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Lean- Green and Triple Bottom Line: A Systematic Literature Review

ABSTRACT

The purpose of this paper is to perform a systematic literature review of peer-reviewed journal articles on the topic of lean and green integration and its impact on the triple bottom line (economic, social and environmental dimensions). After an extensive search, 60 articles from 2006 to 2016 were identified as relevant to this study. Our findings reveal that whilst there have been a handful of studies done on integrating the two concepts, not much has been done with respect to examining the impact of this on all three dimensions of the triple bottom line (TBL).

KEYWORDS: Lean, green, lean-green integration, triple bottom line (TBL)

INTRODUCTION

Lean and green supply chains are management philosophies implemented in organisations to improve their overall performance by maintaining a competitive position in the industry. Lean supply chain, the philosophy initiated by Toyota Production System (TPS) after the second world war, employs several strategies such as Just in time, continuous improvement, reduction of lead times and inventories, process improvement and elimination of all kinds of wastes to improve customer satisfaction and quality (Carvalho et al., 2010; Garza-Reyes, 2015b). Green supply chain, the philosophy created by the regulations of government and pressures and concerns of environmental activists, uses to some degree different sets of strategies such as reverse supply chain, sustainable value stream mapping and life cycle analysis to improve the ecological benefits of the production system. The ultimate aim behind both philosophies is to reduce costs through waste reduction efforts and efficient use of resources (Carvalho et al., 2010; Duarte & Cruz-Machado, 2013b; Garza-Reyes, 2015a).

Since both lean and green are supply chain and operations management philosophies and aim for similar outcomes, academics and practitioners over the last 20 years naturally search for synergies between the two concepts and aim to achieve common benefits by integrating the two as a single combined approach. Although there have been studies on various aspects of lean and green supply chains, for instance, the synergy between the two concepts and its influence on performance, these studies have been fragmented (Garza-Reyes, 2015b). Mostly studies explored either lean supply chains or green supply chains impact on financial and/or environmental performance; a few studies also looked at the combined impact on the environmental and/or operational performance. For example, Folinas et al. (2013) integrated green aspects into Value Stream Mapping (VSM) to determine and reduce the waste in the agri-food supply chain. There is a lack of research on the joint impact of both concepts on the TBL- economic, social, and environmental performances (a few notable exceptions are studies by Azevedo et al. (2012); Brown et al. (2014); Cabral et al. (2012); Faulkner and Badurdeen (2014)). Since organisational performance is multifaceted (M. G. M. Yang et al., 2011), it is important to explore the impact of the combinative implementation of lean and green on all three dimensions prescribed under the TBL.

In order to develop a thorough understanding about the current research on integration of lean and green supply chains, it is important to do a state of the art literature review, although, not many studies were found to have done a comprehensive literature review on the topic. In addition, frameworks and models proposed for the integration of lean and green supply chains and their impact on the TBL have not been examined thoroughly. To complete the gap, we conducted a comprehensive literature review on the topic of lean-green integration and its impact on the TBL by systematically collecting and critically analysing all relevant studies on the topic. The main research questions of this study are:

What is the current state of research on the effect of innovation-led lean-green supply chain strategies on the TBL?

What are the key themes for future studies emerging from the current research?

Our literature review is different from the existing literature review in the following ways: unlike extant studies a) our literature review primarily focusses on the studies that have integrated the lean and green concepts rather than used them independently; b) we reviewed studies that explored the impact of integration on the three dimensions of TBL (economic, social, and environmental performances), both separately and combined; and c) we proposed future research paths on lean-green integration and its impact on the TBL.

This paper is structured as follows. Section 2 presents the discussions on the key terminology used in this paper. Section 3 presents discussions on the research method we followed to collect articles for this study. A descriptive analysis of papers that we identified from the literature review is also presented in Section 3. Section 4 presents the findings from the study followed by the discussions on future study areas in Section 5. Finally, we draw on some interesting conclusions in Section 6.

LITERATURE REVIEW

In this section, we explain the key terms that are explored throughout the review.

Lean-Green Integration

Lean strategy is a paradigm to generate a system of continuous improvement and elimination of all forms of waste from production and supply chains to improve quality, reduce costs and add value for customers (Duarte & Cruz-Machado, 2013b; Simpson & Power, 2005). Green strategy is a paradigm that focuses on the impact of supply chain and production on the environment and emphasizes on the elimination of environmental wastes related to water, energy and air and includes solid and hazardous wastes (Duarte & Cruz-Machado, 2013b).

Since, both paradigms seem to have some commonality within their definitions, extant studies have endeavoured to find out compatibilities between these strategies. It is pointed out by these studies that the seven key lean principles can lead to the improvement of environmental performances (Vinodh et al., 2011). Some authors focus on the paradigms' synergistic features (Azevedo et al., 2012) whilst others authors assume that lean acts as catalysts to green development (Dües et al., 2013; Garza-Reyes, 2015b). The concept of synergy was first discussed by Florida (1996). His study revealed that to remain competitive, use of several advanced manufacturing practices such as lean management, improved production processes and technology and continuous improvement are necessary and these practices provide benefits to both environmental performance and manufacturing performance. The effort to combine both paradigms has increased recently due to the increased pressure from green activists and general struggle of organisations to operate in a resource constrained world (Dhingra et al., 2014). Simons and Mason (2003) were one of the earliest group of

authors who attempted to explore the interactions between lean and green supply chains by using Value Stream Mapping (VSM). Bergmiller and McCright (2009) observed that lean organisations develop prevention strategies by implementing systematic solutions that yield sustained results for environmental related issues. Hence, lean manufacturers can naturally transcend into greenness. Brown et al. (2014) used the term Sus-VSM to integrate both lean and green concepts together. Toyota formed the Toyota Production System and was able to integrate both environmental and social aspects within its traditional lean practices up to a certain level to achieve this synergy (Verrier et al., 2016). Recently, Campos et al. (2016, p. 628) defined the lean and green synergy as “the additional effects produced by the implementation of green practices and lean practices together” that individual practice alone cannot bring.

There are several benefits associated with the combined implementation of lean and green paradigms in organisations. These are waste reduction, reduction in energy and raw material consumption, increased efficiency, improved reputation and customer satisfaction and above all reduction of operating costs (Verrier et al., 2014). However, literature has also identified some trade-offs associated with the lean-green integration. These are just-in-time inventory management versus higher emissions due to frequent delivery and increased use of transportation; re-use and remanufacturing under green paradigms versus high quality new products under lean paradigms, and overall cost reduction focus in lean management versus environmental improvement in green management (Dües et al., 2013; Garza-Reyes, 2015b).

There have been several studies that explored cases where the synergy between lean and green supply chains were possible. Environmental Protection Agency (EPA) has provided a list of case studies that used lean principles to gain environmental benefits (see: epa.gov.au/lean/case-studies). It has been found that the most important catalyst for achieving synergy is the potential of recombining lean and green knowledge resources through the support of different supply chain actors such as suppliers and customers. Dües et al. (2013) concluded that green organisations cannot automatically become lean organisations but lean organisations are often greener since the green philosophy is a natural extension of the lean philosophy. Galeazzo et al. (2014) suggested that the simultaneous implementation of lean and green practices was more efficient than the sequential implementation of the two. On the other hand, several studies pointed towards the lack of synergies between the two concepts. Campos et al. (2016) through case studies asserted that too much adherence with lean principles, lack of communications between lean and green team within the organisations, presence of power differentials and the lack of risk sharing attitude create barriers in lean-green synergy. Garza-Reyes (2015b) provided discussions about the conceptual differences between the lean and green philosophy. The primary differences between the two are related to how waste is defined, divergences in focus, and the expectation from customers.

Triple Bottom Line (TBL)

The first and the most widely used definition of sustainability was made by the World Commission on Environment and Development. The definition focuses on ‘meeting development needs of the present without compromising the ability of future generations to meet their own needs’ (Brundtland, 1987). Later, Elkington (1998a) simplified the definition and operationalised it through the TBL concept by integrating economic, social and environmental issues (Seuring & Müller, 2008). Findings from latter studies illustrate the need for firms to measure the supply chain performance from three interrelated components/dimensions: environment, society and economy and put equal emphasis on all three components (Azevedo et al., 2012). In general, the environmental dimension involves the initiatives and responsibilities undertaken by an organisation in its operations for a greener planet, social dimension includes the actions and efforts taken by an organisation for the well-

being of its people and economic dimension is the effort by organisations to maximize profits, with minimum raw materials, inventory management and reduction of production costs.

There are several viewpoints on how to measure these three dimensions. Economic dimension is generally well understood however there is still a confusion regarding the environmental and social dimensions (Gimenez et al., 2012). The common indicators to measure economic and environmental performance are air emissions (mainly CO₂ emissions), solid wastes, pollution reduction, energy efficiency, consumption of toxic and hazardous materials, inventory levels, product quality, capacity utilization, ROA, operational costs, environmental costs, and training costs. The social dimension, includes both support for internal (employees) and external (community) environments and is measured by corruption risks, supplier screening, use of local suppliers, maintenance of human rights, supplier labour practices, supplier codes of conduct, job satisfaction and cooperative work environment, diversity and equal opportunity (Azevedo et al., 2012; Gimenez et al., 2012).

Although the three dimensions are connected, a few studies look at the interrelationships between the indicators. It is often argued that environmental performance or social performance may not always bring positive financial outcomes. 'A debate about eco-efficiency versus eco-effectiveness pinpoints the trade-offs between the environmental and economic dimensions' (Galeazzo et al., 2014, p. 193). Anecdotal evidence suggest that investment in environmental management can improve environmental performance at the expense of financial performance (Klassen & McLaughlin, 1996). However, (Gimenez et al., 2012) found that various environmental programmes lead to improvements in all dimensions of TBL by reduction of wastes and associated costs and improving the company image. However, the impact of social programmes on TBL is mixed. Although, environmental performance was improved due to more workers training and the creation of safe work places through social programmes, financial performance was hampered due to higher manufacturing costs in the short term.

Therefore, while studies have emphasized on all three dimensions of TBL, not many studies have comprehensively explored this. As found out by Hassini et al. (2012), majority focus has been on the environmental dimension, followed by economic and social dimensions.

Additionally, in their literature review, they highlighted that a wide variety of performance measures were utilised to measure individual dimensions.

RESEARCH METHODOLOGY

A systematic literature review is useful in finding out the gap in existing studies and provides information on areas where majority studies have already taken place (Garza-Reyes, 2015b). To perform the literature review systematic we followed the five criteria approach: a) a research question; b) searching different databases for locating the articles; c) article selection and exclusion; d) analysis; and d) reporting/discussions.

Search, Inclusion and Exclusion, Analysis

At first, we used Google Scholar to search for articles that had lean and green concepts mentioned in them. Google Scholar helps to include articles from various sources including books, thesis and conference papers by pooling from many different databases (Halldórsson et al., 2010). This unstructured review assisted us to have an overall understanding about the depth of the study already undertaken. The initial search terms were 'lean-green integration', 'lean-green supply chain', 'environmental lean', 'lean environment' and 'TBL' to include the articles that involved social, economic and environmental perspectives. In the next step, we used several databases such as Science Direct, Elsevier, Taylor & Francis, EBSCO, Pro-Quest, Scopus, Business Source Premier, Emerald and Web of Science to narrow our search. By

following existing literature reviews, we added 'sustainability', 'JIT', 'TQM', 'six sigma' 'supply chain performance' and 'lean-green manufacturing' in our search terms to add more articles and exclude articles that did not focus on the integration of lean and green. In this structured and systematic review process, we found several articles that dealt with lean and green separately. Since, our purpose of the literature review was to focus on the integration of lean and green paradigms, we excluded those articles that did not fulfil this criterion. Next, we performed a search in a list of representative journals such as Journal of Cleaner Production, International Journal of Production Economics, International Journal of Production Research, International Journal of Lean Six Sigma, Journal of Operations Management and Production and Operations Management similar to that employed by Martínez and Javier (2016). Finally, we used the snowballing technique to find out more articles from the reference list of the already selected articles. Out of all the articles found, 60 articles fittingly discussed the integration of lean and green paradigms from supply chain perspectives and impact on supply chain performance.

Although, we found several interesting articles dealing with the topic from various sources, we focused predominately on those that had been published in the last 10 years (2006-2016) to develop more recent knowledge about the topic. Nonetheless, we included some of the widely referenced and well-known past papers that were relevant for the topic such as Florida (1996) and King and Lenox (2001). Although, our focus was on high quality, peer reviewed journal articles, we also included a few conference papers such as Duarte and Cruz-Machado (2013a) and Bergmiller and McCright (2009), if the papers were highly cited by later articles and used conceptual models on lean-green integration.

At first, the abstracts were read to put them under individual categories such as 'only lean', 'only green', 'lean-green integration', 'economic performance', 'social performance', 'environmental performance' and 'TBL'. Later, the relevant papers were read and analysed in detail.

Descriptive Information

Consequently, a total of 60 articles matched our selection criteria of a) focusing on lean and green integration; and b) mentioning at least one of the three TBL performance dimension.

Figure 1 presents the number of publications per journal, year, industry, and methodology. In general, the results indicate that the lean-green integration topic has gained popularity among academics and practitioners since 2010. Despite a slight drop in publications in 2012, numbers have been growing. This can be attributed to the fact that the topic is still comparatively new, although the origin of the integration concept can be traced back to the year 1996.

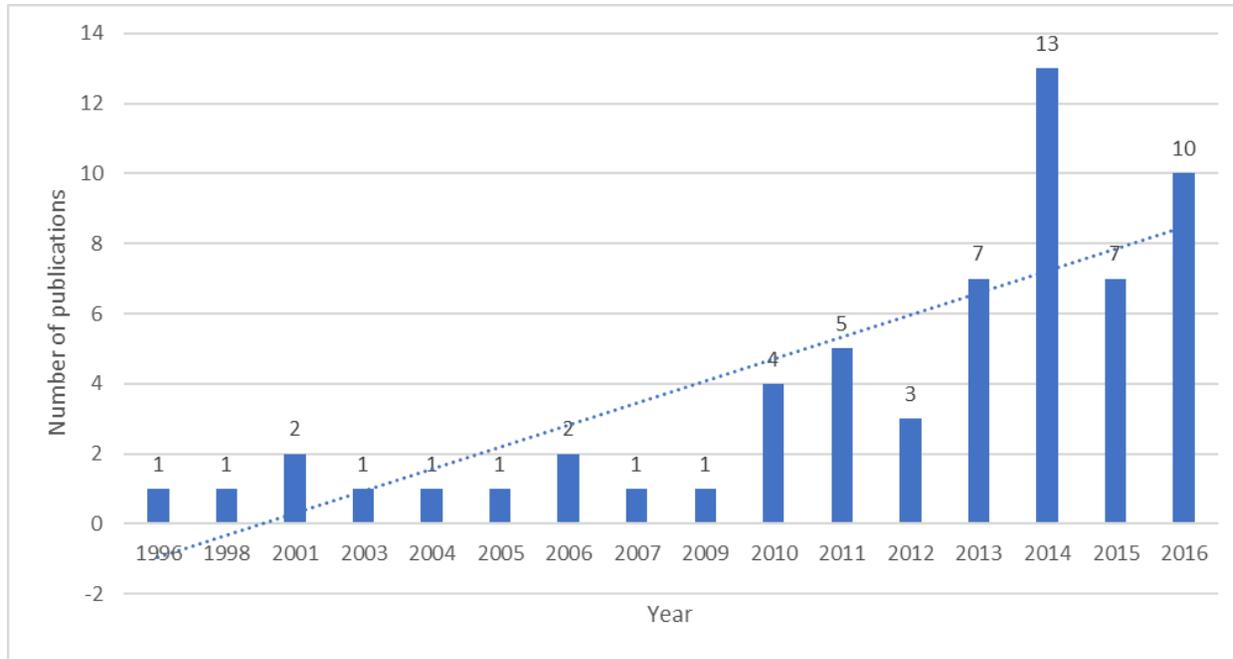
In terms of the number of publications per journal, Journal of Cleaner Production has always been in the forefront of publishing on lean-green topics. As the figure 1 (b) shows, majority of the articles on lean-green integration and performance are still published in Journal of Cleaner Production (24) followed by three other journals: International Journal of Production Economics (3) and Environmental Quality Management (3) and International Journal of Lean Six Sigma (3). It is also evident from the figure that a wide range of journals were used by the authors to publish these articles on lean-green integration.

Regarding the industry (see Fig 1 (c)) used to perform the empirical study, automobile industry (12 articles) was popular among researchers. General manufacturing category was also quite popular as this sector is a mix of manufacturing firms from different backgrounds. Since, automobile industry and overall manufacturing industry deal with major pollution and waste generation issues, and are subject to stringent regulations (Verrier et al., 2016), researchers were interested to explore these sectors to develop frameworks or validate models.

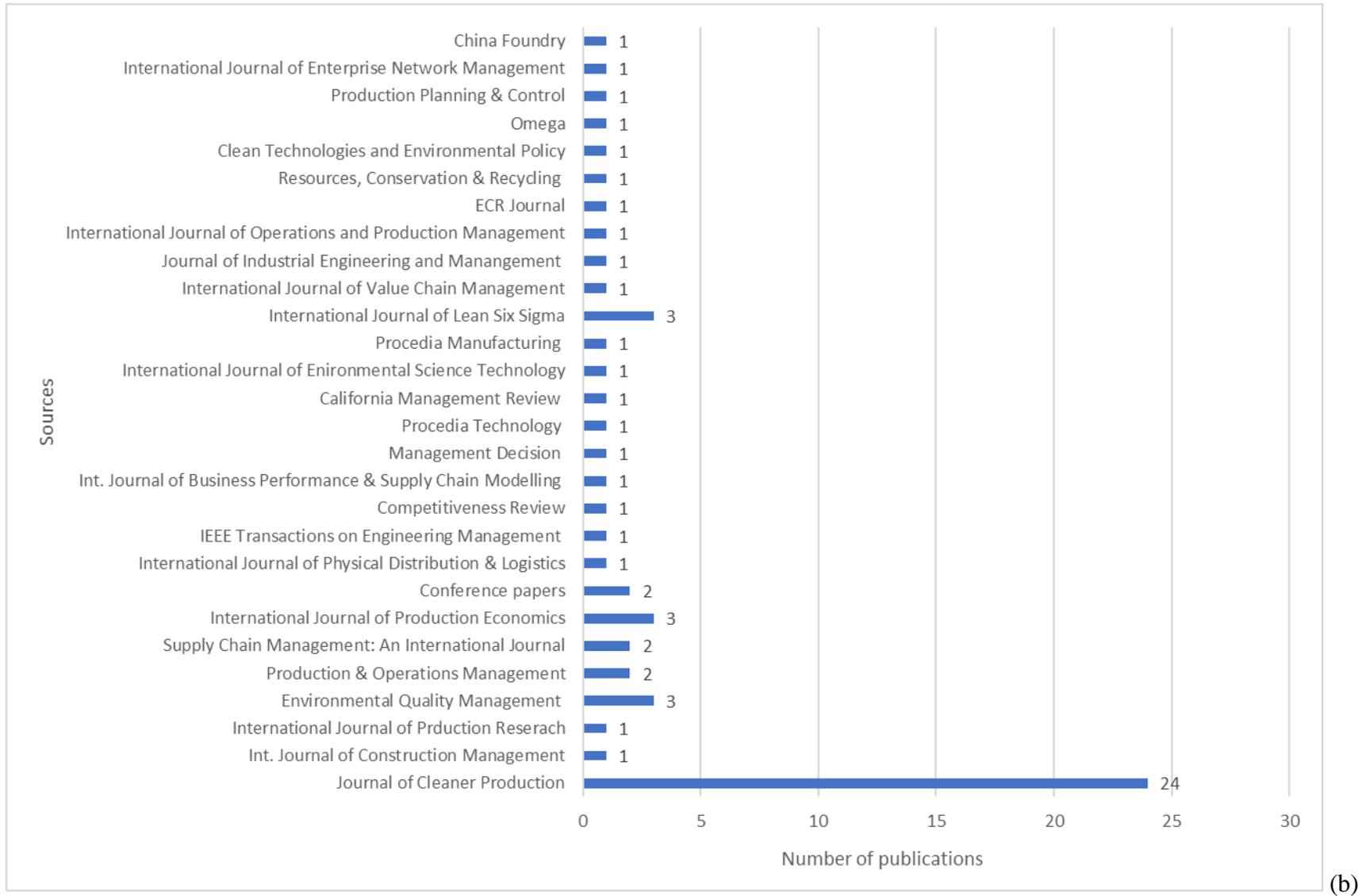
Fig 1 (d) also includes information about the nature of these papers. As is evident, majority of the papers were case study based (28). Since, the topic is comparatively new and

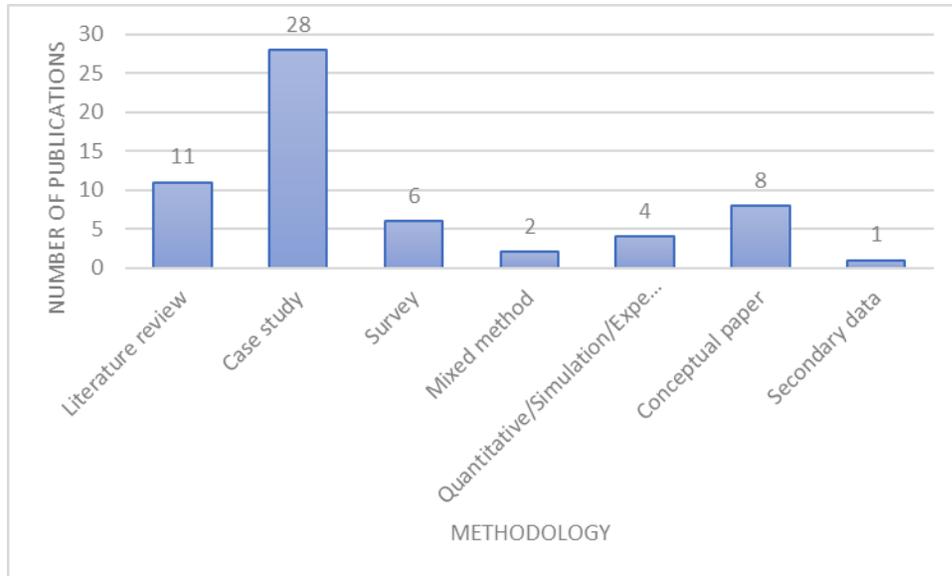
there is a lack of research and understanding or developed theories on the lean-green integration topic, authors used exploratory case studies to explain their findings.

Finally, figure 1 (e) illustrates a handful of studies (8) that looked at the impact of integration on the TBL economic, social and environmental factors. The most popular performance dimension was environmental performance (35), followed by economic dimension (12) and last social dimension (6).

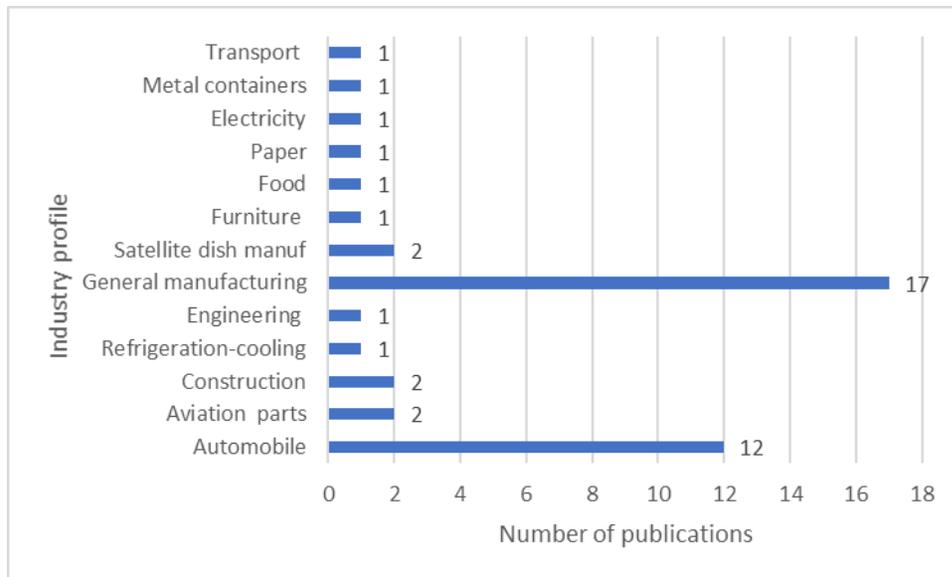


(a)





(c)



(d)

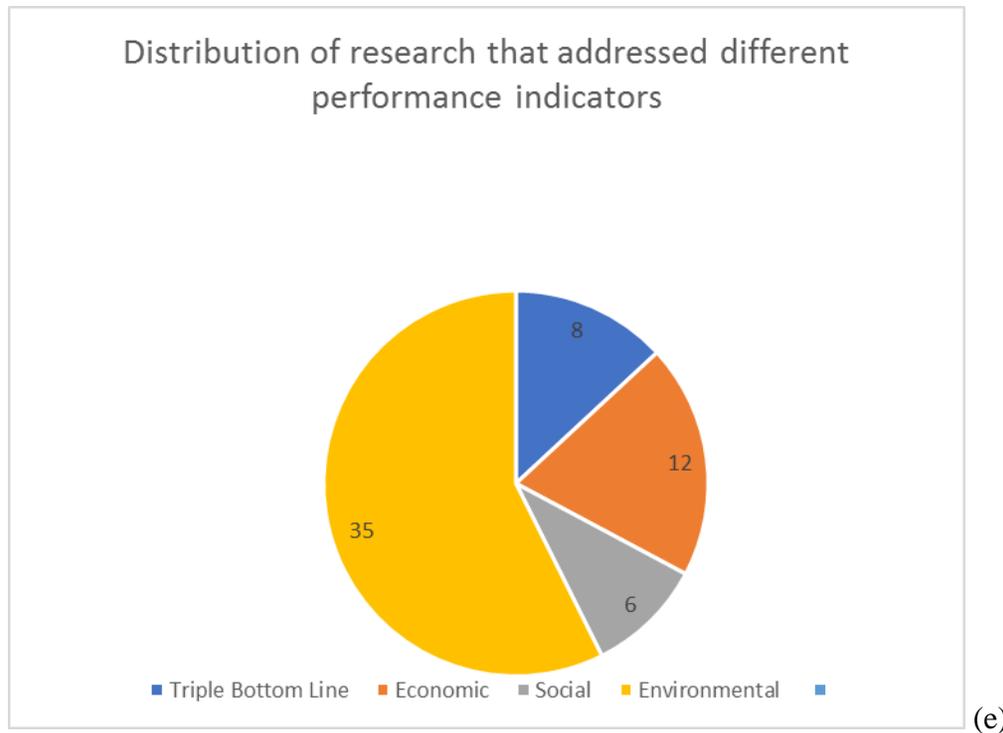


Fig 1: Descriptive data – (a) Year of publication, (b) Number of publications per journal, (c) Number of publications per industry, (d) Number of publications per method, (e) Number of publications per supply chain performance dimension

FINDINGS

Our study findings only explored the combined impact of both lean and green supply chain/operations strategies. The findings revealed that to achieve the benefits from both lean and green supply chains, innovation in supply chain/operations is a prerequisite (Hartini & Ciptomulyono, 2015). In the next subsections, we explain the studies that looked into the impact of lean-green integration on all three dimensions of the TBL. Table 1 and 2 summarise the articles reviewed. Table 1 focuses on empirical studies and conceptual articles. Table 2 focuses on the literature review papers.

Table 1: Details of the articles reviewed

Author/year	Research methodology	Lean-Green frameworks/model	Impact on Triple Bottom Line (TBL)			Other performance indicator	Comments
			Economic performance	Environmental performance	Social performance	Operational performance	
(Verrier et al., 2016)	Some information on Toyota case study	Causal link between lean and green wastes; Lean tools and their impact on lean and green waste management; Lean and green house; lean and green capability maturity model	No	Wastes reduction	Workforce improvement, health & safety, lost people potential	No	Literature review performed to summarize recent findings on lean-green integration
(Sagnak & Kazancoglu, 2016)	Quantitative analysis, Thermal power emissions	Six sigma methodology was employed to facilitate the integration of lean and green approaches	No	Gas emissions from power stations	No	No	Inclusion of six sigma can eliminate the limitations of lean and green approach and improve the performance after integrating lean and green.
(Fercoq et al., 2016)	Quantitative experimental study	Lean and green integration in waste management	No	Waste management	No	No	Combining 3R and the deadly wastes of lean management improve performance of a waste minimization program.
(Garza-Reyes et al., 2016)	Case study, Transport & Logistics	Use of Sustainable Transportation Value Stream Map (STVSM) to allow simultaneous deployment of	No	Reduction of toxic gas emissions,	No	Operational efficiency: excess distance reduction, excess delivery time reduction, average number of clients served increased, demand not satisfied	Simultaneous application of lean and green concepts through STVSM improves road transport operations

		lean and green principles				reduced	
(Campos et al., 2016)	Case study, appliance sector	Conceptual model to explain when synergistic relationship between lean and green possible and when not.	No	3R, waste reduction, pollution prevention, emissions reduction, use of green technology, reverse logistics, green/less packaging	Supplier evaluation/training, information sharing, collaboration.	No	Not all practices from lean and green can be considered synergistic. Some factors influence the potential for lean-green synergy and some factors influence the realization of the synergy potential.
(Ng et al., 2015)	Case study of a firm produces metal stamped parts	Carbon-Value-Efficiency Value-Stream-Mapping (CVE-VSM)	-	Carbon footprint reduced	Safer working conditions, improved skill sets/employability, team spirit, trust between management and workers, sense of accomplishment	Production lead time, processing time reduced	Lean-Green integration can benefit production, improve working environment and support workers.
(Govindan et al., 2015)	Interpretive structural model (ISM) used for automotive supply chain	Impact of lean, green and resilient supply chain on performance	Operation cost, environmental costs,	Reduce material wastage and resource consumption	Customer satisfaction	No	JIT, flexible transportation and environmentally friendly packaging are the three common features of lean, green and resilient supply chain. However, trade-offs could emerge.
(Fahimnia et al., 2015)	Mathematical modelling and case analysis (manufacturer of metal)	Trade-off model	Overall supply chain costs	Carbon emissions, waste reduction and energy	No	No	Lean and green integration debate focus on both overlap among two concepts and barriers. The study

	containers such as water tanks)			consumption			found that trade-offs may exist depending on the environmental objectives and SCM strategies (production, transportation etc.) of the lean practices.
(Piercy & Rich, 2015)	Multicase analysis, manufacturing firms (cosmetics, pharma, metal, drink, furniture)	Conceptual model to integrate lean operations and green business to develop a full CSR & lean supply chain	No	Waste reduction, less defects, use of less resources	Workplace improvements, supply chain improvements, community improvements	No	The study highlights how lean supports green and green supports lean practices.
(Besseris & Kremmydas, 2014)	Experimental, manufacturing (metal cutting)	Lean and green application in manufacturing	No	Sustainability	No	Productivity	Lean-green implementation improved the productivity and sustainability.
(Faulkner & Badurdeen, 2014)	Case study, manufacturer of satellite television dishes	Comprehensive sustainable VSM or Sus-VSM tool used.	Costs incurred and value added	Process water consumption metric, raw material usage metric,	Physical work metric, work environment metric, energy consumption metric	No	Revealed in the literature review that several studies extended lean tools to include green measurement criteria, not many studies truly measured the impact on economic, society and environmental performance. Also, they mentioned that the integration needs to be in the whole supply chain, not only in silos.
(Chiarini, 2014)	Case study, manufacturers of motorcycle components	Use of VSM and other four lean tools to develop a mapping system	No	Waste reductions and atmospheric emissions	No	No	Literature review revealed lack of theoretical frameworks on lean-green

		to support environmental benefits		reductions			integration and relationships between use of specific lean tools and environmental benefits.
(Kurdve et al., 2014)	Case study, five Swedish automotive manufacturing company	Integration of formal management systems such as quality management (QMS), environmental management system (EMS) and occupational health and safety (OHS) into firms operations improvement system	No	Environmental management system	No	Quality, cost, delivery	5 global car companies revealed that integration is beneficial but needs cultural shift in the firms, support from top management and inclusion of some environmental management related KPIs in place.
(Brown et al., 2014)	Case study, a satellite dish manufacturing facility	No model proposed, use Sus-VSM methodology	Value-added ratio: % of time during which a part/product in being transformed into a form that the customer desires.	Energy use, water use, water, energy and material wastes	Ergonomic motion and work environment	No	The study revealed that a few consider sustainability holistically by focusing on one aspect of TBL.
(Pampanelli et al., 2014)	Case study, a global manufacturing engineering company	Lean-green model based on Kaizen approach	Cost reduction of by 5-10% of the total cost of mass and energy flows	Reduced environmental impact and increased productivity in the use of resources	No	No	Integration of green practices into lean practices required merger of traditional lean waste management principles and environmental concern about resource usage. However, to successfully operate the

							integration it is important to be lean first and involvement of all team members.
(Galeazzo et al., 2014)	Case study of refrigeration-cooling-water pump industry	No framework proposed, Natural Resource Based View used to integrate lean and green principles	No	VOC emissions, hazardous wastes	No	Production costs savings, productivity, quality, dependability, speed, volume flexibility	Two propositions: a) simultaneous implementation of lean and green practices were efficient more than the sequential implementation; b) collaborations between operations managers and environmental managers are important.
(Banawi & Bilec, 2014)	Case study in construction industry	Integrated model to validate the link between three constructs	No	Waste generation in time and materials	No	No	The framework designed to improve process performance by elimination/reducing design changes during the construction phase.
(Wong & Wong, 2014)	Case study, manufacturing	Lean-ecosphere management system by using ISM and ANP.	No		Human factor (dissatisfaction, conflicts among departments, cohesiveness among employees)	Quality, costs, delivery	Scientific and innovative management of lean is beneficial for the firm and environment.
(Duarte & Cruz-Machado, 2013a)	Case study, automobile industry	Lean and green success roadmap	No	Not explicitly	No	No	Case study companies are aware of the lean-green integration and possible benefits, however, implementation was not done completely.
(Duarte & Cruz-Machado,	Conceptual paper	Transformation model by integrating	No	Not explicitly	No	No	To integrate lean and green, appropriate culture, involvement of

2013b)		leadership, people, strategic planning, stakeholders, processes and results					employees, leadership commitment and suitable strategies are important.
(Sobral et al., 2013)	Case study of automobile manufacturers	Focus on how lean manufacturing practices generate green benefits although no new model proposed	No	Efficient use of resources such as water, energy, and raw materials, waste generation	No	No	Adoption of lean can generate green benefits but this synergy between the two concepts not always identified/understood by the managers.
(Aguado et al., 2013)	Case study of manufacturers of industrial pipes	Efficient and sustainable improvements in a lean production system through processes of environmental innovation	Material costs, production costs, general costs, selling price, benefits	Environmental impact, global warming,	Social responsibility because of reduced consumption of the raw materials and customer satisfaction.	Productivity, quality	Costs, the incomes, the social responsibility and sustainability can be improved with innovative environmental approaches to lean system.
(Jabbour et al., 2013)	Survey study in Brazilian automotive sector	Conceptual framework to validate the relationships between environmental management, lean management and human resource management with the influence of environmental management on operational performance	No	No	No	Cost, quality, flexibility, delivery, new product development, time to market for new products	There is a need identified in the study to focus on human side (such as recruitment/selection, training, performance evaluation and rewards/benefits) of environmental management in addition to lean management.

(Hajmohammad et al., 2013)	GMRG survey, manufacturing sectors	Integrating lean management, supply chain management, environmental practices and environmental performance, Environmental practices act as a mediator.	No	Air emissions, waste water generation, solid waste disposal, consumption of hazardous/harmful/toxic materials and energy consumption	No	No	Lean management makes the organisational environment conducive for development of environmental management practices and these environmental initiatives improve the environmental performance. The impact of supply chain management was marginal.
(Folinas et al., 2013)	Conceptual paper	Systematic approach for determining the waste in agri-food supply chains through VSM	No	Waste management	No	No	VSM is an effective and efficient tool for waste removal and greening food supply chain.
(Bandehnezhad et al., 2012)	Survey of manufacturing firms in Malaysia	Process/equipment, manufacturing planning/control, human resource practices, product design, supplier relationship, customer relations and environmental outcomes are included in the model.	No	Environmental outcomes	No	No	Not all lean practices are beneficial for the green outcome. Manufacturing planning/control and suppliers' relationships were found to have no significant impact on environmental performance.
(Cabral et al., 2012)	Case study, Automotive company	Conceptual decision making model: ANP by integrating lean, agile, resilient and green supply	Environmental cost, cash-to-cash cycle	Business waste	No	Inventory levels, quality, customer satisfaction, time, cost	To improve competitiveness, agile is the most important feature followed by lean, resilient and green.

(Azevedo et al., 2012)	Case study, automobile industry	chain A theoretical framework by integrating lean and green supply chain practices developed by including relationships of the focal manufacturer with upstream suppliers, an analytical framework follows this	Operational cost, environment cost, inventory cost	Business wastage, green image, co2 emissions	Corruption risk, supplier screening, local suppliers	No	The authors proposed six propositions related to the impact of lean and green practices on the TBL.
(Carvalho et al., 2011)	Conceptual paper	Conceptual model to explain synergies and divergences between lean, green, resilient and agile management paradigms	No	Redundant and unnecessary material reductions, waste minimization, reduce transportation lead time, efficiency of resource consumption	No	Flexibility, responsiveness, customer demand, speed/quality	Lack of research on all four features and their integration. The study revealed synergies possible for some supply chain attributes (information frequency, production lead time, transport lead time etc.), not for all attributes.
(M. G. M. Yang et al., 2011)	Survey in manufacturing firms worldwide	Integration of lean and environmental management practices led to environmental and business performance	Financial performance: return on assets and return on sales, market performance: sales and market share	Environmental performance improvements over last 3 years and comparison with their competitors	No	No	Lean principles with the help of green management practices can improve environmental performances, only lean practices cannot improve environmental performance. Environmental

							management practices directly impact the business performance negatively, but, positively influence the environmental performance.
(Vinodh et al., 2011)	Conceptual paper	Strategies/techniques to achieve sustainability objectives using lean initiatives	No	Waste elimination	Occupational Health & Safety	No	Several lean principles such as Kaizen, VSM and 5S can be used to integrate environmental concept.
(Torielli et al., 2011)	Conceptual paper, Foundry industry	Comprehensive lean-green system model	Cost	Environmental Management System	No	No	Lean alone cannot improve environmental performance but integration with sustainability can improve company's ability to continuously improve.
(Miller et al., 2010)	Case study, Furniture industry	Discussions on lean-green integration but no model proposed.	No	Waste reduction, recycling	No	No	Lean transcends green if combination of lean tools can be applied. However, the article did not talk about the lean-green integration.
(Carvalho et al., 2010)	Conceptual paper	Conceptual model focusing on supply chain performance and lean-green practices integration.	Cost, ROA, efficiency, cash-to-cash-cycle	Environmental costs, LCA, business wastage	No	Inventory levels, quality, customer satisfaction, time	Lack of supply chain metrics can create problem in integrating lean and green and find out the impact on TBL.
(C.-L. Yang et al., 2010)	GMRG survey, various manufacturing sectors	Integrated model by including advanced manufacturing practices, environmental	No	No	No	Manufacturing competitiveness: cost, quality and delivery	Environmental management practices act as mediator between advanced manufacturing practices and competitiveness.

		management practices and their influence on competitiveness.					
(Sawhney et al., 2007)	Case study, manufacturing (metal cutting)	Lean and green integration matrix through En-Lean methodology	No	Solid waste, toxic chemicals, water pollution	Employee's air pollution, health safety and energy use	-	The case study illustrated that there are trade-offs between lean and green performance.
(Vais et al., 2006)	Case study, paper board companies	Focus on lean-green principles but no model/frameworks proposed.	Profitability	Discharge to water, water savings	No	No	Innovative use of lean and green tools reduced the environmental impact and tripled profitability.
(Kainuma & Tawara, 2006)	Experimental, simulation	Extending supply chain to include re-use and recycling to integrate green onto lean concepts	Supply chain ROA	LCA	Customer satisfaction	No	Multiple attribute theory supported the integration between lean and green paradigms.
(Simpson & Power, 2005)	Case study, Automotive company	A conceptual model between supply relationship, environmental management practice and lean manufacturing	No	Environmental performance, mainly focus on waste reduction	No	No	Lean performance is positively related to environmental management practices and relational customer-supplier relationship supports the spill over from lean to green.
(Larson & Greenwood, 2004)	Case studies undertaken by EPA, primarily focusing on Boeing company	Lean and green synergies and performance improvement	Touched on overall cost improvement	Waste management	No	No	The study found that currently lean and green operate in parallel in most firms. Integrating both could reduce the weaknesses associated with each paradigm and improve overall competitiveness.

(Simons & Mason, 2003)	Case study, food industry	VSM methodology used to integrate environmental impact, no model proposed.	Value-added percentage	CO ₂ minimization throughout the supply chain	No	No	Use of VSM to measure environmental impact is a new but growing area in research.
(Rothenberg et al., 2001)	Surveys and interviews, automobile industry	Integration between lean practices (such as buffer minimization, work practices and human resource management) and environmental practices	No	Air emissions of VOCs, and resource efficiency	No	No	Some aspects of lean principles may conflict with some aspects of environmental performance. The relationship between lean practices and environmental practices will be stronger for energy resources than water since plants perceive energy as more valuable.
(King & Lenox, 2001)	Secondary data from existing database from US manufacturing facilities	Conceptual model to test the relationships between lean production and adoption of ISO 14000, waste generation, on-site treatment and emissions	No	Total emissions, relative emissions, Waste generation	No	No	The authors found evidence to confirm that lean is green.
(Maxwell et al., 1998)	Automotive, case study	No separate model, discussions on productivity, high quality and environmental sustainability	-	VOC emissions	Human resource policies	-	Implementation of lean management makes the adoption of green management easy.
(Florida, 1996)	Mixed method, manufacturing firms	Use of advanced manufacturing practices to improve	No	Pollution prevention	No	No	Innovative use of advanced manufacturing systems can improve

		environmental outcome					environmental impact of manufacturing practices.
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Table 2: Summary of the literature review

Authors	Variables of interest	Time Period, number of publications	Contribution				Findings/comments
			Focus of the study	Any future study area proposed	Any model proposed	Proposition proposed	
(Cherrafi et al., 2016)	Lean/six sigma and sustainability	1990-2015, 118 articles	The authors did a state-of-art literature review on the integration between lean, six sigma and sustainability by focusing on barriers, drivers, benefits and conflicts among the variables.	Yes, seven major future research areas identified.	Integrated model by including barriers/drivers and critical success factors	No	The study identified a lack of integrated model between lean, green and Six Sigma. They proposed a model to fill this gap with the help from DMAIC pattern.
(Hallam et al., 2016)	Lean and green	1996-2016, 60 articles	Relationship between green and lean wastes	Yes	The integration of lean and green and impact on performance from both lean and green management side	No	Lean and green practices were implemented separately, although synergistic benefits can be obtained if the implementation of both can be integrated.

(Verrier et al., 2016)	Lean and green	2008-2015, number of articles reviewed not mentioned	Synthesized research on lean and green topics	Yes	Several models proposed and tested	No	This study is not only focused on literature review but is a part of the large scale 'Lean and Green project'.
(Martínez & Javier, 2016)	Lean and green and TBL	1987-2014, 57 articles	Lean and green synergy and impact on TBL	Yes	Conceptual maps to identify affect and effect of lean and green integration on TBL	Yes	The review revealed that more research is needed to explore the impact on financial dimension compared to social and environmental dimension. They also supported existing research findings that lean has positive implications for the environment, however, lean sometime can have negative implications for the environment too.
(Garza-Reyes, 2015a)	Lean, green and six sigma	No time-period mentioned, 57 articles	Focus on limitations of lean-green integration and compatibility with Six Sigma	Yes	Integrated Green Lean and Six Sigma to influence environmental, operational and financial performance through DMAIC model	No	The inherent limitations of green and lean approach require firms to integrate with Six Sigma to address the limitations and complement the green lean approach and improve effectiveness of the overall integration.
(Garza-Reyes, 2015b)	Lean and green	1997-2014, 59 articles	Concept map of the lean and green literature review to show the different research streams	Yes, with future research questions	No	No	The concept of lean-green integration is still not clear and the authors proposed several future research paths with potential research questions. The critical area is to undertake research in under-researched organisation functions.
(Hartini & Ciptomulyo no, 2015)	Lean and sustainable manufacturing performance	2000-2014, 58 articles	Interrelationships among lean and sustainable manufacturing on performance	No	No	No	Research gaps identified but no future research path shown.

(Johansson & Sundin, 2014)	Lean product development and green product development	2000-2012, 102 articles (35 LPD, 67 GPD)	Potential conflicts, synergies or overlap between LPD and GPD	Yes	No	Seven propositions	Lean and green are not two sides of the same coin, LPD will not automatically lead to GPD.
(Martínez-Jurado & Moyano-Fuentes, 2014)	Lean management, supply chain management and sustainability	1990-2013, 58 articles		Lack of research on the social sustainability area, definition of lean supply chain social impact, key social performance indicators	Yes	No	The key future research area could be to look at the social sustainability in lean supply chain management.
(Dhingra et al., 2014)	Lean and green	Special issue of Journal of Cleaner production, 2014, 43 articles	All types of paper submitted in the special issue on lean and green paradigms	Yes	No	No	Review of the articles published in the special issue reveal that lean-green integration can help society to move towards a sustainable future.
(Dües et al., 2013)	Lean and green	1990-2011, publication number not mentioned	Lean and green synergy and distinguishing features	No	A model to explain the possible overlap between lean and green paradigms	No	The study highlighted the major areas of similarities and conflict.
(Halldórsson et al., 2010)	Green, lean, and global supply chains	1990-2009, first 1000 articles scanned	Complimentary and conflicting factors between lean, green, and global supply chains	Four future research agenda proposed.	No	No	The study found out that there is a lack of research regarding how to implement green, lean and global supply chain concurrently. Also, there is a lack of theoretically grounded research on the synergies and conflicts between three principles.

Lean-Green and Environmental Impact

The highest number of studies (35 articles) considered the relationships between lean-green synergy and environmental performance. Mostly studies found that lean supply chain management has a positive relationship with green supply chain management because the underlying principal of both paradigms is waste reduction (Hajmohammad et al., 2013; King & Lenox, 2001; Rothenberg et al., 2001). Environmental Protection Agency (EPA) mentioned that environmental wastes are embedded in or related to Taichi Ohno's 7 deadly lean wastes. It is shown that lean is green because the experiences accumulated through lean management help organisations to move towards green management. Through an empirical study, the authors found that different lean management processes, such as adoption of ISO 9001 or minimising inventory, increases the likelihood of adoption of ISO 14000, waste reduction, pollution prevention and lowering emissions (King & Lenox, 2001). The authors suggested for managers to consider lean and green practices as a bundle. Rothenberg et al. (2001) in their study on the automobile industry demonstrated that if lean organisations wanted to integrate green practices into their strategies, they would need to focus on value-added activities. For example, pollution prevention strategies such as process improvement, recycling, energy recovery and material change are used by lean organisations to attain the benefit of lean green combination. On the other hand, some organisations use pollution control technologies to comply with the regulations quickly. The first group of organisations was able to integrate both concepts by using value-added activities from both concepts, however, the last group of organisations treated both concepts separately and failed to receive similar benefits. These findings support the research by Florida (1996) that organisations that are innovative and research intensive are able to combine lean and green paradigms and achieve environmental improvements as a result. Other factors that generally help in the integration are supportive work practices like empowerment to employees and having an environmental manager work on the shop floor. Jabbour et al. (2013) found that lean management has a strong positive influence on environmental management which in turn influences operational performance.

On the other hand, another series of studies claimed that the direct relationship between lean and green is not possible. For instance, Hajmohammad et al. (2013); Rothenberg et al. (2001); M. G. M. Yang et al. (2011) stress that lean management cannot improve environmental performance alone because of the inherent conflicts in these two practices. However, lean management supports development of environmental management practices (such as ISO 14001 certification or life cycle analysis or investment in pollution prevention technologies) in the organisation which in turn improves environmental performances. Martínez-Jurado and Moyano-Fuentes (2014) state that lean supply chain encourages long-term collaborative relationships throughout the supply chain which in turn encourages environmental management processes from design to product take back. Pampanelli et al. (2014) demonstrate that the combined impact of both strategies can be beneficial for the environment since both philosophy emphasize on waste reduction, productivity increase by optimal use of resources and collaborative supplier arrangements. However, their model was based on some prerequisites. The most important one was the presence of a lean environment first to smoothen the transition into the green environment.

On a different note, Bandehnezhad et al. (2012) revealed that lean practices can improve environmental performances in some 'specific functional areas' in the organisations. Specifically, lean management related to processes and equipment, human resources, product design and customer relationships positively influenced environmental outcomes, while, manufacturing planning/control and supplier relationship did not show any significant relationships with environmental outcomes. A study by Verrier et al. (2016) provided an integrated lean and green maturity deployment model. This model used the waste concepts from lean paradigm and found

a link with waste concepts from green paradigms. Moreover, the authors prescribed several lean management tools (for e.g., Value Stream Mapping or Gemba Walk - used to describe personal observation of work -where the work is happening) to reduce green wastes. Fercoq et al. (2016) studied the impact of seven deadly wastes from lean paradigms and 3R (reduce-reuse-recycle) from green paradigms and found that combined applications of the two can reduce waste generation more than what an individual paradigm can achieve. The authors developed a lean/green matrix to help practitioners and academics in their waste minimisation plan.

On the contrary, Hallam et al. (2016) model demonstrated that green management if combined with lean management can together reduce the wastes from the 'whole supply chain' such as design, production, factory management and supplier network, not only from specific functional areas. Verrier et al. (2016, p. 90) studied the integration of lean and green paradigms and revealed that both 'lean and green actions should be taken as a whole' in order to achieve the common target of environmental improvement.

From our systematic literature review, we have observed that research findings are mixed regarding the impact of integration of the lean and green concepts on environmental performance. Some studies indeed found positive relationships between the two, however, others showed that integration between lean and green is a complex issue and may not always lead to positive influence on the environment directly or indirectly.

Lean-Green and Social Impact

Compared with the other two dimensions, extant studies (6 articles) have paid little attention on the impact of lean and green supply chain/operations on the social dimension.

Maxwell et al. (1998) through the Honda case study identified that integration of green management into lean manufacturing practices can help employees feel more empowered regarding finding suitable environmental related solutions for car painting. Similar to lean management principles, production workers (or associates) were involved throughout the production processes to find innovative environmental and occupational health safety solutions and received awards. In every step of the supply chain, the company motivated workers to improve environmental performance. Chiarini (2014) revealed that lean management tools such as 5S can reduce the injury rate and improve the poor conditions of health and safety. Wong and Wong (2014) found that the lean-ecosphere model assisted companies to reduce employee dissatisfaction and improved overall employee behaviour by increasing their motivation. Throughout the integration, humans were considered as a resource by following the lean principle. Govindan et al. (2015) state that a combined impact of lean, green and resilient supply chain can improve customer satisfaction by decreasing transport lead time, making packaging environmentally friendly and improving quality of the products in the automobile industry. Hallam et al. (2016) explains how lean-green combined strategy can help the social aspects by improving employee satisfaction, retention rate and having high quality prospective candidates because of good company reputation. Verrier et al. (2016) included 'lost people potential' as the 8th lean waste that has social implications. Lost potential can be created through poor health and safety in organisations and can lead to missed opportunities and lack of motivation. The lean-green integration can therefore help reduce human waste and improve social and environmental dimensions.

As can be seen above, only a handful of studies have focused on the social impact. This gap in research has also been highlighted in several literature reviews (Hartini & Ciptomulyono, 2015; Martínez & Javier, 2016).

Lean-Green and Economic Impact

The systematic review revealed around 12 articles that explored the impact of lean-green integration on the economic dimension. Although, it is not as large as the environmental dimension, the sample is unquestionably more than the social dimension.

Florida (1996, p. 101) asserts that 'convergence of zero defect, inventory and emission approach lead to improvement of productivity, performance, and profits'. Vais et al. (2006) through a case study on the paper industry found that due to the lean and green synergy, the organisation was able to reduce water consumption and triple its profit. Miller et al. (2010) also found that lean-green combined effect improved financial performance by cost savings when implemented concurrently. M. G. M. Yang et al. (2011) saw that the presence of various lean management concepts in organisations (such as continuous improvement, TQM, JIT and collaborative supplier relationship) creates strong managerial experiences to develop a proactive environmental management process which in turn improves the competitiveness of the organisation by improving costs and delivery performance.

The impact of lean and green integration on economic performance may not be direct or positive always. Hallam et al. (2016) found that lean and green strategies together cannot directly improve the financial performance. However, indirectly both of them could improve the productivity which in turn can reduce the operating costs. On the other hand, they also found that the choice of green supply chain strategies can sometimes reduce the financial benefits by increasing operating costs or production times (Hallam et al., 2016). This finding is in line with that of Carvalho et al. (2010). Their findings show that green supply chain has minimal direct impact on economic performance but can impact indirectly through improved efficiency, customer satisfaction and reduced environmental costs. Likewise, M. G. M. Yang et al. (2011) found that the relationship between lean/green management and financial performance is a complex one. Initially, financial performances could be negative since organisations need to invest in human, structural and social capital for the implementation of various environmental management practices. However, in the long run, good environmental performances such as waste reduction or reduced emissions lead to higher market valuations of the organisations which eventually improves financial performance.

It is evident from the above discussions that the impact of lean-green integration on economic dimension is mixed. In the short term, during the initial periods of implementation and investments, the costs would be higher, hence, economic performance may go down. However, in the long run, the impact may become positive.

Fig 2 is based on the findings of the literature. According to the literature, lean and green are two separate paradigms and only few areas of both paradigms can be integrated. The shaded area in Figure 2 highlights the common segments of both paradigms that can be integrated. Also, the figure shows that the influence of integration on TBL is mixed, according to literature. It is also evident that the lean-green integration can influence TBL dimensions stronger than what lean or green paradigm individually can.

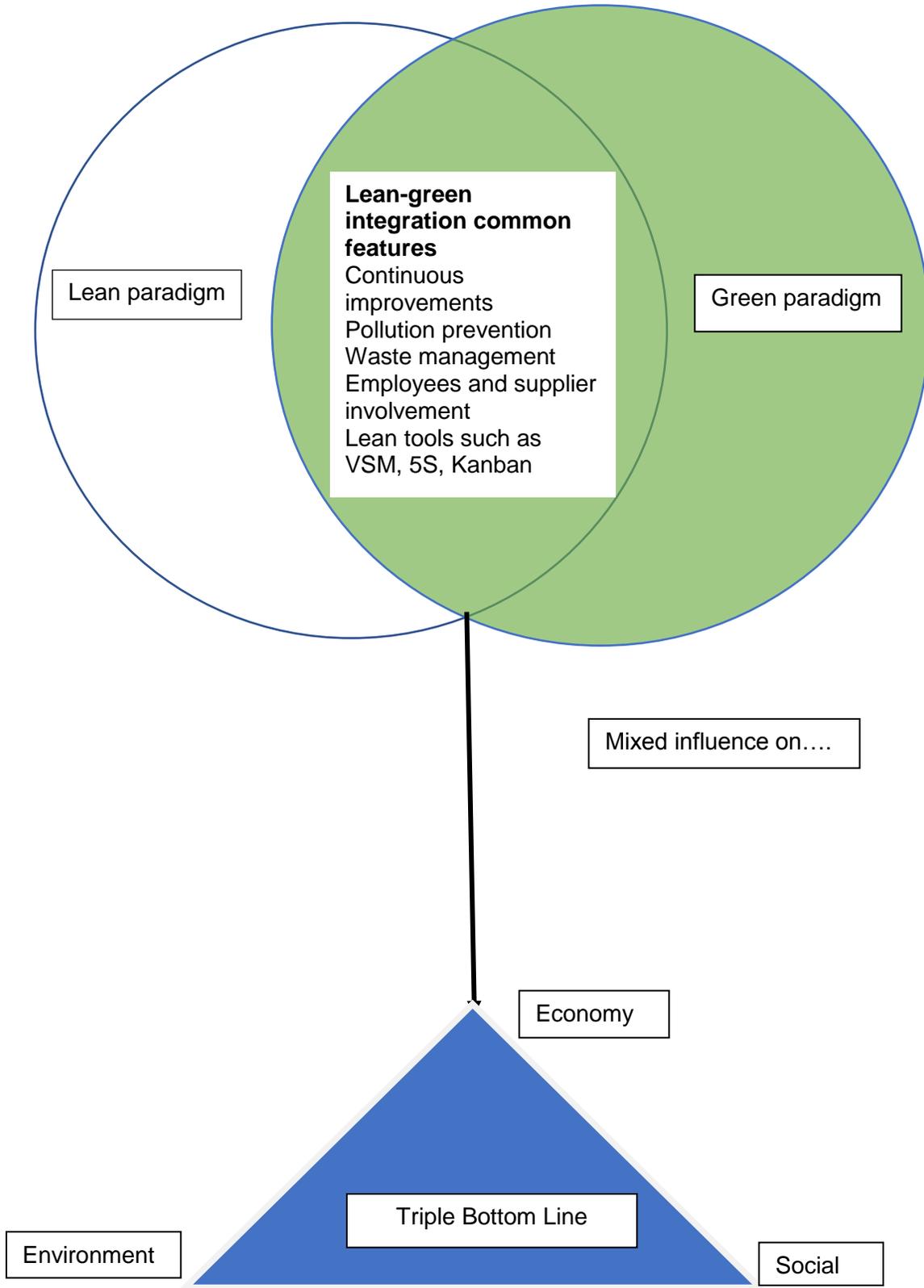


Figure 2: The relationship between lean-green integration and TBL

DISCUSSIONS AND FUTURE STUDY AREAS

USA Environmental Protection Agency (EPA) toolkit in 2003 provided guidelines to practitioners regarding how to extend lean principles to include various green principles to benefit organisations EPA (2007). According to EPA, the lean definition should now include environmental and social concerns to provide a holistic improvement in organisations. Nonetheless, our literature review revealed that still more studies are required to focus on the suggestions provided by the EPA and overcome the gap in existing studies. In this section, we will discuss the gaps in existing studies and propose some potential future research paths.

It is evident from our literature review that the empirical research on the integrated impact of lean and green management are limited (Garza-Reyes, 2015b; Garza-Reyes et al., 2016; King & Lenox, 2001; Martínez-Jurado & Moyano-Fuentes, 2014) although it is often mentioned that there is a connection between lean and green paradigms in strategic, tactical and operational levels (Duarte & Cruz-Machado, 2013b). Nevertheless, there needs to be a systematic way to implement both lean and green paradigms in a combined and innovative way. Zhu et al. (2008) mentioned that to reduce the external pressure from community and regulators, manufacturers need to integrate green concepts into existing manufacturing practices. To generate combined impact of both paradigms, a mix of critical factors are needed. Some of these critical factors include a supporting culture, involvement of all employees, leadership commitment and existence of suitable organisation structures. Maxwell et al. (1998) showed that Honda's US plants were able to not only extend the lean management principles but also successfully trained workers to solve the manufacturing and environmental issues with common solutions. It was possible partially due to its culture and mostly due to the integration of lean and green paradigms. Although, several models and frameworks have been proposed, various limitations or barriers against the lean-green integration have been put forth too. Galeazzo et al. (2014) revealed that lack of interactions of green practices with other operational and organisational practices such as lean practices hinders the firm's ability to create unique combinations of resources and capabilities required for developing competitive advantage. Pampanelli et al. (2014) identified that lean manufacturing is centred on preserving value with less work, whereas, green manufacturing is centred on preserving value with less damage to the environment. Garza-Reyes (2015b) mentioned that the lean is a concept composed of a series of practices and methods, but green is more than a collection of tools, an overarching philosophy. Another issue associated with the lean-green integration is a lack of resources to invest in the integration. A lot of data and effort are required to map and analyse sustainability performance. Therefore, if a firm already is facing resource constraints, it may not be willing to spend more resources on lean-green integration (Ng et al., 2015). For instance, Vinodh et al. (2011) explained how additional data and more time are required to use the conventional Value Stream Map (VSM) for environmental purposes. Hence, more research is required to develop a simple but comprehensive lean-green integration model that is also easy to implement and measure.

As mentioned earlier, only a handful of studies attempted to find the link between the combined impact of lean and green on the three dimensions of the TBL. For example, Carvalho et al. (2011) through a conceptual model proposed the links between lean, green, agile and resilient paradigms and different supply chain performance attributes. They assert that the synergic impact is possible for some attributes but not for all. Likewise, Cabral et al. (2012) proposed that a lean, agile, resilient and green supply chain can improve operational, environmental and economic performance. However, their study also revealed that in organisations, equal importance was not given to all four features of a supply chain. The greatest emphasis was placed on the agile feature and least importance was placed on the green feature. Likewise, the study by Govindan et al. (2015) on the relationships between lean,

resilient and green practices and performance found that these supply chain features can influence operational cost, business wastage, environmental cost and customer satisfaction significantly. Martínez and Javier (2016) explained that lean means efficiency and effectiveness whereas green means efficacy, effectiveness, and ethics. Therefore, in isolation lean, or green philosophy may have a negative impact on TBL dimensions. Hence, the results from these studies are inconclusive because these studies included several other features (such as agile or resilient) in addition to lean and green and only a few studies explored the impact on TBL from the supply chain/operations perspective. Therefore, the future research areas proposed by Martínez-Jurado and Moyano-Fuentes (2014) to look into the integration between lean and green beyond waste minimization and impact on environment, social and economic aspects have yet to be addressed properly.

There is a lack of studies that considered the combined impact of lean-green paradigm on social factors (Cherrafi et al., 2016; Verrier et al., 2016). Both paradigms focus on employee training and involvement to reduce waste, improve processes to eliminate defects and accidents in the production process. Although, it is stated by some studies that the combined impact of both paradigms can create more efficient employees and improve operational efficiency (Ng et al., 2015; Sobral et al., 2013), it has been found that organisations often do not use the paradigms in a synergistic way to receive the combined benefits from a social perspective. For example, lean training provides information about how to reduce lean waste, reduce input consumption and increase equipment's life efficiency. However, these trainings do not encourage employees to think about managing green waste through recycling and responsible resource consumption. The tools useful for lean paradigms can be used to improve social efficiency as long as employees understand how to extract the combined value from these two paradigms. Gimenez et al. (2012) noted that innovative and advanced production processes (a lean concept) can reduce pollution which in turn improves working conditions and quality of life of the community. Verrier et al. (2016) and Hines (2009) included poor health and safety and lost people potential as additional factors under both lean and green waste management paradigm. However, none of the studies empirically tested the impact of lean-green integration on other social factors such as community benefits or customer welfare.

Another future area of research could be to consider the combined impact of lean and green on different stakeholders. As yet, relationship with suppliers and employees (Florida, 1996; Rothenberg et al., 2001; Simpson & Power, 2005; Verrier et al., 2016) were found as key factors behind the integration between lean and green, however, no research has looked into the impact of the integration on other key stakeholders such as customers, community, employees or regulators. For instance, Vais et al. (2006) and Sobral et al. (2013) note how lean tools such as 5S, TPM and Quality circles train employees to improve efficiency of the equipment through regular maintenance, monitoring and cleaning. Likewise, these tools can be used to motivate employees to improve the environmental impact of operations. This finding also received support from González-Benito and González-Benito (2008). Simpson and Power (2005) on the other hand, focus on supplier involvement and collaboration to develop and use innovative environmental practices for pollution prevention and waste reduction. The authors draw references from Japanese manufacturing practices regarding how suppliers' direct-involvement approach facilitate the implementation of lean and green teachings into the production system. Future research could consider how the integration of lean-green paradigms influence employees and suppliers and other stakeholders.

All the reviewed studies mostly focused on the automobile industry since lean management originated from Toyota (Cherrafi et al., 2016). As seen through the literature review, around 28% studies were done on the automotive sector. A few other industries such as construction or general manufacturing were included in the empirical studies, although no studies looked into the impact on service industry. The impact of integration may vary

significantly from one industry to other. Therefore, future studies could look at firms from different industry backgrounds and also examine industry effects on the implementation of lean-green integration.

Finally, we found that there is a lack of universal measurement scale that include achievements from integrated lean and green supply chains and influence on economic, environmental and social performances. ISO 9000 series can measure lean performance, ISO 14000 series can measure environmental performance and ISO 26000 can provide some evidence about social performance individually (Verrier et al., 2016), however, there is very little research on the combined measurement criteria (Halldórsson et al., 2010). Since, different authors measure economic or environmental performance with different criteria, it is hard to compare the overall performance improvements across industry or country. Out of the nine reasons Hassini et al. (2012) explained behind lack of reliable metrics to measure TBL dimensions, the most important ones were a lack of understanding regarding which measure to use when and how and lack of agreements among supply chain actors to use one common measure for all three dimensions. Zhu et al. (2008) mentioned that to advance knowledge about emerging concepts and theories, it is important to identify appropriate measurement scales. Since lean-green integration is an emerging concept, a future research area could be to develop a performance metric that includes TBL factors and explore the impact of lean-green integration.

CONCLUSION

We conducted a systematic review of literature on the integration of lean and green paradigms and their impact on the TBL. We identified 60 papers published between the years 2006-2016 that were relevant to our review. Through our review, we were able to identify potential gaps in the current study and propose a framework highlighting the relationships among the key constructs. We also identified six future research areas that can certainly bring more knowledge into the study area and enrich our knowledge on lean-green integration.

This study makes several contributions. Unlike existing studies, we only reviewed the studies that focused on lean green integration and its impact on at least one of the dimensions of the TBL. In addition, we also briefly addressed other relevant issues such as benefits/barriers of synergy and challenges behind the integration of lean-green concepts. Based on our review, we were able to recommend six future research areas that will enrich our knowledge on the topic. We hope our findings will help academics to do more research on the areas of lean-green integration and develop simple and easy to implement frameworks.

We have limitations in our study too. Although our sample size of 60 articles may not be a large one, it shows the depth of study undertaken so far on the topic. As mentioned by Halldórsson et al. (2010), literature and research are continuously being published and added. Therefore, we may have overlooked a few recent articles although, we have tried to make the literature review as comprehensive as possible.

Despite the limitations, our literature review is able to shed light on a very useful topic that is emerging and is of value to both academics and practitioners. Our review and future research areas illustrate that although the literature is replete with discussions on lean and green issues, still more research is required to fill the gap and enrich the body of knowledge. From a managerial perspective, an easy to implement framework or model by integrating lean and green will help firms achieve competitive advantage without costing a lot and maintaining equal contributions towards society and environment.

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