green), (Sustainability), (SME), (small and medium-sized enterprise), (model) and (framework). While using the same search strings in every database led, to some extent, to the appearance of the same articles, this approach was essential to ensure a complete and thorough exploration of the literature. The search was considered complete when the same articles continued to appear. A final sample of 45 articles was identified. These articles enabled us to articulate a sound discussion that linked the three main themes of this research, i.e. Green-Lean, Sustainability and SMEs. The discussion is presented in the following subsections.

2.1. Green-Lean and sustainability

The literature review revealed that the amalgamation 'Green-Lean' utilises the best aspects of both methods: lean processes and enhanced environmental performance (Dieste, Panizzolo, and Garza-Reyes 2020; De Giovanni and Cariola, 2021). Environmental management is frequently also equated with Sustainability, both in theory and practice, yet this neglects the two remaining dimensions of social and economic Sustainability. Companies cannot be truly sustainable if they do not take employee and community wellbeing into account, alongside their long-term financial goals. Ultimately, Sustainability 'provides a balanced relationship among economic, social and environmental aspects' (Alves and Alves 2015). Figure 1 illustrates the interrelation of the three dimensions of Sustainability. When the pillars interact with each other, 'fair', 'feasible' and 'bearable' relationships can be achieved. Where all three dimensions intersect, a sustainable relationship is accomplished (Oliveira et al. 2011).

A social transformation of the company is crucial to support and sustain the successful implementation (Arumugam, Kannabiran, and Vinodh 2022) of Green-Lean and

Sustainability. The social pillar is complex and includes various stakeholders, and the lack of theoretical and empirical studies in the existing Green-Lean literature creates an even greater need to explore the human factors that enable the effective integration of improvement strategies (Cherrafi et al. 2016). Long-term financial goals characterise the economic dimension and enable the commercial Sustainability of a company's operations. In the end, being mindful of the environmental, but also the social and economic pillars of Sustainability will lead to added benefits, such as fair practices for the community, employees and partners; and will generate economic value that meets shareholder's expectations and benefits the community and wider society (Alves and Alves 2015).

The existing literature considers Green-Lean and Sustainability as complementary (Inman and Green 2018). Green-Lean is an effective tool to reduce waste and improve environmental efficiency, but only joined with Sustainability can long-term success be achieved (Cherrafi et al. 2016; Garza-Reyes 2015a). Figure 2 illustrates the common elements that Green-Lean and Sustainability share (overlapping circles), along with the elements that each individual concept brings along additionally and which can be integrated (outside overlap). The two approaches are complementary through shared factors and provide mutual support through individual aspects.

From our literature review into Green-Lean and Sustainability, key themes emerged that outline these concepts in their entirety. These can be categorised as challenges, tools and techniques, success factors, frameworks, factors of Sustainability and benefits of Green-Lean (Siegel et al. 2019).

Reportedly, many companies struggle with the implementation and sustainment of Green-Lean practices (Arumugam, Kannabiran, and Vinodh 2022; Grigg, Goodyer, and Frater 2020; Alefari, Almani, and Salonitis 2020; Cherrafi et al. 2019; Sony and Naik 2020). The most common challenge proved to be a lack of metrics and measurements, as well as the absence of management support and the cultivation of a corporate culture and employees mindset (Alves and Alves 2015; Duarte and Cruz-Machado 2013). In addition, it was found that Green-Lean tools developed to date have either not been adapted, lack maturity or are frequently not acknowledged by the industry (Siegel et al. 2019). Key factors for successful implementation were considered to be employee involvement and, again, the commitment and support of (top) management (Cherrafi et al. 2017b; Wong and Wong 2014; Cherrafi et al. 2016; Duarte and Cruz-Machado 2013).

A number of models and frameworks for the integration of Green-Lean or Lean and Sustainability in organisations have been developed in recent years. While every framework has unique and beneficial features, each exhibits one or more limitations inhibiting their applicability in various environments. These limitations include models being sector or industry-specific, (Alves and Alves 2015; Zhang and Awasthi 2014; Aguado, Alvarez, and Domingo 2013; Sawhney et al. 2007); with potential for improvement in the design and

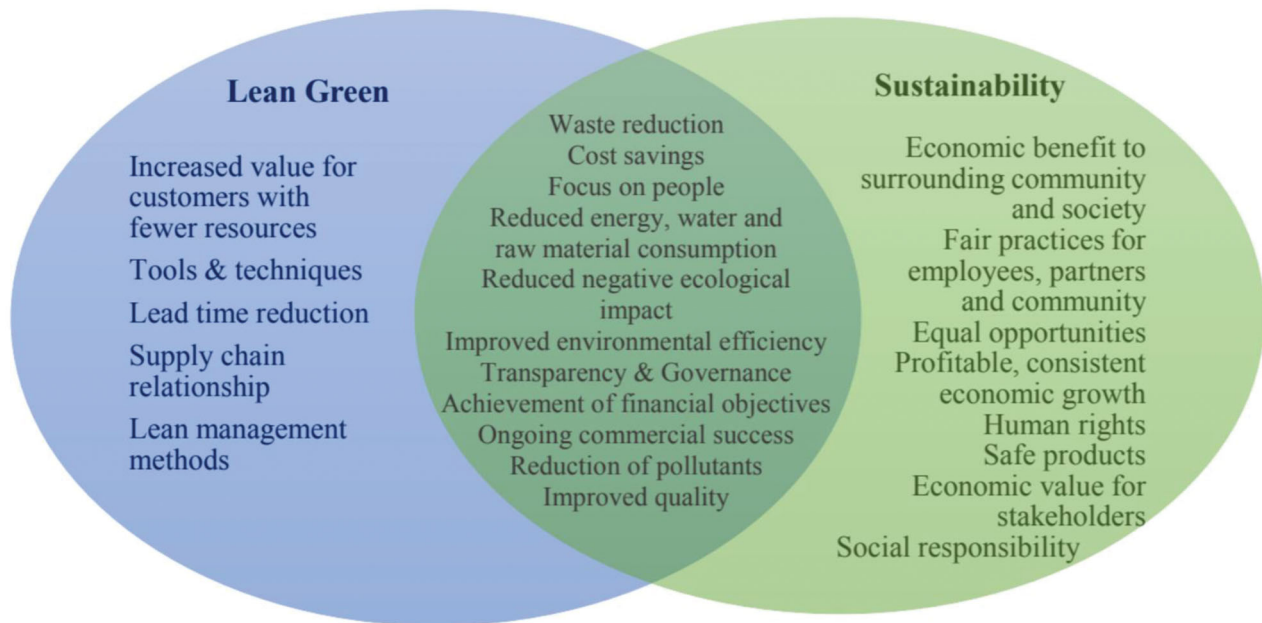


Figure 2. Lean green and sustainability venn diagram. Source: Adapted from Dües, Tan, and Lim (2013), Piercy and Rich (2015).

comprehensibility of the different stages (Duarte and Cruz-Machado 2013) and; a lack of ensuring company readiness for a GLS initiative (Piercy and Rich 2015; Bergmiller and McCright 2009). Few frameworks discuss which tools may work best for an individual company, but rather predetermine the type of Lean and Green tools and techniques an organisation should deploy (Piercy and Rich 2015; Zhang and Awasthi 2014), thereby restricting the scope of their application. In addition, most frameworks only address the environmental and economic dimension of Sustainability but fail to include the social dimension (Sawhney et al. 2007; Bergmiller and McCright 2009). Table 1 summarises the advantages and limitations of each examined framework.

The existing frameworks are more useful for larger organisations, and rarely consider the characteristics of SMEs, such as a lack of financial and human resources. Hence, we believe that the existing implementation frameworks demonstrate shortcomings, especially for SMEs, which can be overcome through the development of a single comprehensive, simplified and generic framework for SMEs, upon which this study focuses.

2.2. The importance of lean and green and the integration of sustainability into small and medium-sized enterprises (SMEs)

This paper focuses on the implementation of GLS in SMEs, many of which remain unfamiliar with the implementation of Lean (Hu et al. 2015). This has resulted in a dearth of research in this field (Yadav et al. 2019; Hu et al. 2015). Worldwide, SMEs comprise 90% of businesses and provide 50% to 60% of jobs (Antony, Vinodh, and Gijo 2016). In the European Union (EU), SMEs represent 99% of all businesses and have created approximately 85% of new employment in the past five years (European Commission 2018). The

competitiveness of SMEs influences the competitive ability of an entire economy, as SMEs and large organisations are frequently linked through complex networks of businesses (Wessel and Burcher 2004).

SMEs typically pose several particular challenges to the adoption of improvement strategies (Alefari, Almani, and Salonitis 2020; Caldera, Desha, and Dawes 2019; Dora, Kumar, and Gellynck 2016). In SMEs, every employee is allocated a key role, sometimes even several, which leads to little spare human resources. When employees are engaged in additional tasks or projects, they have less time at their disposal for their normal workload (Wessel and Burcher 2004). Management may, therefore, consider training a waste of time; labour force constraints are regarded as a critical failure factor of Lean implementations in SMEs (Albliwi et al. 2014). A general lack of financial resources prohibits large investments in training, infrastructure or new technology and can prevent SMEs from maintaining or improving their competitiveness (Wessel and Burcher 2004).

Management and leadership in an organisation present one of the greatest challenges (Grigg, Goodyer, and Frater 2020; Antony, Vinodh, and Gijo 2016; Timans et al. 2012). Without the appropriate attitude, involvement and commitment of the top and middle management projects easily fail (Albliwi et al. 2014; Antony, Vinodh, and Gijo 2016). Since SMEs often emphasise short-term objectives to achieve quick results, overall objectives and a well-defined strategy may be missing (Grigg, Goodyer, and Frater 2020). Another major challenge, especially towards the integration of continuous improvement programmes, is resistance from employees. Implementing new methods raises employee concerns over job security. According to Timans et al. (2012), internal resistance is the key challenge for SMEs regarding the implementation of improvement strategies. Finally, the selection of projects plays a vital part in sparking employee and the top management interest and engagement, and in

Table 1. Green-Lean Frameworks.

Green-lean frameworks					
Key objective	Complexity	Practicality	Effectiveness	Usability	Limitation
Cherriani et al. (2017a) The framework explains how organisations can integrate Lean Six Sigma and Green systematically to improve economic, environmental and self-assessment models and five phases which are broken down into sixteen steps.	Designed in comprehensible steps that fit many industries and company sizes.	A generic framework that is designed to be implemented in all sectors.	The framework was tested for its validity before rolling it out to other companies. No feedback mechanism.	Stages are broken up into individual steps which guide users through the implementation process.	There is little detail about how to sustain the achieved results. A feedback mechanism is missing. Includes Six Sigma approach.
Alves and Alves (2015) The model integrates the principles of lean manufacturing and Sustainability, supported by a cultural transformation in the organisation.	Very well-structured and comprehensive	No loop for feedback mechanism designed for production sector only.	Model yet needs to be tested. Includes cultural transformation for sustaining change.	Stages are clearly defined, and tools are pre-determined	Focus is restricted to areas related to the production sector. Predetermined tools are tailored to the production sector.
Piery and Rich (2015) A theoretical model for lean and sustainable change in a single framework. Shows linkages between lean and sustainable operations and identifies the full Sustainability benefits of lean operations beyond green improvements at the workplace level, which includes community, supply chain and company strategy.	Easy to comprehend. Stages include necessary techniques and tools.	Loop for feedback mechanism in place. Lean and Sustainability stages are aligned according to their reference but have separate starting points.	The framework allows the integration of lean and Sustainability through an integrative stage-based model and captures the holistic change process.	Clear, consecutive approach including necessary steps.	Does not include a readiness phase or how to sustain Lean & Sustainability. Predetermines Lean and Green tools.
Verrier et al. (2014) A tool to target and promote best practices for lean-oriented sustainable development. Proposes Lean indicators, Green performance indicators and Green intentions indicators. Enables benchmarking to target best practices.	Works with plotting graphs and matrices. Difficult to comprehend the overall structure.	Not one joint framework, but separate three indicators.	A repository that allows measurement of Green and Lean ability and bench-marking with other companies. Maps various companies according to their organisational and Green performance.	Indicators are relatively easy to calculate.	Framework more useful and applicable with a group of companies available to benchmark them to Lean and Green initiatives in order to target best in class and associated best practices.
Wong and Wong (2014) The framework addresses human integration in lean for sustaining operations.	Quite complex through several hierarchical structures, matrices and indexes	Lacks a feedback mechanism	Benefits have been proven through a case study, results signify that people can be integrated through a scientific methodology in lean.	A detailed introduction into methods of model needed.	The framework does not incorporate the other two pillars of Sustainability (economic and environmental).

(continued)

Table 1. Continued.

Green-lean frameworks					
Key objective	Complexity	Practicality	Effectiveness	Usability	Limitation
Zhang and Awasthi (2014) The framework integrates Six Sigma and Sustainability. Fully presents the necessary steps to achieve truly sustainable development.	A very thorough model with straightforward instructions.	Tools and techniques are clearly stated, however, links between problems and solutions are only explained in a separate model.	No loop for feedback mechanism, the model yet needs to be tested.	Stages are clearly defined and show the necessary tools.	The framework is not validated in a real environment. There is less focus on the economic dimension. It is geared to the needs of manufacturing companies, and additionally a Six Sigma approach instead of Lean.
Aguado, Alvarez, and Domingo (2013) The model identifies and quantifies efficient, sustainable improvements in a lean production system through processes of environmental innovation by waste elimination.	The model itself is not well structured nor expressive and hard to comprehend. The description, however, is well-structured and comprehensive.	Steps are achievable due to the use of tools. Able to identify and quantify improvements in environmental impact and productivity.	The model was tested in a small business. Results demonstrate a competitive advantage through reduced costs and a reduction in emissions and waste.	The approach can be easily adapted to most businesses oriented towards production.	Leaves room for improvement, does not address sustaining Lean and Sustainability.
Duarte and Cruz-Machado (2013) Model for implementing Lean and Sustainability initiative. Indicates how and when Lean and Green strategies can be synergetic and compatible, using principles and tools from both philosophies.	Criteria for business model are expansive and comprehensible	A feedback mechanism is incorporated. Some criteria suggest ideas but do not explain them in more detail.	The model needs to be fully developed and tested and validated.	Good guidelines for different success factors, however, the model itself needs to be expanded further.	This model can be developed using an exploratory case study methodology to understand if it is important to industry and where the compatibilities between Lean and Green are.
Bergmiller and McCright (2009) Model to integrate lean and Sustainability systems into one system that can contribute significantly to long-term financial and environmental Sustainability.	Comprehensible, yet lacks exemplification. Identifies many different techniques and benefits.	The framework comprises many different elements but does not offer a comprehensive explanation of how to utilise them.	The framework has not been tested. The feedback mechanism is not implemented.	Proposes many specific techniques which may not work for every company. No further introduction into the procedure.	The framework is not validated in a real environment. It lacks a readiness phase and a feedback mechanism.
Sawhney et al. (2007) The model assists in developing a relationship between environmental concerns and Lean principles for specific processes.	Complex, but thorough.	Loop for a feedback mechanism. Model designed only for one particular manufacturing process (metal cutting).	Effective to use in the metal-cutting industry.	Specific software needed.	Needs to be evolved for other processes. Leaves out the social aspect of Sustainability.

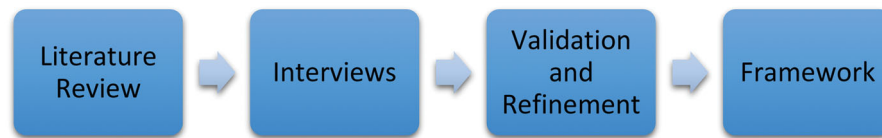


Figure 3. Framework development research methodology.

demonstrating potential cost savings. Su and Chou (2008) and Duarte et al. (2012) agree that an entire programme may fail if the wrong project is selected.

It is clear from the literature review that significant shortcomings exist, both in the incorporation of social sustainability, which is a decisive factor for successful Green-Lean integrations (Popovic et al. 2018; Mani, Gunasekaran, and Delgado 2018; Eizenberg and Jabareen 2017), as well as adjusted frameworks or guidelines specifically for SMEs in the context of Green-Lean (Yadav et al. 2019; Hu et al. 2015). In addition, the considered frameworks, beyond their individual limitations, stipulate predetermined tools and fail to provide a model applicable to many industry sectors (Cherrafi et al. 2016). Lastly, the lack of measures to ensure the long-term success of an integration (Siegel et al. 2019) means that many companies fail to either implement Green-Lean in the first place or to sustain it in their organisation (Arumugam, Kannabiran, and Vinodh 2022; Grigg, Goodyer, and Frater 2020; Alefari, Almani, and Salonitis 2020; Cherrafi et al. 2019; Sony and Naik 2020). To overcome these limitations, the authors were motivated to conduct this research and provide SMEs with a systematic and disciplined guide that has practical significance and value.

3. Research methodology

This section outlines and discusses the methodology applied to conduct this research. Figure 3 illustrates the approach adopted in the development of the proposed framework. First, a literature review of theory, concepts and frameworks was conducted. In addition, practitioners with experience in Lean, Green-Lean and the integration of Sustainability in businesses were consulted to develop a model that was adapted to address the contemporary challenges in today's corporate world. Finally, the framework was developed, validated and refined. It was reviewed by seven experts to capture any limitations and to review and present a revised version.

This study used an exploratory data collection approach as it reassessed the phenomenon of Green-Lean in the context of Sustainability as an added dimension. Therefore, and to further investigate the concept and applicability of Green-Lean and Sustainability in businesses, interviews were selected as the most appropriate research strategy.

We also used a non-standardised, semi-structured interview approach to gather primary data. This type of interview gives researchers the flexibility to omit questions and adapt them to a specific organisational context or to ask additional questions to investigate the research questions and objectives further. It additionally enables an understanding of the relationship between variables (Saunders, Lewis, and

Thornhill 2016). Moreover, due to the nature of the study, the interviews were conducted on a one-to-one basis between the researcher (and in this case, the interviewer) and a single participant.

Each participating company was required to:

- Have less than 250 employees; and
- Have implemented and used Lean for six months or more. This was to ensure that the company had some reasonable time to assess the impact of the new system.

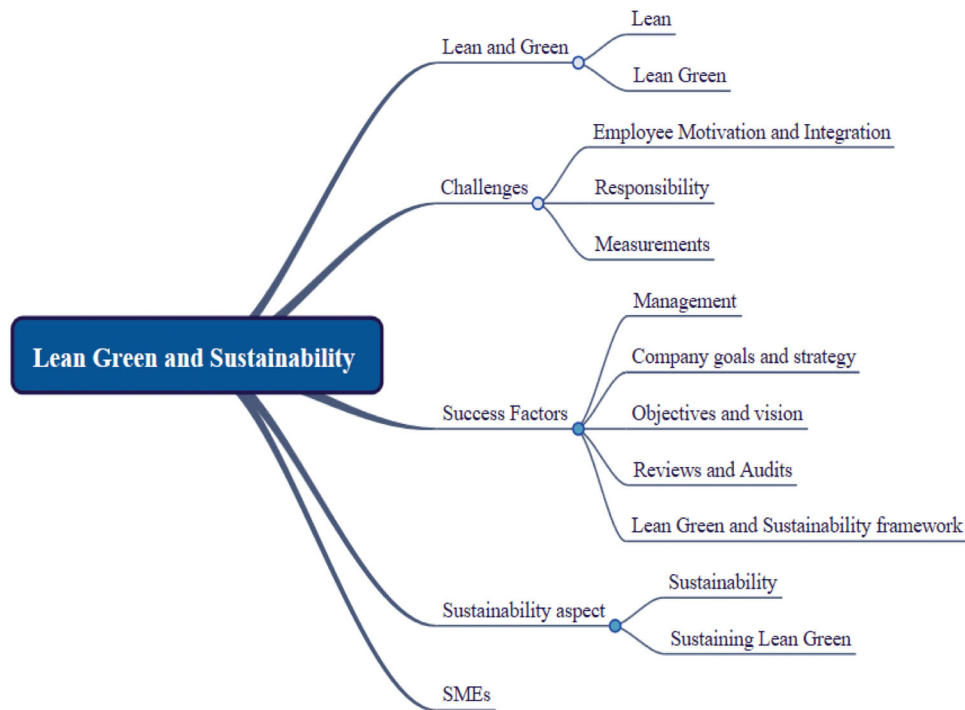
Companies fulfilling all criteria and willing to participate in the study were located across all of Germany. Therefore, both face-to-face and telephone interviews were conducted. The companies were approached via email, telephone or through online business networks LinkedIn and XING. Lists of SMEs were obtained by contacting Trade Departments and the German Chambers of Commerce of individual federal states. The data was collected in the period between March 2018 and May 2018.

Due to their in-depth nature, semi-structured interviews are time-consuming, and hence sample sizes are limited. 12 companies agreed to be part of the study. One company provided two participants, resulting in 13 interviewees in total. Since the research aimed to develop a generic framework of Green-Lean and Sustainability, a cross-case study was conducted. This entailed studying companies in a range of industries and with different degrees of experience in Lean. The participants held a range of positions from different hierarchical levels, such as Managing Director, Head of Change Management or Lean Manager. Some of the interviewees additionally possessed Lean Six Sigma certifications such as Black Belt or Master Black Belt, making them experts in this particular field. Moreover, three of the interviewed companies were Lean or Green-Lean consultancies for specific industries. Table 2 shows the full list of companies, including the type of industry, company size, experience with Lean in years and the interviewee's company position.

A semi-structured interview schedule was developed. The questions were derived from the literature, with each question supported by at least one source. The schedule began with a general enquiry into the company's Lean operations and results, followed by questions regarding the interviewee's understanding of Green-Lean and the company's approach towards Sustainability. The questions were open-ended to encourage and promote in-depth discussion of the topics presented (Braunscheidel et al. 2011). The interview aimed to form a basis for the development of a framework applicable to SMEs. Through the assurance of anonymity, the participants were encouraged to talk openly about any issues concerning their company. The interviews typically lasted

Table 2. Profile of interviewed companies.

Company	Type	Size	Company experience with Lean (years)	Interviewee	Interviewee experience with Lean (years)
A	Software	Medium	14	Lean Java Expert	7
B	Manufacturing (Printing)	Medium	5	Master Black Belt / Lean Manager	12
C	AI and Machine Learning Solutions	Small	3	General Manager	3
D	Consulting (Lean)	Small	16	Green-Lean Consultant	8
E	Manufacturing (Furniture)	Medium	3	Head of Change Management	12
F	Energy	Small	2	Managing Director	2
G	Consulting (Lean)	Medium	18	Black Belt, Project Manager Lean Development	11
				Consultant Holistic Lean Transformation	8
H	Building materials	Medium	7	Lean Manager Group	12
I	Consulting (Lean)	Small	16	Master Black Belt / CEO	15
J	Engineering Consultancy	Small	7	Senior Manager Quality Management	9
K	Software	Medium	14	Black Belt, Lean Manager	10
L	Metal and metalworking	Medium	10	Lean Manager	7

**Figure 4.** Coding levels. Source: Author's own.

three-quarters of an hour, audio recorded where consent was given, and notes were taken for an accurate evaluation.

Once the data collection process was completed, template analysis was used to investigate the generated data. This type of analysis thematically organises and conducts analyses according to a set of codes developed *a priori*. It uses predetermined codes that can then be amended or added while the data is gathered and analysed (Saunders, Lewis, and Thornhill 2016).

Following the procedure of the template analysis, the interviews were carefully transcribed and the first round of coding the data was conducted. Emerging codes were identified and labelled. Levels of codes and later a hierarchy of codes (see Figure 4) was produced to maintain a structure

and create an overview. Once all emerging codes were added, the template was applied to the entire data set and findings were interpreted and written up.

Validity and reliability

For the purpose of maintaining quality standards throughout the data collection phase, validity and reliability were pursued through several techniques. Validity was assured through multiple sources of evidence and a chain of evidence (Yin 2014). While interviews served as the main data collection method, information acquired through the company's websites were additionally considered (such as Sustainability reports, organisation charts, etc.). These were

Table 3. Questionnaire feedback.

Questionnaire Feedback	
Participants	Professor of Quality Management and LSS Master Black Belt Associate Professor in Marketing with a specialisation in Sustainability General Manager Master Black Belt Green-Lean Consultant
Feedback	Question for a definition of Lean by interviewees to see how perspective has changed over time Strategic and tactical benefits of the company and the ratio of investment in Lean to its benefits Number of employees trained on Lean per year and number and setting of Lean projects per year Focus of Sustainability questions in regards to its application in business, such as through Sustainability management systems Reduction of questions and elimination of redundancies Refinement of German translation to clarify meaning Suggestion to include Six Sigma Focus of questions on SME requirements Improvement of Sustainability-related questions

used to complete an overview of the organisation and to fill in data that may have been left out by the interviewee. A chain of evidence was upheld through research questions that were connected to the design of the research strategy, creating and piloting an interview protocol that was followed by a detailed process of analysing data, which included relevant quotations and establishing relationships. Finally, an anonymised overview of participating companies was created.

The interview schedule was piloted with two academics and three practitioners from industry to ensure the intelligibility and relevance of the questions. Their feedback enabled the author to enhance the questions and revise the design of the schedule (Saunders, Lewis, and Thornhill 2016). Table 3 illustrates the participants that tested the interview protocol and the feedback that was given.

Apart from a suggestion to include Six Sigma questions, each piece of feedback was incorporated in the interview protocol. Six Sigma went beyond the scope of the research and was therefore not included. The final interview schedule is found in Appendix 1.

The limitations of this approach lay in the restricted number of interviewees per organisation, as a minimum of two employees per case company should be interviewed to ensure the viewpoint of a company (Lo 2013). However, as the interviewees represented a range of positions from several hierarchical levels, the data gathered was regarded as a representative cross-section of viewpoints from SMEs.

4. Results

This section presents the results from the interviews that were incorporated into the framework. The purpose of this section is to:

1. Overcome the shortcomings of existing frameworks by developing a practical framework that guides SMEs, regardless of their industry, to implement Green-Lean and Sustainability;
2. Allow the rectification of implementation errors through a feedback mechanism;
3. Enable the organisations to choose appropriate tools and techniques;

4. Integrate and addresses social Sustainability to close a significant research gap;
5. Incorporate methods to sustain the two strategies.

The model's acronym is based on its five phases of Readiness, Conceptualisation, Planning, Execution, and Sustain (RCPES) and will be addressed as such.

The proposed RCPES framework enables SMEs to systematically implement Green-Lean and Sustainability within limited budgets and resources. It aims to improve their environmental, social and economic performance and to ensure long-term success. The conceptual model comprises five phases divided into 20 steps, illustrated in Figure 5.

4.1. Phase 1: Readiness

The readiness phase is designed to assess the willingness and maturity of a company to embark on a long-term journey that will transform their organisation to become leaner and more sustainable. It is essential for the success of the initiative to ensure that only companies with an evolved mindset and sufficient resource capabilities proceed to the next stage to prevent the failure of projects, which may result in a negative perception of Lean and Sustainability improvement strategies in their entirety.

Step 1: Analysis and benchmarking

Step 1 serves as an opportunity for the company to analyse its current situation and position and assess whether they have reached a maturity level sufficient enough to proceed with the integration of an additional management method (Kumar, Antony, and Tiwari 2011). It allows the organisation to consider its desired target state and compare its position with the competition through benchmarking.

To comprehend a company's situation, the authors suggest using the self-assessment model for SMEs developed by Machado et al. (2020). With a reduced set of dimensions, the model specifically considers the characteristics and limitations of SMEs. Companies can use the self-assessment questionnaire to test their degree of compliance with the necessary attributes.

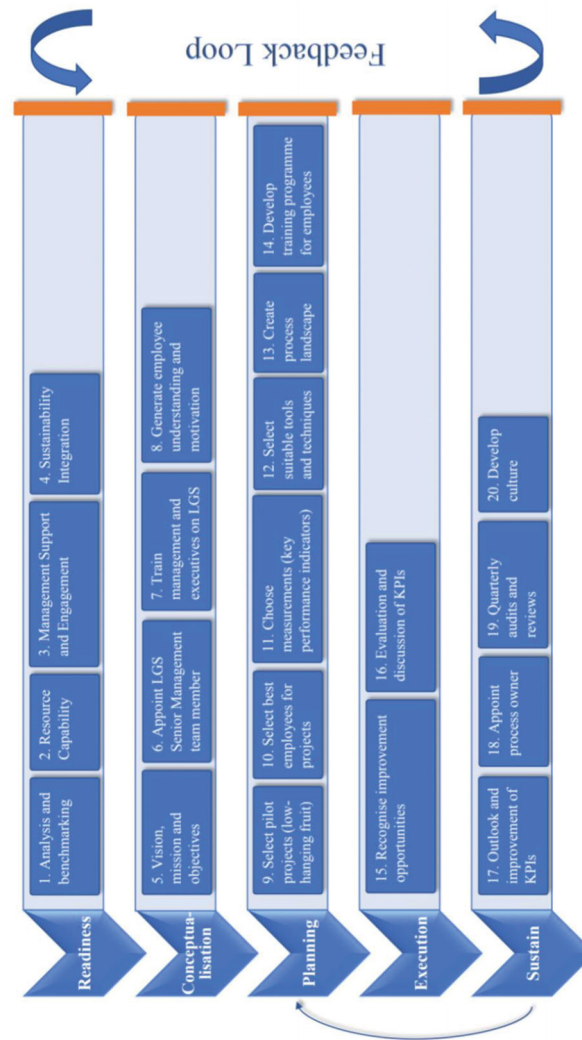


Figure 5. Original structure of the framework.

Step 2: Resource capability

Organisations also need to ensure the availability and capability of the necessary resources for a Green-Lean and Sustainability integration. These include labour skills, machines condition, materials quality and professional expertise. These aspects need to be considered in regard to both Lean and Sustainability requirements.

Step 3: Management support and engagement

Commitment and involvement of top management are crucial to the success of the initiative (Grigg, Goodyer, and Frater 2020). Managers must carry the implementation of RCEPS through their involvement, demanding results, supporting and motivating teams, removing barriers and monitoring progress (Cherrafi et al. 2017a). According to the Holistic Lean Transformation Consultant from Company G, 'once the owner of a company has acknowledged a topic as important, it is much easier to intensely promote the topic among the employees'. If management is not convinced and unwilling to invest, the initiative should not be pursued further, as the prospects of success are minimal (Albliwi et al. 2014; Snee 2010).

Step 4: Sustainability integration

The integration of Sustainability should not present an entirely new phenomenon for the company. While the aim of RCEPS is to enable the organisation to become more environmentally, socially and economically sustainable, the implementation of two wholly unknown concepts at once (Lean and Sustainability) may lead to incomprehension and resistance amongst employees. It is advisable to include Sustainability in the company strategy to generate an understanding of the basic concepts across all organisational levels.

The next phase of implementation should only begin after the execution of each preceding step and when the necessary criteria are met.

4.2. Phase 2: Conceptualisation

The conceptualisation phase establishes foundations and paves the way for a successful implementation of the two paradigms. It creates the knowledge, understanding, motivation and authority that is required for the initiative to continue effectively.

Step 5: Vision, mission and objectives

Developing a vision, mission and objectives will enable the organisation to create a holistic concept for GLS and demonstrate its commitment. A vision allows the company to give its employees an understanding of the reasons why the organisation is implementing GLS measures. It supports the development of a mindset that assists employees to see and embrace Green-Lean and Sustainability as a philosophy instead of a single project. The vision also describes the 5-year-goal that the company should set as a preliminary achievement. This long-term goal should be aligned to the company strategy (Grigg, Goodyer, and Frater 2020) and can be broken down into annual, short-term milestones to track progress more effectively.

Step 6: Appoint GLS senior management team member

Through the appointment of a GLS Senior Management team member (SMTM) or GLS executive department, companies can create a position solely responsible for the successful implementation of RCPES and its progress. These should be employees with expert knowledge on both Lean and Sustainability, or a minimum of two experts with individual knowledge on either Lean or Sustainability. Their responsibilities include framing the project charter, defining stakeholder requirements, identifying the areas to integrate GLS, conducting training and monitoring the advancement of the initiative. They represent the connection between the strategic management level and the operative level and need to be afforded the necessary trust, tools, freedom and authority to look after the implementation.

Step 7: Train management and executives on Green-Lean and sustainability

In order for the executives to bring GLS to a wider base, motivate employees and engage in the implementation of the RCPES framework, the management level needs to receive training for both Lean and Sustainability. This includes knowledge of tools, principles and the philosophy of each paradigm. This will allow the management to grow in the system. To save costs, training can be conducted by the GLS experts of the Senior Management team or through collaboration with non-profit organisations. Without an adequate level of knowledge, the implementation should not proceed, as the executives will be unable to meet their obligation of engaging in the process (Grigg, Goodyer, and Frater 2020).

Step 8: Generate employee understanding and motivation

Without the acceptance and commitment of employees, the integration of GLS has little chance of success (Alves and Alves 2015; Duarte and Cruz-Machado 2013). As the Master Black Belt of Company B summarised: *'The biggest crux is to get the people on board'*.

Staff should be openly integrated and educated on the change that is happening in the company, its reasons and the benefits for both employees and the company. A

thoughtful communication plan including newsletters, assemblies, team meetings, etc. can be established to generate trust and understanding (Cherrafi et al. 2017a).

4.3. Phase 3: Planning

This phase serves for the detailed preparation, specification and careful selection of resources for the execution of individual projects in the following stage.

Step 9: Select pilot projects (low-hanging fruit)

SMEs should start with simple pilot projects, also called low-hanging fruit, to gain confidence in the tools' effectiveness (Johansson and Sundin 2014), demonstrate savings potential (Su and Chou 2008; Duarte et al. 2012) and earn the trust and approval of management and employees. The selected projects need to be aligned to the company strategy (Grigg, Goodyer, and Frater 2020) and stakeholder requirements and can gradually move towards the bigger transformation of the processes. An important source of inspiration for potential pilot project selection, besides company strategy and stakeholder requirements, are for instance the United Nations Sustainable Development Goals. These 17 universal goals are designed 'to achieve a better and more sustainable future for all' and provide important directions for firms' sustainability performance improvement projects (United Nations 2022). It is important to present successful projects in the beginning, as employees and management will otherwise doubt the effectiveness of the entire initiative.

Step 10: Select best employees for projects

The right employees will come from all levels and areas of the company and possess good social and technical skills. It is advised to consider their availability, level of knowledge, commitment to the initiative and sense of responsibility (Cherrafi et al. 2017a). These employees need to receive the necessary training, tools and expertise to conduct the project.

Step 11: Choose measurements (key performance indicators)

The effectiveness of RCPES and the individual goals should be measured and documented with suitable KPIs (Aguado, Alvarez, and Domingo 2013; Duarte and Cruz-Machado 2013; Kurdve et al. 2014). According to the Master Black Belt of Company I, making problems measurable *'is the most important message of all Lean approaches'*. This makes the change towards the target state measurable, confirms whether the company is moving in the right direction and detects any deviations. For this purpose, both Lean and Sustainability KPIs appropriate to the projects should be chosen. It is necessary to obtain measurements of the current performance that can be compared to future results. Environmental, social and economic measurements should be identical for all projects to generate a basic understanding of the impact of the company's processes.

Step 12: Select suitable tools and techniques

The purpose of this step is to identify the most suitable and useful tools and techniques for the respective projects. While there are many tools available for Lean and Sustainability, they should be chosen according to their problem-solving ability and how well they can improve the measurements selected in step 11. Additionally, they should fit well with the organisational culture and available resources (Duarte and Cruz-Machado 2013; Alves and Alves 2015). A good starting point is the implementation of 5S, an easy and practical tool to improve workplace safety, organisation and cleanliness (Sobral, Sousa Jabbour, and Chiappetta Jabbour 2013). Further tools and their environmental and social benefit are described by Cherrafi et al. (2017a).

Step 13: Create process landscape

Creating a process landscape will optimally connect every process in the organisation, thereby removing further waste that is idle capacity. Production is strongly impacted by its linkage with upstream processes, which is why a company should be viewed as an organism. A process landscape connects information, work packages, responsibilities and expertise, and aims to cover the entire spectrum of the organisation. Integrated from the beginning, this will ensure that every employee possesses the necessary expertise and tools to accomplish the given task.

Step 14: Develop training programme for employees

For employees to be able to take part in the implementation, they need to be properly trained and educated on GLS concepts. Training programmes should additionally include soft skills such as team building, motivation and communication, based on the needs of the employees (Cherrafi et al. 2017a). Smaller workshops can be conducted ahead of each project to introduce specific tools. These programmes and workshops can again be performed by the SMTMs to save costs.

4.4. Phase 4: Execution

The execution phase comprises the execution of training programmes, improvement project execution and resulting change implementation.

Step 15: Recognise improvement opportunities

With the execution of projects and the collection of data, the team identifies root causes and develops and implements solutions to address these. Brainstorming sessions are encouraged to develop creative solutions (Cherrafi et al. 2017a).

Step 16: Evaluation and discussion of KPIs

A dialogue is initiated to discuss and evaluate the measured KPIs and find ideas and solutions for their improvement.

4.5. Phase 5: Sustain

This phase enables the company to ensure continuous improvement of its processes in the long term. It is an opportunity to consolidate the perception of GLS as a philosophy rather than a singular occurrence.

Step 17: Outlook and improvement of KPIs

Rather than looking at specific KPIs in the context of the individual project, this step concerns the prospects of overall KPIs. Managers and project team members should come together to discuss what the metrics should show in the future to advance towards the target state.

Step 18: Appoint process owner

Another important step to sustain the GLS initiative is to select one participating employee and hand over the responsibility for a particular process. This responsibility includes maintaining the achieved results (performance monitoring- and benefit tracking mechanisms), supervising other employees and reporting to the SMTMs. The employee should be chosen carefully and rewarded accordingly for the additional responsibility.

Step 19: Quarterly audits and reviews

It is important to carry out audits and reviews on a regular basis to update goals and objectives and to reassess employee willingness to change. Frequency is dependent upon the duration of the projects (e.g. biannually). They can be carried out internally, by the SMTM, or externally with the help of a consultancy. Instead of focussing solely on numbers and data, the reviews should encourage dialogues with employees to understand their adoption of the intended mindset.

Step 20: Develop culture

The last step aims at the cultural transformation of the company. Especially important for the Senior Manager Quality Management in Company J was *'what happens to the employees that are involved in the Lean projects. There should be a 'we'-feeling, a mindfulness and the celebration of success'*. Kumar, Antony, and Tiwari (2011) agree that successes should be celebrated. These can be communicated via newsletters, assemblies or other internal marketing opportunities such as the intranet. The generated environmental, social and economic benefits should be widely reported to increase commitment and enthusiasm around the Sustainability initiative.

Since Green-Lean and Sustainability address the continuous improvement of processes in an organisation, RCPES is an ongoing development. It is, therefore, recommended that companies return to the 'Planning Phase' after completing the first successful cycle of the framework, as well as after each conclusion of the 'Sustain Phase'. This gives the organisation the opportunity to continuously and systematically

Table 4. Framework feedback.

Company	Interviewee	Interviewee experience with Lean (years)	Feedback
B	Master Black Belt / Lean Manager	12	The framework should illustrate its compatibility with management systems such as QM or ISO. This can be covered by steps two and four (if it concerns a Sustainability system), as management systems should receive a separate implementation due to their scope. Hence, if the inclusion of management systems is deemed necessary, it should be taken care of in the Readiness Phase.
C	General Manager	3	While it is difficult to assess the implementation costs of the RCPES framework, a roughly estimated budget should be given in step two.
D	Green-Lean Consultant	8	The advantages of a joint GLS integration were considered unclear, but can and should be demonstrated through a number of steps (see Figure 5). This illustrates the reduced effort of carrying out only one implementation instead of two, and that better results can be achieved through the synergistic effects of GLS.
E	Head of Change Management	12	While an acknowledged definition of GLS does not exist to date, a general explanation of both concepts should be added to steps five and eight to ensure a general understanding. A visualisation of a process landscape can be included in step 13 as a practical addition.
L	Lean Manager	7	Benchmarking should occur more often than just during the readiness phase as otherwise market trends are not consistently observed. Therefore, benchmarking can be included in the audits and reviews of step 19.
Company X	Lean and Process Manager Ground Operations	5	The complexity of projects concerning strategy, tactics, etc. can be included in step 9.
Company X	Operations Manager	5	Where social and economic aspects are featured in the model, supplementary visualisation through colours or symbols can be added, while the engagement of employees in social actions and services can be added as a KPI in steps 16 and 17, as well as become part of the development of a culture in step 20.

increase productivity in the consumption of resources and enhance its Sustainability performance.

4.6. Feedback loop and tollgate review

The *Feedback Loop* between the five phases is designed around double-loop learning theory, which reflects upon and questions the fundamental procedures, norms and rules of an organisation to establish new knowledge (Argyris 1977). Feedback is gathered to challenge organisational methods and consequently identify opportunities to develop new practices, norms, policies or knowledge (Bagodi and Mahanty 2013). It may initiate a cultural change with long-term effects on a company. The cultural change requires open communication to enrich the dialogue, accelerate the flow of insights and thereby support learning (Jaaron and Backhouse 2017). Double-loop is considered a crucial learning system, as it not only complies with standards but also supports their improvement (Rauffet, Da Cunha, and Bernard 2014).

To ensure that every phase is completed, they are each additionally provided with a *Tollgate Review*. This is a formal process designed to ensure the continuous progress of a project. It should be executed by a Lean champion, who approves the accomplishment of each phase before the project leader and his team can proceed to the next (Antony, Vinodh and Gijo, 2016). For this purpose, the champion should utilise a checklist with key questions to be asked in each stage.

The RCPES framework was tested by seven experts. From these, five had initially been interviewed in the data collection process and two were not familiar with the model but had worked with Lean methods in the past. The overall feedback was positive and corroborated the general structure, all five phases and 20 steps of the framework. Table 4 presents

the experts' individual comments/feedback in regards to the proposed framework.

These comments can be fed into the individual steps or phases they refer to, which is additionally visualised in Figure 6.

5. Discussion and implications

The study demonstrated that the significant shortcomings in the understanding and application of Green-Lean and Sustainability in German SMEs can be overcome through a comprehensive, simplified and generic framework. Existing frameworks are useful primarily for larger organisations, and rarely consider the characteristics of SMEs (Piercy and Rich 2015; Verrier, Rose, and Caillaud 2016), such as a different structure, resources, orientation and culture. This study takes into account the main challenges SMEs face when confronted with implementing a new strategy. These reach from spare human resources and a lack of financial resources to an emphasis on short-term objectives and internal resistance from both management and employees. The paper, therefore, proposes a practical step-by-step guide that will aid SMEs, regardless of their industry, to implement Green-Lean and Sustainability successfully with limited budgets and resources over the long-term. The overarching aim hereby is to improve SME's environmental, social and economic performance and to ensure long-term success.

The paper will simplify the implementation of GLS in SMEs through a feedback mechanism that allows the rectification of errors at a later stage (Rauffet, Da Cunha, and Bernard 2014) and a Tollgate Review that is designed to ensure the continuous progress of a project (Antony, Vinodh and Gojo 2016). Organisations can choose tools and techniques appropriate to their company size and characteristics. In addition, the framework integrates and addresses social

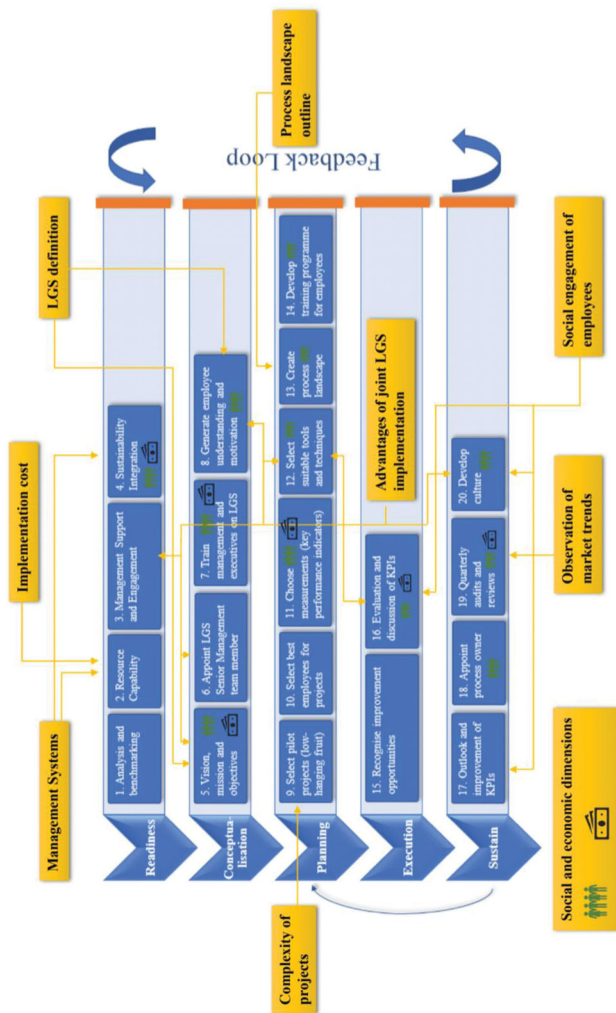


Figure 6. Revised version of the LGSF including expert feedback.

Sustainability, which has been almost entirely overlooked in the literature to date (Martínez-Jurado and Moyano-Fuentes 2014; Siegel et al. 2019). Since SMEs often emphasise short-term objectives to achieve quick results, the framework also incorporates methods to sustain the two strategies in the long term.

The framework is designed to be as easy to implement as possible for SMEs. However, its integration still requires an evolved company mindset and sufficient resource capabilities to start the journey of Green-Lean and Sustainability. The framework is oriented towards long-term success and therefore requires perseverance and diligence in the execution of activities such as the Feedback Loop and Tollgate Review.

Our findings suggest that the implementation of Green-Lean and Sustainability plays an important role in adapting to increasing stakeholder demands for sustainable operations and products. Thus, it is important to adopt these strategies for companies seeking the benefits from fair practices for the community, employees and partners, and the economic value that meets shareholder's expectations and which benefits the community and wider society. Our findings are particularly applicable to SMEs, who will be

encouraged to think, source and operate sustainably to preserve the environment and achieve long-term financial results.

The benefit of our study to SMEs is a step-by-step explanation of how to implement GLS that is specifically geared to their needs. The framework takes into account the main challenges SMEs commonly face, is based on the fundamental success factors that will allow SMEs to meet their goals, and has been reviewed, edited and approved by Lean practitioners. Challenges that might be encountered by SMEs with the adoption of LGS, such as the willingness of management to invest or the availability and capability of employees, are clearly defined and measures to overcome them are advised. Green-Lean practitioners in industry will find useful insights through our study as we offer a unique framework that implements Lean and Green, but additionally pays special attention to Sustainability, i.e. it incorporates all three dimensions including the social dimension, which has often been overlooked, and attends to the crux of sustaining Lean Green results in the long term. Besides SMEs, our framework can act as a useful guide for consultants as well as it is systematic, disciplined and has practical significance and value.

In terms of the theoretical implications gained from this study and its findings, it represents the first endeavour to help bridge the gap in the academic literature by studying and extolling the virtues of the GLS framework in providing social sustainability in the context of SMEs. In this sense, the research might be utilised as a starting point for analysing the current framework in other nations' SMEs. In exceedingly chaotic and uncertain times, social sustainability is a source that can assist organisations in expanding and gaining long-term competitive advantages. Several previous studies have been undertaken to investigate the impact of green-lean integration on the sustainability of larger organisations. These studies, however, were directly associated with environmental and economic sustainability. As a result, our understanding of the potential impact of GLS on social sustainability is still restricted. In this sense, this study seeks to fill this gap in the literature.

Researchers and academics can build onto our study to expand the framework by incorporating Six Sigma, for example. Our framework must also be tried and tested in practical circumstances. This study can serve as a basis to dive deeper into the connection and interdependence between Lean, Green and Sustainability.

6. Conclusion, limitations and further research directions

With increasing pressure in recent years for progress on the environmental and social performance of organisations and their products and services, Green-Lean and Sustainability have been established as strategic requirements (Cherrafi et al. 2017a; Garza-Reyes 2015b). Consequently, a number of frameworks and management systems have been introduced to accomplish a truly sustainable organisation. Our research demonstrated significant

limitations in the existing frameworks, especially for SMEs. Therefore, our study documents significant evidence for a five-phase framework, called RCPES, which incorporates Green-Lean and Sustainability concepts and their synergistic benefits to achieve long-term environmental, economic and social Sustainability in SMEs. The model was created to explore the potential benefits of jointly implementing Green-Lean and Sustainability approaches, with regards to reducing waste, energy, water and raw material consumption, fair practices for employees and economic benefit for the organisation and surrounding community. We identified particular challenges SMEs need to overcome when implementing the framework and addressed these by incorporating additional supporting measures.

To further advance research on this topic, it is important to highlight the issues and limitations of the study. Due to the novelty of research on Green-Lean, Green-Lean theory lacks an acknowledged research definition and has a restricted number of studies that provide evidence of its workings. The sample size of interviews conducted is relatively small. Given that this is the first theoretical testing of the framework, it is crucial to assess the validity of the model by repeating the approach with larger samples. In addition, the geographical focus of our study was Germany. Hence, samples must include additional geographic locations to ensure the viability of the framework in different geographical settings. These could provide further insights and strengthen the results of our evaluation. Should these results reflect different styles of leadership and organisational cultures in other countries, it is important to adapt the framework accordingly, especially when testing the framework in practice. Applying the framework in a real industrial setting is also part of the future research directions suggested to be conducted to advance the present research. This will allow testing the suitability of the proposed framework in different industrial sectors. Finally, incorporating financial measures such as return on investment (ROI) as part of the framework can also be investigated in future research to help in the selection and success measurement of projects.

Above all, the RCPES remains a conceptual framework that must be tested in a real-life environment. It is recommended to test the framework in several companies with diverse organisational characteristics and of various industry backgrounds, as these will be affected by different environmental and social conditions. The implementation on-site should be supported by discussions with both experts and researchers and should include oral and written feedback, workshops and seminars. The framework should be employed in a single company to test its validity and applicability and to make any required changes before rolling it out to other companies (Cherrafi et al. 2017a).

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors



Rebecca Siegel Rebecca Siegel holds a Master of Science in International Business Management and Sustainability Management from Heriot-Watt University, Scotland, and has worked and studied in London, New York, Edinburgh, Brisbane and Auckland. With a strong interest in Sustainability and Lean Management, she supports clients across industry sectors with successful strategies to improve the environmental and social performance of their products, services and processes for long-term success.



Jiju Antony is recognised worldwide as a leader in Lean Six Sigma methodology for achieving and sustaining process excellence. He is currently serving as a Professor of Industrial and Systems Engineering at Khalifa University in Abu Dhabi, UAE. He is a Fellow of the Royal Statistical Society (UK), Fellow of the Chartered Quality Institute (CQI), Fellow of the Institute of Operations Management (FIOM), Fellow of the American Society for Quality (ASQ), Fellow of the Higher Education Academy, Fellow of the International Lean Six Sigma Institute, Fellow of the Institute of the Six Sigma Professionals (ISSP) and an Academician of the International Academy of Quality (IAQ). He is a Certified Lean Six Sigma Master Black Belt and has trained over 1200 people as Lean Six Sigma Yellow, Green and Black Belts from over 20 countries representing over 170 organisations in the last 10 years. Professor Antony has coached and mentored several Lean Six Sigma projects from various companies in the UK ranging from manufacturing, service to public sector organisations including the NHS, City Councils, NHS 24, Police Scotland, ACCESS, Business Stream, and a number of Universities. Professor Antony has authored over 500 journal, conference and white papers and 12 text books. He has won the outstanding contribution to Quality Management Practice Award in 2019 from the Chartered Quality Institute (UK); Life time Achievement Award for his contribution to Lean Six Sigma from the International Lean Six Sigma Institute (UK) in 2020 and Outstanding Contribution to Six Sigma Practice award from the Institute of Six Sigma Professionals, UK in 2021. His book on Ten Commandments of Lean Six Sigma: a practical guide for senior managers has won Walter Mazing Book Price in 2021 (International Academy of Quality, USA) and Crosby Medal (American Society of Quality, USA) in 2022.

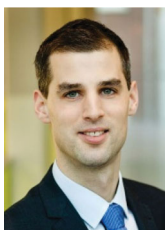


Kannan Govindan is currently a Distinguished Professor with the China Institute of FTZ Supply Chain, and the Head of Intelligent Supply Chain Centre and the Professor and Head of Centre for Sustainable Supply Chain Engineering with the Department of Technology and Innovation, University of Southern Denmark, Odense, Denmark. He has been recognised as a Highly Cited Researcher within 'Engineering' for the fourth year in a row (2018, 2019, 2020, and 2021) from Thomson-Reuters/Clarivate Analytics. He has authored/coauthored more than 290 international journal articles (more than 37469+ citations and H-index of 105) in leading journals such as Nature, Omega, Decision Sciences, European Journal of Operational Research, Journal of the Operational Research Society, Journal of Environmental Management, Renewable and Sustainable Energy Reviews, Journal of Cleaner Production, Computers and Industrial Engineering, Ecological Indicators, Transportation Research Part E: Logistics and Transportation Review, Transportation Research Part D: Transport and Environment, Transactions on Systems, Man, and Cybernetics Part A: Systems and Humans, European Management Journal, Computers and OR, International Journal of Production Economics, and International Journal of Production Research.

Many of his papers were selected as the ESI top 1% highly cited papers or 0.1% hot papers or identified and highlighted as the Key Scientific Article contributing to the excellence in Engineering and Environmental research (Source: Web of Science). His research interests include digital supply chain, Industry 4.0 on supply chain, sustainable development goals, reverse logistics, closed-loop supply chain, digitalised sustainable circular economy, green supply chain management, and sustainable supply chain management. Dr. Govindan is an Executive Editor of the Journal of Cleaner Production, an Associate Editor of Transportation Research Part E: Logistics and Transportation Review, a Senior Editor of Industrial Management and Data Systems, an Editor of Annals of Operations Research, an area Editor of INFOR: Information Systems and Operational Research, an area Editor of Computers and Industrial Engineering, and was a Guest Editor in journals such as Decision Sciences, European Journal of Operations Research, Computers and OR, Annals of OR, Journal of Cleaner Production, and International Journal of Production Economics. Finally, he was an Editorial Board Member of several international journals.



Jose Arturo Garza-Reyes is a professor of Operations Management and Head of the Centre for Supply Chain Improvement at the University of Derby, UK. He is actively involved in industrial projects where he combines his knowledge, expertise and industrial experience in operations management to help organisations achieve excellence in their internal functions and supply chains. He has also led and managed international research projects funded by the British Academy, British Council, European Commission and Mexico's National Council of Science and Technology (CONACYT). As a leading academic, he has published over 200 articles in leading scientific journals, international conferences and seven books. Prof. Garza-Reyes is Associate Editor of the Int. J. of Operations and Production Management, Associate Editor of the Journal of Manufacturing Technology Management, Editor of the Int. J. of Supply Chain and Operations Resilience and Editor-in-Chief of the Int. J. of Industrial Engineering and Operations Management. Areas of expertise and interest for Professor Garza-Reyes include Operations and Production Management, Supply Chain and Logistics Management, Lean and Agile Operations and Supply Chains, Sustainability within the context of Operations and Supply Chains, Circular or Closed-Loop Operations and Supply Chains, Sustainable and Green Manufacturing, Industry 4.0 technologies application in operations and supply chains, Lean Management, Quality Management & Operations Excellence and Innovation Management.



Bart Lameijer is Assistant Professor of Business Analytics at the Department of Business Analytics of the University of Amsterdam Business School, the Netherlands. Furthermore, he is co-director of the Institute for Business and Industrial Statistics at the University of Amsterdam Business School. His expertise lies in Lean management and Six Sigma implementation for Operational Excellence purposes, and his research interests centre around both organisation-wide and project-level data-driven process improvement methodology implementation.



Ashutosh Samadhiya is a research scholar of production and operations management and pursuing PhD from the Department of Management Studies at the Indian Institute of Technology Roorkee, India. His research area includes lean, Total Productive Maintenance (TPM), Sustainable Manufacturing, Design Thinking and Innovation management. He has presented papers in many recognised International conferences such as POMS and IEOM

and published one Indian Patent. Mr Samadhiya was selected for the prestigious Newton Bhabha fellowship 2021. He completed his visit as a visiting research fellow at the University of Derby, UK, under Newton-Bhabha PhD placement programme 2021.

ORCID

Jiju Antony  <http://orcid.org/0000-0002-8197-5736>
 Jose Arturo Garza-Reyes  <http://orcid.org/0000-0002-5493-877X>
 Ashutosh Samadhiya  <http://orcid.org/0000-0002-7613-7252>

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Appendix 1 Interview protocol

No.	Question
General Questions	
–	What is your position in this company?
–	How long have you worked for this company and how long have you and the organisation worked with Lean methods?
–	What is your role or responsibility in regards to the Lean operations in your company?
Questions about Lean	
1.	What is your understanding of the term “Lean” and how do you define it from your own perspective?
2.	What are the strategic goals of Lean for the current management? (Zhang and Awasthi 2014)
3.	What are your company’s current operational, strategic and tactical benefits? (Zhang and Awasthi 2014)
4.	How much of investment has your company allocated to continuous improvement methods? (Zhang and Awasthi 2014). In your view, what is the ratio of investment on Lean to benefits achieved from Lean implementation (on a scale of 1:1 to 1:10)?
5.	What percentage of the employees have been trained on Lean Production System and how many days of training have they received? (Daily and Huang 2001)
6.	How many Lean projects on average have employees executed per year? (Cherrafi et al. 2017b) Have the projects been carried out in production setting or have you deployed Lean across the whole business? If so, where else you have applied Lean within the business (e.g. Lean in HR, Lean in Finance? Lean in Product design and development)? (Piercy and Rich 2015)
7.	How do you measure the success of Lean implementation? (Aguado, Alvarez, and Domingo 2013)
8.	What are the key lessons learned from the implementation of Lean? What are the difficulties of implementation and what should other businesses look out for when considering to implement Lean? (Aguado, Alvarez, and Domingo 2013)
Questions about Green-Lean and Sustainability	
9.	The term Green-Lean addresses the combination of Lean efforts with environmental management to increase resource efficiency and reduce costs. Do you see a synergy with these two approaches, or are they competing with each other? (Dües, Tan, and Lim 2013)
10.	Does your company deploy any environmental management systems, or does it address the environment with other methods such as energy or water management, reduced CO2 emissions, etc.? If not, why? (Garza-Reyes et al. 2014)
11.	Do you see benefits in the combined implementation of Lean and Green as a single approach? Would it be conceivable and useful to combine Green-Lean for your company? (Dües, Tan, and Lim 2013)
12.	The term Sustainability does not only address the environment, but comprises three dimensions, and it is completed through economic (e.g. long-term and sustainable economic growth) and social (e.g. human rights and workers’ rights, community engagement) aspects. (Verrier et al. 2014; Alves and Alves 2015) Does your company address the other two components of Sustainability in any way? If not, why?
13.	Finally, Sustainability also implies the ability to sustain Lean (and Green) efforts in the long-term. How does your company intend to achieve this? (Wong and Wong 2014)
14.	How important is the topic of Green-Lean and Sustainability for your company? Do you see a need for action? If yes, why? (e.g. Government regulations, climate change, lack of resources) (Daily and Huang 2001)
15.	In your opinion, what are the obstacles for implementing a sustainable strategy and which aspects need to be addressed in an organisation to overcome these? (Zhang and Awasthi 2014)