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ORIGINAL CONTRIBUTION

Research Gap on Lean-Green Integrated Approaches and Its Impact on Sustainability Performance: A Post COVID-19 Reminiscence

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Abstract— This study is not about the evolution of Lean or Green Practices but the latest developments of its integration in positive and negative ways and their main classification, benefits, and limitations. We critically assess previous research from various theoretical perspectives in the lean-green domain. Review is conducted after the COVID-19 pandemic. It guides significant awareness related to ecological and environmental issues helping the organizations, governments, and other stakeholders in economic recovery and environmental security and the conservation of natural resources. We use the five-criteria approach for conducting the literature review. Time chosen for this systematic literature review is 2010 to 2021. 61 research articles used to analyze and explore the impact of integrated lean-green concepts and ultimately its results on triple bottom line (TBL) performance of the organizations. Comprehensive results show that integrated lean-green approaches have significant impact on a firm's sustainability performance, although few research studies have negative results and related trade-offs as well. Findings and conclusions are beneficial for researchers, organizations, governments, and other stakeholders because this paper has the critical and comprehensive explanation of different classifications, theoretical perspectives, benefits, limitations, and related future directions of lean-green integration. As this study is conducted after the COVID-19 pandemic, this review guides significant awareness related to the environment for economic recovery and environmental security as well as the conservation of natural resources.

Index Terms— Lean manufacturing, Green manufacturing, Sustainability, Covid-19, Triple bottom line, Performance

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Introduction

For a long time, the primary focus of manufacturing techniques has been on meeting and developing customer needs while attempting to attain competitiveness in terms of product design, product quality, product delivery, and innovation (Abualfaraa et al., 2020; Leong et al., 2020). Companies are currently employing creative techniques to boost operational efficiency and cut manufacturing costs to remain competitive in the market (Cherrafi et al., 2017; Teixeira et al., 2021). A well-known method to continuously improve operational production performance is Lean Manufacturing. After world war II, the Toyota production system (TPS) developed and utilized a Lean

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Manufacturing strategy that consists of multiple production techniques such as Continuous Flow, 5S, Just-in-Time, Kaizen, Kanban, Continuous Improvement, PDCA, Poka-Yoke, Single-Minute Exchange of Die, Process Improvement, Takt Time, Total Productive Maintenance and elimination of waste to continuously improve the product quality, customer satisfaction, flexibility, efficiency, effectiveness and overall profitability (Carvalho, 2010; De et al., 2020; J. A. Garza-reyes & Garza-reyes, 2015; Inman & Green 2018; Singh et al., 2021).

Organizations working in different sectors such as the service sector, manufacturing, hospitality, education, and healthcare face various ecological and environmental concerns, including operational waste. Greenhouse gas emissions such as carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4), fluorinated gases, and water vapor are among the most well-known environmental concerns (Bai et al., 2018; Galli et al., 2012; Singh et al., 2021). Green House Gas emissions are produced in the organization's production and operational processes and the Supply chain process of acquiring goods and materials via transportation and logistics (Tseng et al., 2019). Companies also face global resource constraints, such as water, energy (Fuel and Electricity), and raw materials (Mangla et al., 2018; Tripathi et al., 2021). Abrupt disruptions, such as the current global economic disruption accompanied by a significant increase in ecological and environmental awareness because of COVID-19, have highlighted the strategic need to assist organizations, governments, and other stakeholders in both economic recovery and environmental security as well as the conservation of natural resources. Framework is necessary that improves the organization's overall environmental performance without compromising the firm's operational objectives and goals. As a result, the green paradigm emerged. "Green" is defined as operational philosophy that gradually improves the system's environmental efficiency, primarily reduces the product or service's negative environmental impact, and maintains or improves the firm's financial success (De et al., 2020; Garza-Reyes, 2015; Inman & Green 2018; Tripathi et al., 2021).

Because both lean and green concepts are primarily aimed at achieving similar results, academic specialists have been examining and exploring the similarities between the two concepts to achieve the common goals through their integration. For example, Honda US Plant that was able to apply lean manufacturing techniques to teach workers to solve environmental challenges effectively. It is possible practically because of the company's proactive culture and, more broadly, due to the system's lean green integration (Teixeira et al., 2021).

Many studies believe that Lean and Green are naturally aligned and have similar qualities in the operations management field (Dieste et al., 2019; Huo et al., 2019; Leong et al., 2020). As a result, researchers have proposed a consistency of Lean and Green concepts and that the two can effectively collaborate in a way that has a direct positive influence on a company's operational, environmental, and social performance (Marques et al., 2019). Both the Lean and Green approaches can boost the company's competitiveness sustainably (Azevedo et al., 2012; De et al., 2020; Singh et al., 2021). In this scenario, companies are required to become more proactive regarding their social and environmental stance, which leads to the adoption of more sustainable manufacturing practices, which is well-known as Triple-Bottom-Line (TBL) sustainability (Abualfaraa et al., 2020) illustrated in Figure 1. According to TBL, an organization can achieve sustainable performance if it can simultaneously improve its economic, environmental, and social performance gradually. As a result, experts have begun to think about lean manufacturing practices in the context of producing greener solutions. Furthermore, such a production system can minimize operational waste and lower the harmful impact on the environment and social aspects caused by traditionally used industrial practices.

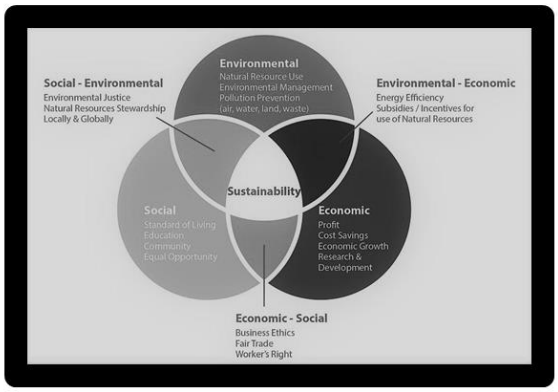

Fig. 1. The three pillars of sustainability performance (TBL)

For researchers and practitioners, combining lean manufacturing principles with green approaches is a difficult, challenging, and complex task (J. A. Garza-reyes & Garza-reyes, 2015; Kurdve et al., 2014; Marhani et al., 2013; Maruthi & Rashmi, 2015; Singh et al., 2021). Furthermore, while the study on the individual implementation of lean manufacturing and green manufacturing approaches is advancing, there is still a lot of research and investigation to be done on their combined effect as a single integrated approach (J. A. Garza-reyes &

Garza-reyes, 2015; Kurdve et al., 2014; Tripathi et al., 2021). Furthermore, according to a literature review published in a recent research study by (J. Garza-reyes et al., 2016; Leong et al., 2020), conflicting results and outcomes have been documented regarding whether lean manufacturing approaches and green manufacturing are genuinely suited to combine in a single framework. On the one hand, certain research studies support their integrated approach to the firm's sustainability performance (J. Garza-reyes et al., 2016; Kurdve et al., 2014; Teixeira et al., 2021), arguing that both techniques can assist each other to provide a synergetic impact, with their strengths steadily increased while system weaknesses are mitigated. On the other hand, several research investigations (Sundar et al., 2014) argue that these two manufacturing practices contradict each other while attaining their fundamental goals and are, in certain situations, incompatible. In this contradictory environment, a detailed literature review research is needed to assess the real-time ability of lean and green manufacturing practices to work together in an integrated framework, with having a significant impact on TBL performance in terms of economic, environmental, and social outcomes. It is also worth noting that most literature evaluations that combine the lean-green principles do not go into considerable depth about social performance.

So, the current review adds the novel contribution to the lean-green literature by conducting systematic review research to identify the most related lean-green integrated strategies and techniques currently available in the literature, their combined effect on sustainability performance, and their main classification, benefits, and limitations. Past literature reviews have primarily focused on operational performance, environmental performance, and the least on social performance. This literature study further analyses the capacity of Lean-Green integration to achieve social performance while focusing on organization's production system. Instead of focusing on the evolution of the Lean-Green concepts, this systematic literature review primarily focused on the latest advancements in this field. Furthermore, we critically assess previous research from various theoretical perspectives in the lean-green domain.

This review is beneficial to researchers, organizations, governments, and other stake holders because this paper has the critical and comprehensive explanation of the Lean-Green integration on sustainability performance and elaborate different classifications, theoretical perspectives, benefits, limitations, and related future directions. As this study is conducted after the COVID-19 pandemic, so this review guides significant awareness related to ecological and environmental issues helps all stake holders in both economic recovery and environmental security as well as the conversation of natural resources.

Research Methodology

A systematic literature review is beneficial in identifying research gaps in the current literature and provides a critical overview of the field of study (Garza-Reyes, 2015). We use the five-criteria approach for conducting the literature review, which includes:

- Focusing on a specific theme (Integration of lean-green manufacturing practices and their impact on firm's sustainability performance)
- Searching various databases for the most relevant articles
- Pre-determining a protocol for article inclusion and exclusion criteria
- Comprehensive analysis of selected articles
- Critically discuss the findings in this field, as well as future research opportunities and directions for researchers.

Research questions

Considering the research gap discussed in first section, the following research questions formulated for this systematic literature review:

- To identify and critically examine the various theoretical perspectives, classifications, and linkages of Lean-Green integration in the context of sustainability performance.
- What are the various bundles of Lean-Green combinations used in the literature to effectively apply the combined lean-green impact for sustainable performance?
- Critically examine the latest developments and discuss future research paths on Lean-Green integration and their impact on sustainability performance.

Location and selection of the studies

To begin, Google scholar is used to searching for related publications using lean-green concepts, as it is a comprehensive database that many researchers use. Google scholar makes it easier to find articles from various sources, including research thesis, books, and peer-reviewed conference papers, as it integrated the data from several databases. This initial, unstructured search of papers connected to lean-green practices provided a general sense of the depth of research studies undertaken in the field of lean-green practices. Following that, the below mentioned electronic databases are used for the final search.

- Elsevier (www.sciencedirect.com)

- Emerald Insight (www.emeraldinsight.com)
- Springer Link (www.link.springer.com)
- Taylor & Francis Online (www.tandfonline.com)
- ProQuest (www.proquest.com)
- InderScience (www.inderscience.com)
- Wiley (www.onlinelibrary.wiley.com)
- Google Scholar (www.scholar.google.com)
- Semantic Scholar (www.semanticscholar.org)

Existing literature reviews show that the development of Lean-Green research primarily began around 2010 (Caldera et al., 2017; Garza-Reyes, 2015), the time chosen for this systematic literature review is 2010 to 2021.

The keywords used in initial search terms comprised of "Lean-Green Manufacturing", "Sustainability Performance", "Lean-Green Integration", "Triple Bottom Line (TBL)", "Economic and Social," "Economic and Environmental", and "Social and Environmental", to collect the lean-green articles that involved focusing on all TBL aspects, which are social, economic, and environmental perspectives. As earlier mentioned, several electronic databases were explored to systematically narrow down the article search, including Science Direct, Elsevier, Taylor & Francis, Emerald, Google Scholar, Springer link, ProQuest, InderScience, Semantic Scholar, and Wiley. In the existing literature reviews, particularly by (Cherra et al., 2016; Dhingra et al., 2014; Dues et al., 2013; Garza-Reyes, 2015), were suggested the additional keywords for searching, which are "Lean Manufacturing", "JIT", "TPS", "TQM", "Sustainability", "Six Sigma", "Green Manufacturing", "Supply Chain Performance" and "Lean-Green Practices". Several research articles were found, including those that looked at lean and green independently. These papers were excluded because the main objective of this literature review was to focus solely on combined effect of lean-green integration. In the subsequent stage, we exclude those Lean-Green integration studies that focus on only one aspect of TBL rather than two or all three components of TBL (operational, environmental, and social). At the final stage, we applied the snowballing technique to locate new lean-green integration related publications from the reference list of the previously selected research articles. We have a total of 93 articles according to the systematic search. During the initial assessment, 32 more articles were filtered out due to duplication or being outside our objectives' scope. The articles were mostly excluded because the integration of lean-green principles was not well described in the main text, and the influence of lean-green on all three components of TBL is not explored. Finally, 61 research articles analyzed and explored the integration of lean-green concepts and their impact on sustainability performance.

Criteria of inclusion and exclusion of studies

As our primary objective of this literature review is to thoroughly investigate the integrated Lean-Green approach with all TBL aspects, we exclude those papers that study Lean and Green independently rather than in an integrated way. We also exclude those Lean-Green integration studies that focus on only one aspect of TBL rather than combining two or all three components of TBL (operational, environmental, and social). We only include articles that focus on two or all three TBL aspects in a single study. We exclude all those papers that deal with only one TBL aspect of measuring sustainability performance. Furthermore, we include articles related to the manufacturing sector and exclude the service sector-related articles. In the end, we only include those articles written in English; other language-related papers are excluded.

Search results

Content analyses are utilized to analyze the selected articles in this Literature review (Hsieh et al., 2005). We categories the data from these publications in the findings section below according to Year of Publication, Target Country, Country of Research, Research Sector, Type of Data Collected and Theories Used.

Literature Review Findings

As we review the 61 articles, so in figure 02, descriptive data shown related to number of publications per year selected for this review. It is clearly shown that from 2015 onwards, there is increased trend shown related to lean-green integrated research and its impact of sustainability performance. In figure 03, descriptive data shown related to articles target country. It means that selected article researched in single country of more than on country (multiple countries). So, 51 articles done its research based on single country. In figure 04, descriptive data is shown related to country of research and out of 61 selected articles, 12 focused on India for research, 10 articles done its research in UK. It shows that India and UK are doing more research on lean-green integration among others. In figure 05, descriptive data shown by research sector focused on selected articles of systematic review. 19 articles have done its research on manufacturing sector, 14 have focused on automotive industry and other industries are aerospace, agriculture, chemical, construction, electronic, energy,

food, furniture, IT, textile and apparel and tile sectors. In figure 06, descriptive data shown related to type of data collected related to qualitative and quantitative. 32 selected articles have quantitative research methodology used for lean-green integration measurements and 9 articles used qualitative approach to explore this phenomenon more in details. 20 articles used mixed method approach. Figure 06 shows the theories used selected articles and 11 articles used sociotechnical systems theory. 10 articles used systems theory, 7 articles used actor-network theory, 6 articles used theory of learning, 5 articles used core competence theory, and others are contingency theory, complexity theory and relational coordination theory. Some articles not clearly mention the theory used so we show it in others.

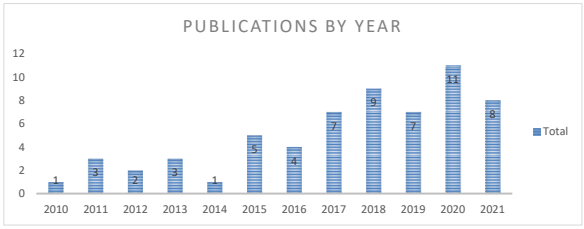

Fig. 2. Descriptive data by number of publications per year

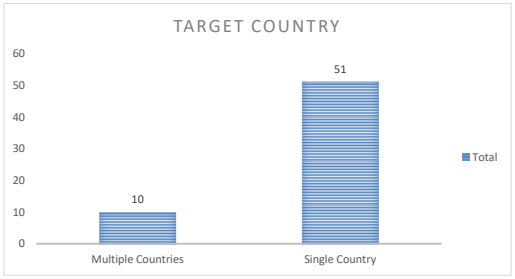

Fig. 3. Descriptive data by number of publications by target country

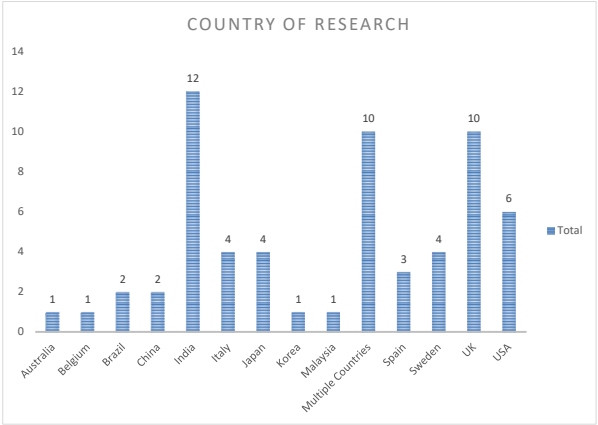

Fig. 4. Descriptive data by country of research

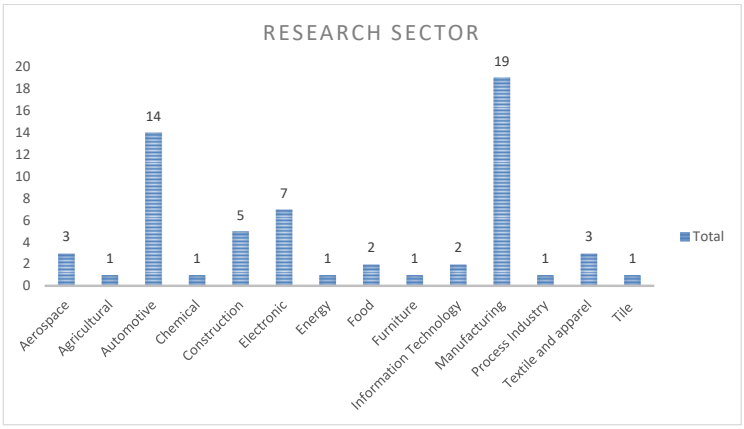

Fig. 5. Descriptive data by research sector

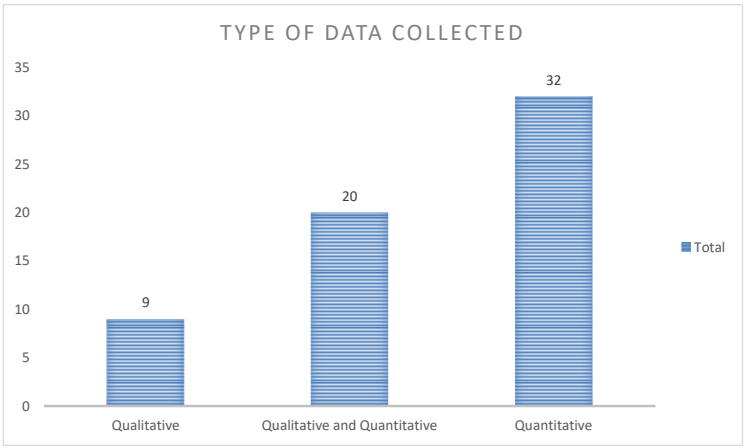

Fig. 6. Descriptive data by type of data collected

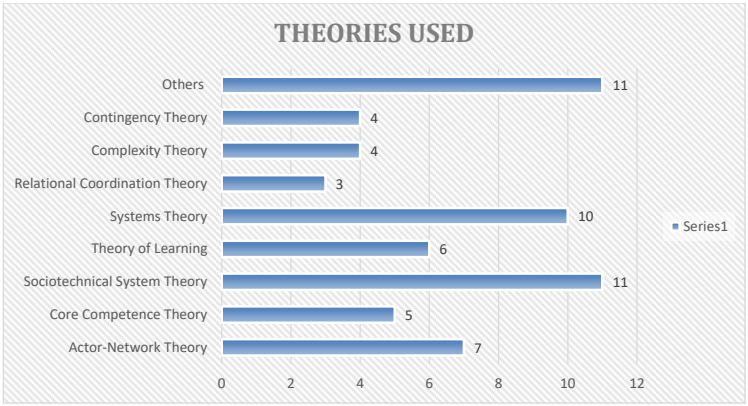

Fig. 7. Descriptive data by theories used

All the main theories used in selected articles are given in Table I below (McGibbon & Van Belle 2015; Muraliraj et al., 2018; Asif, 2020; Belinski et al., 2020; Haque, 2021; Li et al., 2019; Fang & Zhang 2018).

Table I
Data Classification

Theories Used	Definitions
Actor-Network Theory	Everything in the social and natural worlds occurs in continually evolving networks of connections and relationships, according to actor–network theory. Objects, things, ideas, methods, relationships, and any other related components are regarded as equally significant as humans in the formation of social circumstances and related situations.
Core Competence Theory	The backbone of a company's competitiveness is a well-coordinated combination of different resources, skills and abilities that distinguishes it in the competitive marketplace.
Sociotechnical System Theory	Sociotechnical systems theory is a technique to complex organization 's work designs that emphasizes the relationship between people (humans) and technologies. It also relates the interaction between society's complex infrastructures & procedures and human interactive behavior.
Theory of Learning	Organizational Learning Theory is concerned with the generation, utilization, and application of knowledge & ideas inside a company. Learning occurs when individuals engage while identifying, finding, and solving the related problems.
Systems Theory	The multidisciplinary study of systems and networks, i.e., organized sets of connected, interdependent and interrelated pieces that may be naturally occurred or human made. Every system can be defined by its structure, organization, and objective, confined by time and space, impacted by its surroundings & related environment, and represented by its operation.
Relational Coordination Theory	Common shared goals, sharing of knowledge, and mutual understanding & respect facilitate consistent, prompt, reliable, problem-solving communications, and it's also allowing stakeholders to synchronize their activity productively & effectively beyond boundaries.
Complexity Theory	This theory is based on interaction and interconnected feedback processes that keep changing organizational systems. Theory application topics include learning how organizations adjust to their settings and coping with unpredictable circumstances.
Contingency Theory	This theory claims that an organization's framework is shaped by the environment of the company, and that to improve productivity & performance, companies should adjust their processes and structures to that environment.

Lean manufacturing practices and green manufacturing practices when integrated then its shows usually a significant trend related to sustainability performance. Few bundles related to lean manufacturing practices are identified in literature review. These practices are:

Lean Manufacturing Practices	Continuous Improvement (Kaizen), Error-Proofing (Poka-Yoke), 5S (Sort, Set-in-Order, Shine, Standardize, Sustain), Kanban, Just-in-Time, Stop the Line (Jidoka), Takt Time, Production Leveling (Heijunka), Value Stream Mapping, Demand-based flow (pull) manufacturing, Process Management Using Statistical Process Control, Lot Size Reduction, Setup Time Reduction, Total Quality Management, Total Productive Maintenance

Moreover, few bundles related to green manufacturing practices are identified in literature review. These practices are:

Green Manufacturing Practices	ISO 14001 Certification, 5R (reduce, reuse, recycle, recover, reject), Total Quality Environmental Management, Green Purchasing, Green Technology and Techniques, Green Transportation, Energy Efficiency, Renewable Energy, Conservation of Natural Resources

A critical literature review findings below comprehend the overall viewpoint related to Lean-Green integrated approach and its ultimate impact on sustainability performance of organizations production system.

The economic perspective

Bottom-line savings, both operational and financial, are achieved through lean and green methods. By implementing lean-green integrated methods, company increased its profitability as few case studies highlighted this phenomenon. The implementation of lean concepts in organizations (like; total quality management, total quality management, just-in-time, and collaborative stakeholder relationships) resulted to create serious upper level experiences in developing a proactive and constructive environmental management procedures, which ultimately leads to improved the organization 's competitive advantage by lowering operational costs while improving distribution efficiency and performance (Thanki et al., 2016; M. G. Yang et al., 2011).

Lean and green integration may not have had a significant and positive influence on economic performance. Combining lean with green initiatives does not boost firm's profitability directly (Hallam & Contreras, 2016; Tripathi et al., 2021). Furthermore, both may enhance productivity and output in the long run, lowering operational expenses. Green supply chain techniques, but at the other side, were observed sometimes to limit financial gains by rising operational costs or manufacturing time. This result is consistent with (Carvalho, 2010; Tripathi et al., 2021), which found the green supply chain of the firm has a minor straight influence on economic performance of the firm, that would have an indirect effect through improved productivity and efficiency, customer loyalty and satisfaction, and decreased environmental expenditures. Similarly, it is discovered a complicated relationship between lean-green integrated management and financial success of the firm (M. G. Yang et al., 2011;).

Financial performance of the firm can apparently be unfavorable since firms must invest in human capital, infrastructural, and social capital to apply different environmental management techniques. Therefore, positive environmental performance of the firm, such as reducing waste or reduce pollution and harmful emissions, contributes to higher institutional market valuations when companies planned it as long term. Cost of production, productive output, quality and reliability, flexibility, speed, frequency, resource consumption, costs of environmental protection, stock levels, lead time of various manufacturing and operational process, were all used to calculate the overall firm's economic impact. Several research investigated the cash cycle, return on assets, and net operating profitability (Cabral et al., 2012; Carvalho, 2010; Teixeira et al., 2021).

The Environmental Perspective

According to several studies, lean supply chain management along with green supply chain management have a positive association as the minimizing waste is the main objective of both lean-green practices (Hajmohammad et al., 2013; Yadav et al., 2021). "Lean is green" also refers to how lean management experiences assist firms in their transition to green management. Various lean concepts, like; implementing the international standards of ISO or limiting storage and inventory, improve the possibility of implementing environmental programs & related management systems, reducing waste, pollution control, and emission reduction, a conclusion that is backed up by the research (Castka & Corbett, 2013). Green management (when integrated with lean management) has been shown to minimize waste across the 'entire supply chain process,' including designing, manufacturing, production control, plant management and the overall supplier network (Hallam & Contreras, 2016). The combination of lean-green integration observed that if both concepts executed simultaneously, then its improve the ecosystem and its related environment (Teixeira et al., 2021; Verrier et al., 2016).

Much research, on the other hand, highlights unintended impacts of integration of lean-green concepts and examine several integration mediating elements. For example, the degree to which lean along with green practices have been adopted (and the extent to which they have been integrated) appears to moderate the advantages and related benefits: firms which use beneficial tasks from these two approaches beat those that address two approaches independently (Caldera et al., 2017; Galeazzo et al., 2014; C. L. Yang et al., 2010; Yadav et al., 2021). Combining lean and green approaches can lead to environmental advantages if they are innovative, properly planned, and properly deployed. Collaborative and supporting working practices such as employee empowerment, employee engagement, top executives' participation in daily production line activities, and supply chain collaborative integration are further elements that influence integration between lean and agile practices towards greener results. Between productions manager and sustainability managers, it is very important to develop the cross-functional teamwork so that they collectively achieve overall sustainability objectives of the firm (Longoni & Cagliano, 2015). Managers from the productions and operations area should be engaged in sustainability goals and in decision making

process, sustainability managers are involved and linked to productions managers, thanks to an enhanced organizational structure. Finally, employees should work together to implement the decisions. A lean supply chain, according to Martínez-Jurado & Moyano-Fuentes (2014), supports long-term cooperative and collaborative connections all over the supply-chain network, it promotes ecological and environmental practices from shaping to making the product take-back. Pampanelli et al., (2014) explained cumulative effect of these two approaches and it might be useful for the ecological system because two approaches focus minimizing waste, increased output through better resource usage, and cooperative supplier relationships. According to Jabbour et al., (2013), lean concepts plays very important significant impact on ecological system, which impacts manufacturing efficiency and related performance of the firm. Some studies, on the other hand, indicate that combining lean and green approaches is unachievable. Because of the inherent contradictions in these two approaches, (Hajmohammad et al., 2013; M. G. Yang et al., 2011) argue that lean practices may not enhance ecological performance alone. Internally and operational waste management is the main emphasis of the earlier, whereas environmental related emission and waste reduction are the main emphasis of the latter. From these research, lean principles can only have an impact on environmental performance through a variety of environmental management tools and methods like life cycle assessment, accreditation, and ISO certifications, and so on.

Another important body of research examines the effects of lean and green integrated approach on environmental performance measurements in organizations. The effect is quantified in a various method, including reducing waste and toxic waste treatment, energy efficiency, resource consumption and utilization, air pollutants, and carbon emissions, with only a few studies providing comprehensive assessments. The measurements, for example, differentiate between solid and liquid waste, as well as natural water, energy, power and natural material (Banawi & Bilec, 2014; Govindan et al., 2015). Additional pollutants like; ammonia, nitrogen, sand and dust, vapors, are less typically assessed, while CO2 emissions are often regarded for air pollutants (Chiarini, 2014).

The social perspective

When it comes to employee health and safety, only Lean research studies have revealed its impact on employees' on the job setting (Hasle et al., 2012; Longoni & Cagliano, 2015). Employees may feel more comfortable, secure, and empowered at work if green management techniques are combined with lean management practices. Throughout the manufacturing operation process, production operation managers and related professionals are looking for new workplace health and safety solutions and improve the working environment of their workforce. As many of the production and operation managers had worked in SME factories and they felt sympathy and concern for their subordinate workers, for this some manager ready to give up the financial gains related to short terms to enhance the long-term betterment of employees health issues and basic on job safety issues. Lean management practices such as 5S, according to Chiarini (2014), can significantly decrease injury cases and continue improving a firm's insufficient occupational health and safety regulations. According to Wong & Wong (2014), the lean entire ecosphere approach helped firms minimize workforce turnover and significantly improve employee behavior and performance by increasing employee engagement. By decreasing transit and shipping lead times, keeping packaging ecofriendly, and gradually increasing the product quality, the ultimate effect of lean and green integrated approach should enhance stakeholders experience and related satisfaction in the automobile sector (Govindan et al., 2015). According to Hallam & Contreras (2016), integrative approach of lean and green practices might assist different public dimensions by encouraging workers, loyalty, increasing workers job satisfaction level, enhance retention rate, and attracting potentially high recruitment because to a strong company's image and reputation.

By identifying "missing human skills and potential" as the eighth type of lean wastages with different societal consequences and related effects (Verrier et al., 2016). Companies having insufficient occupational health and safety standards can result in losing capability and individual potential, lost opportunities, and a have a very low self-ambition and drive in the employees. For this, an integrated lean and green management model can help minimize the potential human waste in the firm while also strengthening social aspects within working environments. A range of social factors and parameters which applied to evaluate lean-green integrated impacts to improve societal well-being and performance. Most used factors and parameters were corruption and fraud risk, supplier selection and its evaluation to expand geographic focus and promote conservation and consumption of energy, workforce issues connected to equipment utilized, degree of worker satisfaction, consistent loudness and sound level (Brown et al., 2014; Wong & Wong, 2014). Developments in firm beliefs and values, improved health standards and resolved safety issues, wasted human capacity, accountability, openness, and precision were assessed to determine societal benefit (Azevedo et al., 2012).

Conclusion

This review paper presents a comprehensive systematic review on the lean-green integrated concepts and their combined impact on the organizational production system's overall sustainability performance; that is, economic performance, environmental performance, and social performance. A total of 61 articles were considered in the study, which were published during 2010 and 2021. This comprehensive review indicates possible research gaps in the existing literature as well as prospective areas of research that will undoubtedly add to the study's knowledge base and enrich understanding on combined impact of lean-green manufacturing practices on organizational production system.

The review research study reflects the connections between lean-green approaches (waste minimization, productivity growth, continual improvement, process optimization and ultimately overall quality management). Because both lean-green combination have a significant influence on overall organizational production system sustainability and share similarities; academic scholars and practitioners have believed that lean-green combination would have a significant effect on company's production system sustainability performance. Moreover, we showed correlation among integrated lean concepts and green approaches, and TBL performance of firms is not necessarily direct from a various standpoint. It's likewise obvious that previous environmental performance evaluations have placed a greater emphasis on waste management than on other factors and aspects. It is now essential for scholars to look further than this parameter and consider other significant elements to fully comprehend the influence of integration on an organization's overall production chain and system. 'Can integration of lean-green concepts make the entire production and operations cleaner?' is a valid question to ask. Similarly, the current study reveals that separating the operational performance and financial performance aspects is critical for recognize the impact of integrated lean and green concepts on aspect. Although highlighting the effect of integrated lean and green concept on financial performance and ecological performance is crucial, influence on societal performance of the organization must not be overlooked as well. Companies are a component of society. Integration cannot be recognized a total success if it does not enhance the performance of all stake holders; that is, employees, customers and consumers, and the community.

Although some research has indicated negative effects and related trade-offs, it is clear from the previous research studies that the lean-green integrated impact is largely favorable and positive. Identifying the shortcomings and indicating opportunities for further research is maybe more significant than coming to a solid conclusion regarding the influence of combined lean and green integrated approach on the organizational manufacturing system's sustainability performance. Only a few research studies have tried to correlate the integrated influence of lean-green practices on all three aspects of sustainability performance, as stated before. The connections among lean manufacturing, agile manufacturing, green and resilient principles, and several supply chain performance aspects using a conceptual framework, arguing that synergistically impact is feasible for some aspects but not for all aspects and dimensions. A combination of lean and green supply chain performance can boost overall, environmental performance, economic performance and ultimately manufacturing performance. Furthermore, the researchers indicated that these two practices are not having equal weight in organizations; the lean manufacturing feature is given the most weight, while the green feature is given the least. Similarly, a research study among lean and green concepts and sustainability discovered both aspects could have a considerable impact on production and operations cost, organizational waste, environmental cost and consequences, customer satisfaction and service quality. Lean paradigm refers to effectiveness and efficiency of overall system, while green paradigm refers to efficacy, usefulness, integrity, and effectiveness. As a result, lean paradigm or green paradigm taken alone may result in compromised or possibly affect sustainability performance aspects of the organization. Because the research covered various additional aspects, like; agile manufacturing concepts or resilient paradigm in additional to lean-green paradigm, the conclusions are inconsistent and unclear, and only just few research studies looked at the effect on sustainability performance of the firm from the supply and productions viewpoint. As a result, upcoming investigation study areas identified to examine the integrated lean-green combination beyond reducing waste and effect of economic dimensions social dimensions and environmental dimensions, as it is not been satisfactorily answered yet.

Because lean-green integrated approach can minimize non-value-added activities, also the emphasis has been on several types of waste reduction as well. Some effective techniques of monitoring environmental performance of the firm have received less attention. Environment friendly products and packaging, levels of inventory, land utilization, microbial degradation, and pollutants emissions linked to transportation, irrigation management, and chemical discharge treatment are all possible concerns. In the same way, common economic measuring elements were linked to manufacturing costs and lead time. Various research was using the same metrics to evaluate manufacturing and operational success rather than economic performance: quality, value, speed, agility, flexibility, reliability, stocks, position in the market, foreign sales, and satisfaction of customers. Future research might segregate operational and financial components, allowing researchers to analyze the effects of integrated lean and green concepts on everyday firms' processes and the economic performance independently.

There are very few studies that have looked at the integrated lean and green approach effects on societal aspects together. Both perspectives emphasize employee participation and training to minimize wastage and enhance manufacturing processes to minimize faults, defects, and mishaps in the manufacturing process. Even though some studies claim that the integrated effect of both concepts

can produce more productive and efficient workers and enhance firms' operational efficiency. It has been discovered that firms rarely integrate the concepts synergistically to achieve the overall social impacts. Lean training and instructions, for instance, can educate you how to reduce lean wastage, required to cut input consumption utilization, and extend the life of the equipment. This training, on the other hand, somehow doesn't inspire workers to handle green trash and waste through disposal recycling and resource conservation. Employees and workers that learn how to obtain the integrated value from these two philosophies can use the mechanisms employed in lean manufacturing paradigms to increase social performance. Innovative, effective, and improved manufacturing techniques (a lean approach) can help to minimize waste and pollutions while also enhancing workplace environment and the condition of life in society. Under the lean-green integrated approach; waste management approaches, poor occupational health, and safety of the employees, as well as lost human potential, are various problems faced by the firms. Furthermore, neither of the research investigated at how integrated lean-green approach affected other social elements like public benefits or consumer satisfaction. Upcoming research must investigate how combining lean and green concepts can enhance workplace safety to a larger extent than either can alone.

This research study adds to lean-green theory and management techniques in the production and operations system in several ways. The results, in theory, add to the body of knowledge about lean and green integration, their interaction, and their effect on sustainable performance of whole production system. It is discovered that the significant influence of integration of lean and green concepts on firm's TBL performance does not occur instantly. Future research studies should explore the presence of contextual and situational reasons and its effect on the association among integrated lean and green concepts towards firms TBL performance. Furthermore, future research studies should analyze the situational factors to determine which are more essential towards sustainability performance. The findings of this study then pointed out the flaws and shortcomings for TBL performance of the firm evaluated. As lean manufacturing practices and green concepts are focused on reducing waste, waste management during business operations has been the subject of primary (pollution control, improved worker productivity) and secondary (greater quality, fewer wastes) attention. Based on this analysis, the study has generated new recommendations for future research into what as well as how to measure firms' sustainability performance.

Future Research Directions

This review of the literature additionally reveals that there are still substantial gaps in our understanding, knowledge and use of Lean-Green integration and Sustainability performance. Integration of lean-green can be enhanced by using a comprehensive, detailed, simple, and generalized implementation framework for organizations to see the holistic picture in terms of sustainability performance. A Lean-Green and Sustainability performance toolkit has yet to be devised. Because many tools haven't been applied and adapted, or aren't matured yet, or aren't widely known in the manufacturing industry. The authors also emphasize the necessity for a stronger attention on the context of SMEs to help them integrate both approaches efficiently and effectively. The shortage of theoretical input in this domain contributes to the resistance to integrating Lean-Green manufacturing practices and their impact on sustainability performance. Because the lean manufacturing practices and green principles are associated to production operations in the manufacturing firm, their integration was tried there, but their integrating impact should be applied in service sector as well because limited research of lean-green integration have been done on service sector. Given the service sector's continuous expansion, it would be fascinating to learn to what level integrations of lean-green concepts can make service production and operations 'cleaner.' It could be worthwhile to investigate the similarities and contrasts in the combined effect of lean-green integrated approach among the manufacturing, along with service industries. The Lean-Green integrated and firms Sustainability framework into organizations will only be possible if these research gaps are solved.

Limitations

It is also crucial to highlight that this systematic review study have some constrains and limitations related to approach, analyses, conclusions, and assumptions:

As previously stated, Lean Manufacturing ideas and principles can be traced back to Toyota Production System (TPS) and other Japanese manufacturing philosophies. This research study does not add previous literature written in Japanese language, that might have resulted in the elimination of key publications, particularly those referring to Japanese industrial leaders. This work takes a triple bottom line (TBL) view of sustainability; however, additional researchers can investigate the review on how Lean-Green, and sustainability are linked in different sustainability frameworks, perspectives, and paradigms. The shortage of studies linking Lean-Green to social performance in TBL, particularly quantitative work, makes it tough to establish more definitive and meaningful results about the impact of Lean-Green on social performance. Furthermore, the service and hospitality sector used less energy and ultimately has a lower negative effect on the environment and society than manufacturing and production sector; future review studies tend to focus service sector as well and see the lean-green integrated approach towards sustainability performance. Additionally, contextual factors such as company size, life, and age, as well as other situational factors that can affect a lean-green integration assessment, were not examined in this study.

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