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Exploring the Current State of Lean Practices in The Agri-Food Supply Chain: A Systematic Literature Review

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ABSTRACT

The increasing importance of the agriculture and food industry, due to the growing population and competitive business landscape, has driven the need to increase the efficiency and effectiveness of organisational and supply chain processes. Lean practices have been proposed to help reduce wastage, improve processes, and give more value to customers. However, research and debates on the implementation of lean practices in the agri-food industry are still limited. Therefore, this study aims to explore the current knowledge state of lean practices under the agri-food supply chain process by using a systematic literature approach. Additions for future research areas are also identified and presented. Our review suggests that the study of the lean concept in the context of agri-food supply chain is still limited and thus is open for future exploration. Furthermore, future research employing multiple methods, focusing on the downstream actors in the supply chain and empirical evaluations of lean impacts is encouraged. The contribution of this study will provide an insight for scholars of current and future research opportunities to explore. At the same time, practitioners can gain knowledge of lean practices and tools that might be applied to their business contexts.

KEYWORDS

Lean practices
Agri-food supply chain
Systematic literature review

INTRODUCTION

The agriculture and food industry becomes one of the most critical sectors as it provides a substantial source of food and employment for workers globally. The industry is characterised by short product life cycles or perishable products (de Steur, Wesana, Dora, Pearce, & Gellynck, 2016), which call for short and efficient delivery activities (Costa, Godinho Filho, Fredendall, & Gómez Paredes, 2018). It is also characterised by natural resource constraints, higher risks, and higher production costs (Folinas, Aidonis, Malindretos, Voulgarakis, & Triantafillou, 2014). These attributes have caused some challenges for the actors involved in the industry. Furthermore, the change in customer behaviour, increase environmental constraints, and a competitive business landscape have caused a shift to supply chain competition instead of to individual companies (Barth & Melin, 2018; Taylor,

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2006). Thus, companies must collaborate to improve their process efficiency and effectiveness to keep their competitive edges.

The agri-food supply chain concept is commonly used when studying the agricultural industry. It covers activities conducted by producers and customers, ranging from farming, processing, manufacturing, distributing, and retailing to delivering products to customers. A systematic literature review of the agri-food supply chain claimed that the topic is gaining more attention as the sector is increasingly pressured to transform and give importance to supply chain management (Luo, Ji, Qiu, & Jia, 2018; Zarei, Fakhrzad, & Jamali Paghaleh, 2011). Despite the collaboration of actors along the chain, past studies suggested frequent and substantial food wastage throughout the process and the supply chain (Das, 2019; de Steur et al., 2016) in addition to a high risk of the loss of nutrients (Wesana et al., 2018). Therefore, there is an urgent need to reduce wastage while contributing more value to customers, making the industry more productive and profitable (Melin & Barth, 2020).

As a part of solutions to these challenges, and to increase operational efficiency along the chain, the lean approach has been majorly proposed and used. Starting from its usage in the automotive manufacturing industry, lean practices and thinking have emerged as the most well-regarded tool to eliminate waste and improve the value offered to the customers. This thinking guides the elimination of non-value-adding activities and the enhancement of operational processes, which can be useful for increasing efficiency and competitiveness (Zarei et al., 2011). Moreover, the lean philosophy requires collaboration from actors in the value chain in order to achieve collective goals and an effective and efficient supply chain and answer customers' requirements (de Steur et al., 2016; Singh-Peterson & Lawrence, 2015). As a result, reduction of overall costs and increased profits can be achieved by the actors along the supply chain.

Over the years, studies of lean practices in the agri-food industry have increased because of the increasing importance of reducing waste and the growing population in the agri-food supply chain (de Steur et al., 2016; Pearce, Dora, Wesana, & Gellynck, 2021). However, Haq and Boddu (2015) reported that the amount of literature on lean strategies is still lacking. Moreover, there is still a debate on the applicability of lean practices in the agri-food industry. While de Steur et al. (2016) supported the application and implementation of lean practices, such as value stream mapping (VSM) along the agri-food supply chain, Cox, Chicksand, and Palmer (2007) questioned and suggested that lean thinking might not be helpful for all agri-food cases. To date, there is limited research that holistically explores the current knowledge state of lean practices in the agri-food industry by using a systematic literature review approach – except for Costa et al. (2018), who still suggested more investigation of lean practices and adoption in the food industry.

Departing from these research gaps, this paper aims to synthesise the current state-of-the-art of lean literature in the context of agri-food chains and identify knowledge voids. Furthermore, it contributes to scholars and practitioners by providing a comprehensive review of lean literature and identifying potential research opportunities. The remainder of this paper is organised into four sections structured as follows: Section 2 briefly discusses the literature review, Section 3 presents the methodology used to conduct the study, Section 4 delivers the results of the reviews and analyses of the literature, and Section 5 provides discussions and future research opportunities based on the findings. At the end of the article, conclusions of the research, managerial implications and limitations are presented.

LITERATURE REVIEW

There are various strategies that companies can adopt to increase their competitiveness, such as product development, technology investment, and innovation along with tightening coordination and increasing efficiency. Previous literature stated that competitiveness is mainly driven by productivity and the production of high-value products (Matkovski, Kalaš, Zekić, & Jeremić, 2019; Mizik, 2021). Lezoche, Hernandez, Díaz, Panetto, & Kacprzyk (2020) suggested that competitiveness in the agricultural context can be achieved by employing technology to drive innovation for the optimisation of processes while respecting nature. Meanwhile, Ganeshkumar, Pachayappan, & Madanmohan (2017) highlighted the contributions of good relationships between different supply chain components to improve competitiveness. Compared to other strategies, the lean concept was proposed to be the focus of these studies since its objectives and principles clearly align with the goal of increasing competitiveness (Costa et al., 2018; Taylor, 2005; Haq & Boddu, 2015).

Originating in the Japanese automotive industry, the lean concept has evolved from 'hard' tools to soft practices that were developed based on a 'human-centric system approach', which is no longer limited to the automotive and manufacturing industry (Danese, Manfè, & Romano, 2018; Stone, 2012). Over the past few years, the lean concept has been increasingly adopted in other industries, such as healthcare, pharmaceuticals, construction, mining, agriculture, food processing, product development, and supply chain management (Danese et al., 2018; Lanke, Ghodrati, & Lundberg, 2016; Torkko, Linna, Katajavuori, & Juppo, 2013). The concept is also often associated with process improvement approaches, such as just-in-time, total quality management, Six Sigma, and continuous improvement (Stone, 2012). Throughout the years, the lean concept has been defined by several terms, such as philosophy, thinking, principles, practices, tools, and techniques. It is also often directly embedded within concepts, such as manufacturing, production, supply chain, implementation, and others (Danese et al., 2018; Stone, 2012).

In essence, the lean concept is driven by five principles, namely value, value stream, flow, pull, and perfection (Singh & Pandey, 2015). The concept focuses on minimising wastage by evaluating the process and the waste while continuously improving by adding customer value (Hayes, 1981). According to Womack and Jones (1997), waste is referred to as any activity or process that uses resources but does not create value. Meanwhile, value is defined as the capability offered to customers at the appropriate time, price, and use. The implementation of the lean concept does not only require tools and activities but also concerns the behaviour and attitude of the actors involved; the lean concept is continuously implemented in everyday tasks for an extended period (Barth & Melin, 2018). The implementation of the lean concept impacts all components of the supply chain process on both a strategic and an operational level, which entails productivity, waste management, quality improvement, and customer focus, which might not be the case in other strategies (Luo et al., 2018; Vlachos, 2015). For example, Vlachos (2015) identified various lean tools, such as single-minute exchange of dies (SMED) and value stream mapping (VSM), which can be implemented to reduce wastage and create value. In line with its underlying principles, the realisation of the lean concept is proposed to be a continuous rather than a one-time process that should be aligned strategically to the whole enterprise. Furthermore, previous literature has asserted that there is a paucity of research on lean initiatives in the food business despite their positive impacts due to this industry's characteristics (Costa et al., 2018; Taylor, 2005; Haq & Boddu, 2015). Therefore, further study is needed since there is still the possibility of improving the competitiveness of the agri-food business through lean implementation.

RESEARCH METHOD

A systematic literature review was used as the underlying strategy for this research. The selection of this strategy was deemed appropriate since the approach allows conclusions to be drawn with a level of certainty (Briner & Denyer, 2012), which is required in this research for investigating topics state-of-the-art. Denyer and Tranfield (2009) defined systematic review as a methodology that locates existing studies and selects, evaluates, analyses, synthesises, and reports evidence with reasonably clear conclusions about what is known and not known. The outcome of this methodology is expected to provide robust and dependable evidence with transferability to a different context. This approach is argued to be replicable, scientific, and transparent with a minimum bias for summarising existing information. Particularly in the context of management and organisational studies, four guiding principles of systematic reviews to be followed are transparency, inclusivity, explanatory, and heuristic nature. Based on these reasons, the five steps for systematic reviews by Denyer and Tranfield (2009) were chosen as the underlying methodology.

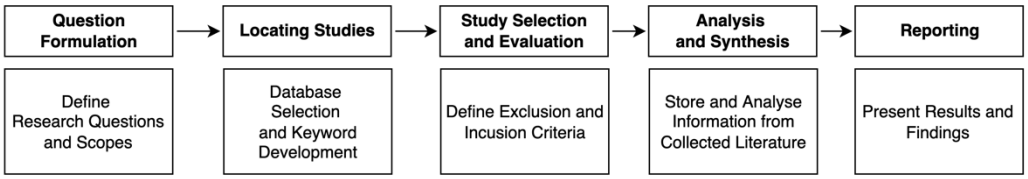

Figure 1. Key steps of systematic reviews (Denyer & Tranfield, 2009)

The method was started by formulating questions, locating studies, selecting and evaluating studies, analysing and synthesising information, and reporting and using the results. The question formulation was aligned with the aim of this study; to answer the question: what is the current state of knowledge about lean practices in the agri-food chain?. Therefore, the literature included in the review discussed lean practices, thinking, approaches, or designs under the context of activities along the agri-food supply chain. In order to collect the related literature, search protocols with inclusion and exclusion criteria were developed and carried out. To ensure the quality of the reviewed journal, Scopus was selected as the database source for the search protocol since it is one of the leading and most accessible databases of peer-reviewed high-quality journals compared to other databases, such as Web of Science and Google Scholar (Dadkhah, Lagzian, & Borchardt, 2017; Pranckutė, 2021).

A string of keywords consisting of the terms lean, practices, operations, supply chain, and agri-food was developed to capture the literature base. Advanced search features and Boolean operators in the Scopus database were also deployed to enhance the search accuracy. The final keywords capturing these concepts yielded 321 documents. The search results were further filtered based on the exclusion and inclusion criteria, which include evaluation of language, article type, industry, and article. Of the 48 screened articles, 39 of them were found to be relevant for the study and went to a full-manuscript reading for the process of information extraction, analysis, and synthesis. The overall process of the search protocols is illustrated in Figure 2.

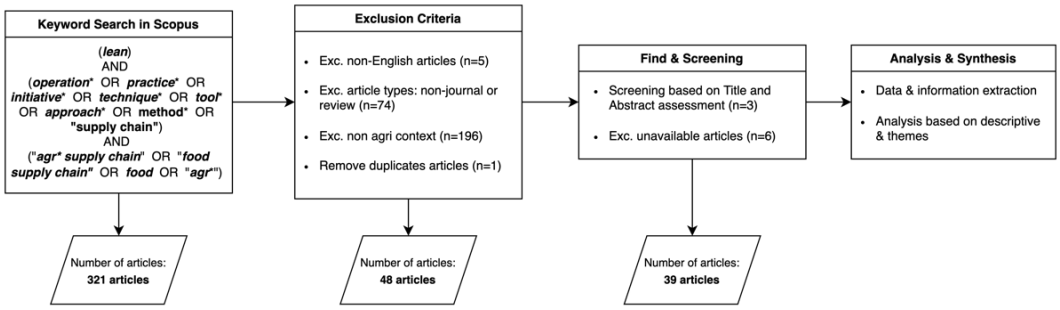

Figure 2. Search protocols, inclusion, and exclusion criteria of the systematic review

Analysis and synthesis processes were conducted to analyse the current knowledge state and future research opportunities on lean practices along the agri-food supply chain. In order to achieve this objective, a descriptive analysis of the information extracted from articles was carried out. In addition, a thematic analysis was conducted to explore practices, tools, approaches, factors, impacts, and related concepts for lean practices in the agri-food supply chain.

RESULTS

This section reports the observations based on the literature collected by the search protocols. Descriptive analyses of publication years, journals, research methodologies and strategies, and research context are reported to provide initial visualisation of the current knowledge state.

Descriptive Analysis

A descriptive analysis was conducted based on the data extracted from the literature collections. As shown in Figure 3, there was an increase in the number of articles in 2013 and 2014 followed by a slight decline between 2015 and 2017. Generally, there is an increase in lean-related research in the agriculture sector. Based on the analysis, it was found that most of the articles on this topic come from reputable journals (Q1), which suggests the quality and trustworthiness of the findings. In addition, a higher number of journals related to sustainability topics, namely Sustainability and Journal of Cleaner Production, was found (Lermen, Echeveste, Peralta, Sonego, & Marcon, 2018; Manzouri, Ab-Rahman, Zain, & Jamsari, 2014; Wesana et al., 2018), while the number of journal titles that focus on operations, production, supply chain, and waste management was lower and more fragmented.

A recap of research methodologies and strategies suggests domination by qualitative and quantitative methodologies with a higher number of qualitative research (see Figure 4). Moreover, the observation results suggest that the single methodology was dominantly used in the literature. Only a small number of these articles employed a systematic literature review (SLR) methodology (Costa et al., 2018; de Steur et al., 2016; Solano, Guisselle, Jairo, & Luis, 2020). These reviewed articles mostly focused on specific processes of production in the agri-food chain, such as reviews of value stream mapping and lean management in production systems. Therefore, this current study fills the gap by providing a more holistic review of the overall lean concept along the supply chain in addition to identifying future research opportunities. For research strategies and case studies, a qualitative methodology is reported to be the most common strategy used for studying the topic of lean practices, followed by surveys (Lyons & Ma'Aram, 2014; Manzouri, Ab Rahman, Saibani, & Zain,

2013; Wesana et al., 2018) and action research in which lean was being implemented and evaluated as a project with researchers involved as participators (Vlachos, 2015). Next, a moderate number of modelling strategies were found; focusing on creating a model that integrated lean thinking or principles with the aim of minimising costs of activity in the agri-food chain (Das, 2019; Faccio, Ferrari, Persona, & Vecchiato, 2013; Solano, Guisselle, Jairo, & Luis, 2020).

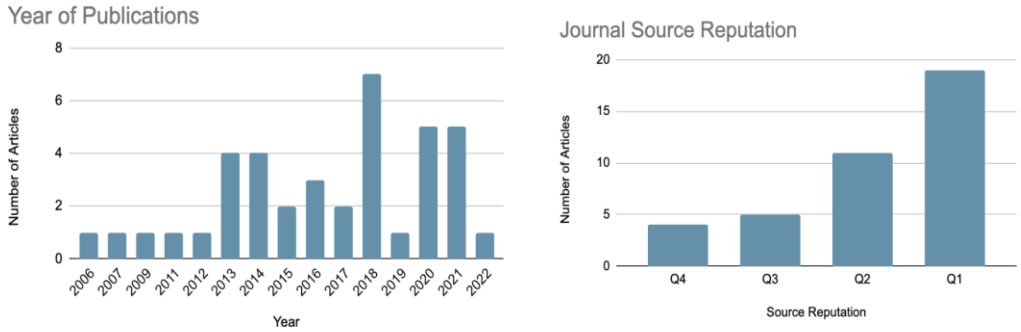

Figure 3. Analysis of the articles' publication year and journals' reputation

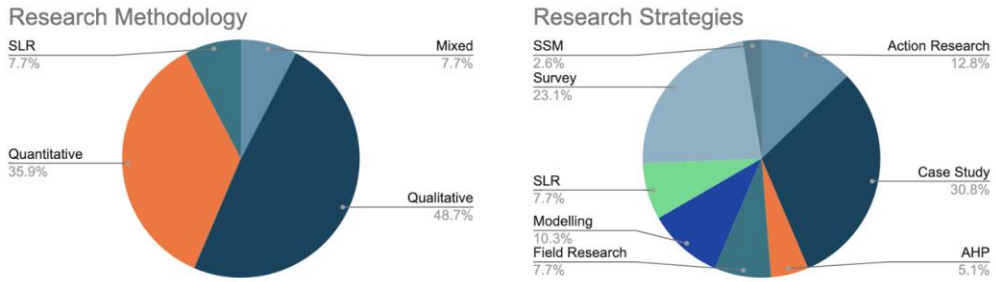

Figure 4. Analysis of research methodologies and strategies

An analysis of countries suggests a higher number of lean-related research conducted in the context of developed countries (see Figure 5), particularly in the UK which focused on red meat (Cox et al., 2007; Taylor, 2006). Besides, a high number of studies from a developing country, Malaysia, that highlighted general food or mixed commodities were reported (Kuzaiman et al., 2018; Manzouri et al., 2013). More research was conducted in developing countries in the African and South American regions, such as Uganda (Wesana et al., 2018), Nigeria (Kolawole, Mishra, & Hussain, 2021), Brazil (Lermen et al., 2018), Colombia (Solano, Guisselle, Jairo, & Luis, 2020) and others. Despite seemingly contradicting Ufua, Papadopoulos, and Midgley (2018), the research in the developing country was usually carried out in a limited case study to validate the proposed model or framework built from literature reviews or established theory. Therefore, the current research findings are still in line with previous findings and call for an opportunity for more empirical research of lean practices in developing countries.

The analysis of commodities suggests that lean practices were being studied in different agricultural commodities with different product characteristics, ranging from livestock (Taylor, 2006), fruits and vegetables (Lermen et al., 2018), to processed food (Kolawole et al., 2021; Tanco, Santos, Rodriguez, & Reich, 2013). It implies that lean practices can be applied to various food

commodities and industries. However, more research is still needed due to each food industry's different characteristics and processes.

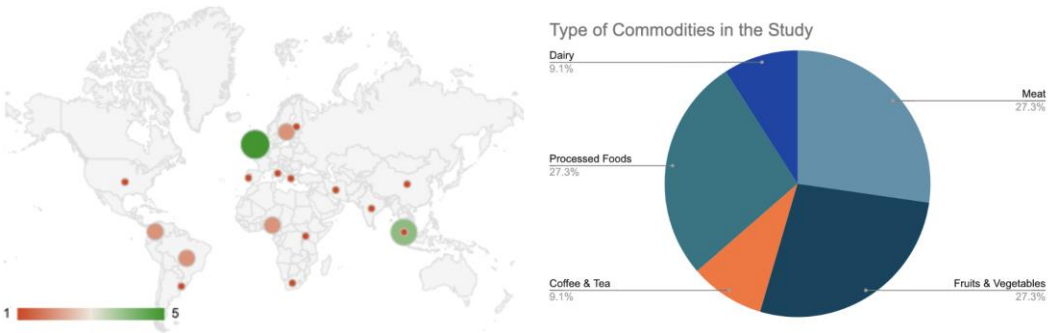

Figure 5. Analysis of countries and commodities focused on research

Thematic Analysis

This section discusses a thematic analysis based on emerging topics in the literature. An analysis of lean tools and techniques in the collected literature shows the dominant use of VSM to reduce waste (Barth & Melin, 2018; de Steur et al., 2016; Folinas et al., 2014; Melin & Barth, 2020; Taylor, 2006; Vlachos, 2015). This tool allows visualisation of the overall and detailed process in organisations and supply chains. Accordingly, this visualisation helps create a current map of activities and waste identification along the process. Thus, a future map with the elimination of waste and improvement to the activity in order to add value for customers was developed. Melin and Barth (2020) applied this tool to a dairy farm to create an action plan with the aim of minimising food waste and increasing the sustainability performance of the farm. Other tools, such as define measure analysis implement control (DMAIC), were used to achieve the objective of Lean Six Sigma (Kolawole et al., 2021). Kuzaiman et al. (2018) evaluated the practices of lean tools such as 5S, preventive maintenance, the pull system, heijunka, and poka-yoke which can identify the implementation level of the lean process practices of a food company.

The application of lean practices or lean-related principles can be categorised based on research objects and focuses (Appendix 1). Most of the focus on lean practices or thinking is being investigated or implemented in production-focused activities carried out by upstream actors. Improvements using lean principles are implemented to help the operational production process, evidenced by the frequent mention of lean production (de Steur et al., 2016; Lermen et al., 2018; Wesana et al., 2018). Satolo, Hiraga, Goes, and Lourenzani (2017) focused on analysing agribusiness's level of compliance to lean production systems for upstream actors, namely farms and processing companies in Brazil, in which the adoption was aimed to improve the mechanism of organisational performance. A higher focus on the farm-level implementation of lean practices was also discovered (Barth & Melin, 2018). Similarly, still, on the topic of production, the farm level is more concerned with the integration of operational planning in the routine production process, such as growing, harvesting, maintenance to reduce waste, and improving product quality and quantity (Barth & Melin, 2018; Solano, Guisselle, Jairo, & Luis, 2020).

Meanwhile, at the supply chain level, Taylor (2006) proposed various strategic considerations for developing a lean agri-food supply chain in the UK sectors. This consideration consisted of organisational and commercial requirements extracted using value chain analysis tools. Operational and strategic concerns and recommendations for actors along the supply chain were proposed to

achieve an integrated lean agri-food supply chain. Distribution actors are often coupled with production companies since some also handle distribution in-house (Lermen et al., 2018; Nabhani & Shokri, 2009). Lean practices by retailers are rarely examined and are limited to large, modern retailers based on the analysis of the collected literature (Bloom & Hinrichs, 2017; Marques, Carvalho, & Santos, 2022). Besides traditional actors along the supply chain, this literature review also discovered external stakeholders' involvement in applying lean practices in the agri-food chain. Ufua et al. (2018) argued that the involvement of the local community in the process of lean initiative implementation can bring a fresh perspective that could benefit organisations and local communities in achieving sustainable product development in the local community.

Many researchers tried to develop an integrated model of lean with other concepts such as quality (Kolawole et al., 2021), nutritional value (de Steur et al., 2016; Wesana et al., 2018), agility (Cozzolino et al., 2012; Purvis et al., 2016), halal (Kuzaiman et al., 2018; Manzouri et al., 2013; Salleh et al., 2020), and sustainability (Das, 2019; Folinas et al., 2014; Reis et al., 2018). The lean concept is often combined with Six Sigma elements that cater to customers' desires, reduce wastage, and eliminate variability to increase performance and organisational competitiveness. Evidently, some articles using a systematic literature review approach could be found discussing its appropriateness for the food industry (Costa et al., 2018) and measurement instruments to evaluate successful Lean Six Sigma practices in the food industry (Costa, Godinho Filho, Fredendall, & Devós Ganga, 2021). Wesana et al. (2018) used lean manufacturing, particularly the waste management approach, to identify stakeholder readiness toward nutrition-sensitive agriculture. It was suggested that actors along the chain positively respond to the reduction of food loss and wastage concerning nutrient-sensitive value chains as long as they are aware of the potential benefits.

Purvis et al. (2016) explored how to develop a resilient supply chain strategy by integrating the concepts of robustness, agility, leanness, and flexibility. They demonstrated that these concepts, also leanness as a prerequisite for agility, are helpful for building resiliency towards demand and supply volatility. Manzouri et al. (2013) studied the need and pressures of adopting a lean supply chain for halal food companies while also investigating barriers they experienced in the implementation process. Das (2019) integrated resilience, green, and lean system concepts to develop a sustainable food supply chain planning model. This model was built based on a grid-based supply chain network. Each grid was managed by food collection cooperatives and was responsible for collecting, processing, distributing, partnering with organisations, and acting as processing centres and retailers for their local area.

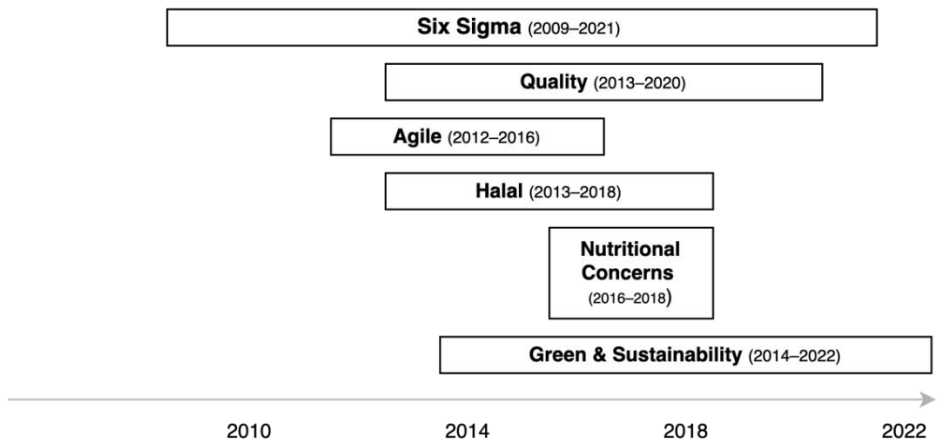

Figure 6. Evolution of lean concept integration with other concepts throughout the year

Previous research brought several factors to ensure the success of lean practice implementation. Multi-stakeholder collaborations of actors along the supply chain are essential to ensure the success of lean practice implementation for reducing waste, particularly for reducing nutrient loss in the food manufacturing process (de Steur et al., 2016). Manzouri et al. (2013) suggested the need for a cooperative relationship to overcome external issues often faced by food companies when adopting a lean supply chain. Cox et al. (2007) stated that the effectiveness of lean operation can be achieved when the buyer has dominance or interdependence in power and leverage relationships between buyers and suppliers. This is caused by the need for long-term operational collaboration between actors in different stages of the chain. Ufua et al. (2018) argued that the mutual understanding and involvement of the local community in the process of lean initiative implementation can bring a fresh perspective that benefits organisations and local communities.

Das (2019) suggested that mutual trust, cooperation, collaboration, and support for inter-organisational processes can boost the adoption of lean and green initiatives among actors in the value chain. Barth and Melin (2018) suggested that successful lean practice requires commitment since integration with existing processes takes a long time and is focused on long-term development. Furthermore, Vlachos (2015) maintained the importance of management support to ensure the positive impact and implementation of lean thinking in the food supply chain. In addition, the creation of dedicated teams consisting of representatives of actors in the supply chain (Taylor, 2006) and the use of facilitative approaches with the help of Lean Coaches (Barth & Melin, 2018) can also help smoothen the implementation of lean practices and increase concept understanding (Manzouri et al., 2013; Marques et al., 2022). The least mentioned factors of lean method implementation are technology and decision support (Sarri et al., 2020).

In order to improve leanness, organisations are required to identify lean enablers and lean attributes. Previous research suggested using prioritisation tools based on quality function deployment to weigh down identified lean enablers and lean attributes. Zarei et al. (2011) based their model on quality function deployment (QFD) and fuzzy logic to identify relevant and practical lean enablers that can be used to increase the leanness of the food supply chain. Building upon previous research, Haq and Boddu (2015) used an integrated fuzzy QFD and TOPSIS-based framework to prioritise lean enablers in relation to lean attributes. The prioritisation results from the model were expected to help industries or organisations enhance their leanness by weighting lean attributes and prioritising lean enablers. A case study of the food processing industry in India was used to illustrate the application of the model.

Previous literature also discussed the benefits of lean practices and related performance indicators that might be useful for monitoring and improving leanness. Benefits such as reducing lead time, eliminating waste, and reducing quality defects in the food distribution industry were found to be the benefits of practicing simplified integration of Six Sigma and lean techniques (Lanke et al., 2016; Nabhani & Shokri, 2009). However, Cox et al. (2007) suggested that implementing lean practice might not always be beneficial for all actors in the agri-food supply chain. Significant gains were only found at multiple retailers who could induce the application of lean practices in their partners but not in their supply chain partners. Folinas et al. (2014) demonstrated positive impacts on environmental metrics through lean technique implementation in production and logistics operations. Positive results were found mainly in the production process in the form of better production planning, the use of an ERP system for demand forecasting, the formulation of least-cost nutritional needs, and the elimination of additional processes. Barth and Melin (2018) reported positive effects of the implementation of lean green tools on animal health and performance, environmental impact, and the increased concern for work safety among farmers. De Steur et al. (2016) identified lead time as the most suitable performance indicator for evaluating lean practices

in manufacturing processes in the agri-food industry. Torkko et al. (2013) suggested that the number of complaints was found to be the most common quality-related KPI in the food industry. Marques et al. (2022) identified shrinkage rate, which contributed to out-of-stock occurrences, as one of the monitored performance indicators in the middle of lean green initiatives implementation for retailers

DISCUSSION

This systematic literature review has demonstrated various lean practices for different use cases in the agri-food supply chain and industry. Since this sector is characterised by short product life cycles, tight quality requirements, uncertain demands, environmental constraints, and demanding customers (Costa et al., 2018; Tanco et al., 2013), a study on the sector will bring impactful contributions to both academics and practitioners. Descriptive and thematic analyses were applied to help synthesise knowledge from the literature. As visualised in Figure 7, the synthesis of the literature resulted in the identification of supporting factors, concept integration, lean implementation, lean tools and techniques, and impacts of lean practices in the agri-food chain. Based on the reviews, it was found that despite the increasing number of literature on lean research in the agri-food industry, the numbers can still be considered low, as explained by Ufua et al. (2018). The search protocols, obtaining literature from Scopus as a highly regarded database of indexed journals, only yielded 39 articles. Therefore, there are still plenty of opportunities for future research on lean practices in the agri-food supply chain.

The descriptive analysis of the methodology discovered that a high amount of research is based on a single method and is dominated by qualitative or quantitative methods. This opens up future research opportunities for mixed-method, system thinking methodologies such as the soft-system approach (Ufua et al., 2018), system dynamic, and agent-based modelling, especially since the agri-food industry can be categorised as a complex system with moving variables. System approach research can offer new insights that might not have been found when using only an analytical approach (Kijima, 2015). More empirical studies based on surveys to validate different integration models of lean concepts are also recommended. Seeing as many studies proposed an integrated lean model with limited validation based on case studies (Lermen et al., 2018; Ufua et al., 2018), more empirical studies are required to check the generalisability of the model.

Furthermore, the literature review found that the topic is highly skewed to the production side or upstream process in the agri-food supply chain since lean is often associated with production or manufacturing systems due to its origin. There is limited research that specifically discusses downstream actors' participation or implementation of lean practices aligned with the previous statement from Marques et al. (2022). Additionally, research that takes in the whole supply chain perspective is still short. Therefore, future studies might want to explore this neglected side of the agri-food supply chain to offer a more holistic knowledge of lean implementations along the chain. Previous research also explored non-traditional supply chain actors who might be influential, particularly in the agri-food industry (Ufua et al., 2018). This might also be a future research avenue to be explored. In addition, gaps in organisational aspects, such as organisational changes, human resources, or employee management were identified. As discovered by Stone (2012) in an earlier literature review of general lean research, more research in organisational change and human resources under the context of lean is encouraged, especially since organisational and employee-related factors are suggested to be one of the supporting factors for practising lean and various organisational structures in the agri-food industry.

Few studies reported the concrete impact of lean practice implementation (Melin & Barth, 2020), except for the output projection of modelling-based research (Solano, Guisselle, Jairo, & Luis, 2020). Most research only evaluated the impacts based on case studies, action research, or perception-based impact evaluations with low generalisability. Thus, further investigation of lean impacts on agri-food chains can be conducted using surveys, longitudinal data, and actual performance data of organisations. Finally, with rising concerns on food security, food quality, and environmental issues (Barth & Melin, 2018), future research is still open to exploring lean concept integration with those concepts throughout the agri-food supply chain.

Table 1. Future research opportunities for lean practices in the agri-food supply chain

Topics	Gaps or Issues	Future Research Opportunities
Methodology	Dominated by a single analytical research approach	Conducting research with a mixed-method approach or system-approach methodology
Research Object	Concentrated on upstream actors such as farms and processors.	Exploration of lean practices implementation for downstream actors such as distributors, retailers, and end-customers. Exploration of non-traditional actors' roles such as cooperatives, food associations, governments, environmental specialists, and nutrition experts in the implementation of the lean practice.
Lean Tools	Mostly reported on Visual Stream Mapping (VSM) as an assessment tools for lean practices implementation	Exploration of other tools besides VSM and assessment phase of lean practice implementation
Impact of Lean Implementation	A low number of empirical reports on lean implementation impacts company performance. Limited mention of KPIs used to monitor lean practices implementation.	Investigation of impacts of lean implementation with longitudinal and real data to produce higher generalizability Examination of relevant KPIs used when implementing lean practices in the agri-food supply chain
Integrated Concepts	Growing concerns of environmental concerns, yet limited research on sustainable lean agri-food supply chain Limited studies with the focus on human or organizational aspects	Explore the integration of lean concepts, especially sustainability and six sigma. Examination of lean practices in relation to organisational aspects such as organisational learning, engagement, etc.

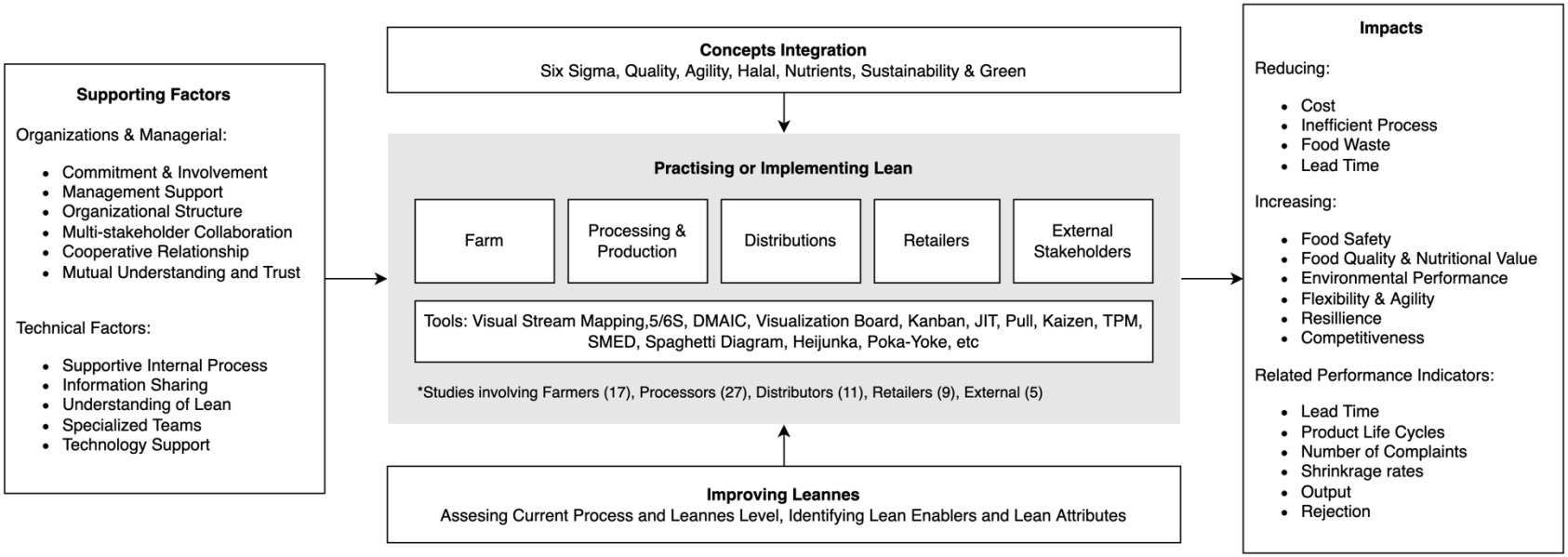

Figure 7. The model of lean practices in the agri-food supply chain

CONCLUSION

This article has explored the current knowledge state of lean principles and practices along the agri-food supply chain. A systematic literature review of 39 scientific articles obtained from reputable journals was conducted to achieve research objectives. As a result, lean principles and practices in the agri-food chain are discussed and visualised. The review suggests that lean practices have been implemented in different processes and by different actors and industries in the agri-food supply chain. Although there is a higher concentration of farm and processing actors, production-related processes, lean tools, and techniques for assessment and improvement were found. Based on the review, future research on the application and implementation of lean practices in the agri-food supply chain is still encouraged despite increasing trends. Moreover, gaps in the methodologies, research objects, supply chain actors, and empirical impact evidence can provide future research avenues. Exploration of other lean tool applications in the agri-food sectors and lean integration with emerging concepts such as sustainability, food nutrients, and halal food products are also still promising.

MANAGERIAL IMPLICATION

The results of this study are expected to guide future research and inform practitioners on applying lean principles to their business context in the agri-food industry. Several factors for increasing the success levels of lean implementation are identified from the literature, which can be placed into two categories, namely organisational and technical factors. First, organisations that wish to implement lean practices should prepare their internal structures, employees, and processes to become more suitable for running lean practices. Management should provide support during the implementation phase and adjust the organisational structure to ensure the success of lean practices. Collaboration with multiple internal and external stakeholders is encouraged and should be done during the transformation. Employee commitment and involvement from pre to post-implementation should also be maintained. External stakeholders should not be limited to traditional supply chain actors only but also involve relevant stakeholders who can offer new insights. The relationship between these stakeholders should be managed by lean actors to encourage mutual understanding, trust, and cooperation. This can ensure a higher impact of lean application throughout the agri-food supply chain process, further increasing companies' competitiveness while contributing to society and the environment.

Second, organisations and their top management should pay attention to technical factors. Internal processes, information sharing, and relevant technology should be deployed to allow lean adjustments. Forming a specialised team, consisting of representatives of internal and external stakeholders, is encouraged to support better information sharing during lean implementation. Essentially, employees or relevant actors should be given a comprehensive understanding of lean principles, tools, techniques, and significance to increase the chance of successful implementation through training. In order to do this, companies can invite lean experts and coaches who can guide the lean integration of work processes, covering pre and post-implementation phases. Third, organisations should monitor the performance of lean practices to identify working lean tools and to adjust approaches if required. Performance indicators related to lean practices should be defined by stakeholders and monitored regularly. This will support the implementation of lean practices because they can be presented as evidence to convince stakeholders of the effects of lean impacts and their importance to organisations and supply chains.

LIMITATION AND FUTURE RESEARCH

While this study offers knowledge synthesis of lean practices in the agri-food supply chain, it still bears some limitations. Since the review only considered literature from the Scopus database, future literature review studies can involve other reputable databases, such as Web of Science and Google Scholar, to increase the number of articles included in the review process. Additionally, further analysis can also be conducted using a method such as bibliometric analysis to oversee the development of research in this area. Established theory in the agri-food supply chain can also be employed in the thematic analysis of future review studies.

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Appendix 1. Map of research object under the studies in the reviewed literature

Authors	Participating Actor along the Supply Chain						Research Object
	F	P	D	R	C	E	
(Taylor, 2006)	x	x	x	x	x		Pork Supply Chain
(Cozzolino, Rossi, & Conforti, 2012)			x				Distributors of UN World Food Programme
(de Steur et al., 2016)		x					VSM Application in the Agri-Food Industry
(Zarei et al., 2011)		x					Canning Industry
(Purvis, Spall, Naim, & Spiegler, 2016)		x					Premium Drink Producers
(Vlachos, 2015)		x					Tea Company (SMEs)
(Nabhani & Shokri, 2009)			x				Food Distribution (SMEs)
(Manzouri et al., 2013)		x					Halal Food Firms
(Manzouri et al., 2014)		x					Halal Food Firms
(Cox et al., 2007)	x	x	x	x	x		Red Meat Supply Chain
(Ufua et al., 2018)	x	x				x	Food Production Company & Local Community
(Folinas et al., 2014)		x	x				Animal Food Producers
(Lermen et al., 2018)		x	x				Food Processing Industry
(Wesana et al., 2018)	x	x		x		x	SC Actors
(Lyons & Ma'Aram, 2014)		x	x	x			SC Actors
(Reis et al., 2018)	x	x					Property Managers
(Das, 2019)	x	x				x	
(Haq & Boddu, 2015)		x					Food Processing
(Bloom & Hinrichs, 2017)	x			x		x	Producers & Commercial Facilitators
(Faccio et al., 2013)		x	x	x			
(Solano, Guisselle, & Jairo, 2020)	x	x					LM in Agricultural Production Chains
(Torkko et al., 2013)							Personnel in both industries
(Viles, Santos, Muñoz-Villamizar, Grau, & Fernández-Arévalo, 2021)		x					
(Kolawole et al., 2021)		x	x				Producers of Bread & Biscuits
(Melin & Barth, 2020)	x						Farm-Owner, Farm Employee
(Domínguez, Espinosa, Domínguez, & Romero, 2021)	x	x	x	x	x		Food Production Industry
(Pearce et al., 2021)	x						Farmers

(Solano, Guisselle, Jairo, & Luis, 2020)	x						Agricultural Production Data on Crop Planning
(Salleh et al., 2020)		x					Food Company (SMEs)
(Kuzaiman et al., 2018)		x					Food Company (SMEs)
(Barth & Melin, 2018)	x					x	Small & Mid-size Farms
(Satolo et al., 2017)	x	x					Agribusiness units
(Sarri et al., 2020)	x						Wine Farm worker, employee, owner
(Lanke et al., 2016)	x	x					
(Marques et al., 2022)				x			Multinational Retail Enterprise
(Tanco et al., 2013)		x					Chocolate Company (SMEs)
(Ma & Zhan, 2014)	x	x	x	x	x		Catering Industry Leaders

Legend: F-Farm, P-Processing & Productions, D-Distributors, R-Retailers, C-Customers, E-External Stakeholders