The relationship between lean and sustainable manufacturing on performance: literature review

Sri Hartini*a, Udisubakti Ciptomulyono*b*

*Department of Industrial Engineering, Sepuluh Nopember Institute of Technology, Surabaya 60111, Indonesia,

Abstract

The aim of this paper is to explore and evaluate previous work focusing on the relationship and links between Lean and sustainable manufacturing. Several frameworks are explored and discussed. Their relationships include correlation, overlapping area, difference, integration and classification based on sustainability dimensions. This paper also examines impact of lean and sustainable manufacturing to improve performance. Many evidences suggested that Lean is beneficial for Sustainable manufacturing, dominantly on perspective environment and economic aspect. This paper identify major research gaps for integrated lean and sustainable manufacturing to improve performance business and modeling as a methodology approach. To do of 58 key research papers have been reviewed for the research contribution, methodologies, country of research, and date of publication. This paper provides a quantitative descriptive analysis and qualitative thematic analysis to provide an analysis of relationship lean and sustainable manufacturing and its impact on performance.

1. Introduction

Many papers that address the connection of lean and green touch on the efficient use of energy (and resources) and the reduction of waste and pollution [1, 2]. Bergmiller and McCright [3] identify the correlation between green operations and lean results. The relationship between total lean results and total GWRT (Green Reduction Waste Total) is a remarkable finding that implies that the lean companies in this study who have opted to complement their lean system implementation with a broad set of GWRT are realizing significantly better results in both green and lean
categories than the other lean plants in the study. This finding not only suggests that lean and green systems can co-exist, but provides evidence of synergy, by virtue of the fact that GWRT improve both green and lean results [3].

Verrier et al [8] presents a simple repository based on a sound analysis of the literature and on three questionnaires which can be used by all kinds of companies. This repository enables the companies to measure the correlation between their lean and green actions, and to benchmark their position on lean and green policies in order to identify the best practices to adopt [4]. The results of survey and study of Alsatian SMEs (small medium enterprises) have provided a tool that can be used to target and promote best practices for lean-oriented sustainable development, and to improve competitiveness. In this research, value stream mapping (VSM) as a tool for identifying environmental impacts has been analyzed as well as the measurable effects of 5S, cellular manufacturing, Single-Minute Exchange of Die (SMED) and total productive maintenance (TPM) on the environmental impacts [5]. Brown et al (2009) said that innovation is necessary to the achievement of sustainable manufacturing systems. The transformation will require an in depth knowledge of system wastes that goes beyond the largely time-based wastes (muda) to include muda of the environmental and societal variety [6]. So some researchers developed lean concept to achieve sustainable manufacturing, for example Dombrowski et al [7], Aguado et al [8], Faulkner and Badurdeen [9].

Due to all these reasons this study, we carry out a literature review with a view to identifying the interrelationships between lean and sustainable manufacturing and analysis in the performance on the three key dimensions of sustainability: environment, economy, and social.

2. Method

The aim of this paper is to structure the research field on lean and sustainable manufacturing in the context of relationship, benefit and its effect on performance and point out the most important gaps. Therefore, this review covers academic papers in the period between 2000 and 2014. This review includes the following major research databases: Emerald, Sciedirect, IEEE, Springer and Proquest. The database search yielded hundreds of articles. Each of the articles was examined to ensure that its content was relevant from the perspective of the aims of our research. The examination and selection of the articles is based on the criteria that only those of which main contribution revolves around the interrelationships among Lean and sustainable manufacturing on performance will be selected. The result of this process was that 58 articles were eventually selected for in-depth evaluation. In order to the descriptive analysis we selected categories: year, author’s country, journal, methodology and sustainable dimensions. The results are structured in two parts: firstly, we provide a quantitative descriptive analysis to get an overview on the research agenda on Lean and sustainable manufacturing. Secondly, this paper presents a qualitative thematic analysis to provide an analysis of relationship lean and sustainable manufacturing and its impact on performance.

3. Results of the descriptive analysis

The most important journals for lean and sustainable manufacturing identified are the Journal of Cleaner Production (14), IJPE (4), POM (4), CIRP (4) and followed by IJOPM (3), JIEM (3), JOM (3). The most dominant author’s countries are USA (36%), UK (14%), Germany (7%), and followed by India (5%). Research about lean and sustainable manufacturing seems to have been the object of growing attention from researchers up to 2014. The number of articles published from 2000 to 2014 had been increasing. The drastic increase occurred from 2011 and continued to rise until 2014. The distribution of articles based on date of publications are 2000 (2%), 2001 (4%), 2003 (4%), 2004 – 2006 (2%), 2007 (4%), 2008 – 2009 (5%), 2010 (2%), 2011 (11%), 2012 (13%), 2013 (20%), and 2014 (25%). Based on 58 articles reviewing, the most important source of empirical evidence in the sample is qualitative approaches: survey and case study (34 articles), literature review and conceptual papers 18 articles, modelling 2 articles [10, 11] and multi method 4 articles. Fig. 1 shows the result of descriptive analysis.
4. Results of the thematic analysis

4.1. Relationship between lean & sustainable manufacturing

Some organizations continued to grow on the basis of economic constancy; the others struggled because of their lack of understanding of the changing customer mind-sets and cost practices. To overcome this situation and to become more profitable, many manufacturers turned to “lean manufacturing” (LM). The goal of LM is to be highly responsive to customer demand by reducing waste [12]. King and Lenox [1] found strong evidence that lean leads to waste and pollution reduction [1]. This evidence is reinforced by Rothenberg et al that Lean production or JIT can reduce emission of VOCs by leading to more efficient solvent use in paints [2]. Also Simons & Mason [11] found that there are relationship between lean & emission reduction. Based on these research, studies about links between lean and sustainable are growing rapidly [13].

Corbett and Klassen [12] conclude that environmental issues can improve financial returns by opening up new customers, competitive differentiation (and increasing market share), reducing cost through waste reduction; focus on environmental improvement may create a more system focused approach to management generally [14]. Bergmiller and McCright [3] identify the correlation between green operations and lean results. This study explores the impact of green programs on lean results. Elements of a green operations system are product redesign, process redesign, disassembly, substitution, reduce, recycling, remanufacturing, consume internally, prolong use, returnable packaging, spreading risks, creating markets, waste segregation, and alliances. The lean results elements consisting of quality, cost, delivery, and customer satisfaction, and profitability. This paper found that lean companies which include green practices achieve better lean results than those companies which do not. Winners and finalists of the Shingo Prize for Manufacturing Excellence (America’s pre-eminent Lean designation) from 2000 through 2005 comprise the sample for this study. Moreover, Bergmiller & McCright [15] provide strong evidence of transcendence to Green manufacturing by leading lean manufacturers. The results indicate that the Shingo plants were significantly greener.
in all but one of the twenty-six green manufacturing system measures. The evidence that plants with lean systems yield higher green results supports the philosophical notion of lean and green synergy.

Rothenberg et al. [2] show that trade-offs between both practices are inevitable. Clearly, not all lean processes, procedures and waste reduction efforts are positively related to environmental performance or pollution reduction, and lean practices alone will never be enough to address all environmental issues.

Dues et al. [16] found the area of overlapping and difference between lean and green manufacturing. The overlap of lean and green paradigm is constituted in the following common attributes: waste and waste reduction techniques, people and organization, lead time reduction, supply chain relationship, key performance indicator (KPI): service level, and that they also share common tools and practices. The differences of the lean and green paradigm lie in: their focus, what is considered as waste, the customer, product design and manufacturing strategy, end of product life management, KPIs, the dominant cost, the principal tool used, and certain practices as, for example, the replenishment frequency. The analysis of the differences shows the areas in which lean and green practices do not connect yet. However, it is also recognized that for these attributes it is also not impossible to combine lean and green practices.

Upadhye et al. [17] tries to highlight the different aspects and benefits of Lean Manufacturing System (LMS) and its implementation in Indian Industries. A model to implement LMS is presented in this paper that includes 10 issues, 11 tools, and 14 results. Organization in global competitive market as well as those wish to achieve sustainable development should strive for lean operations through the application of lean tools and techniques suitable to their situation.

Joint implementation of lean and green practices and their interaction was researched by Galeazzo et al. [18]. This paper found that reciprocal interdependencies are more likely to be associated with the involvement of external suppliers and that the simultaneous adoption of lean and green practices ultimately leads to better operational performance. Some research classified in Table 1.

| Correlation | Integration & Sinergies | Compare & Contrast | Barriers & Drivers | Critical Factors | Assessment |
|-------------|-------------------------|--------------------|--------------------|-----------------|------------|
| [19],[20], [21],[22],[25],[28], [26],[33],[16],[35] | [3],[15],[11],[26], [23],[24],[29],[31], [14],[34],[36],[37], [38],[25] | [26] | [17],[22],[27], [30],[32],[27], [28],[23] | [29],[24] |

4.2. Impact of lean and sustainable manufacturing on performance: empirical study

Application of lean is not limited to the automotive (71%) sector only, but, it has also found acceptance in a wide range of manufacturing industries: electronics manufacturing [30]; [31], aircraft industry [32], furniture industry [33]; [34], ceramic industry [35], and multi sector [36]; [37]; [38]; [39]; [40]; [41]; [42]. Table 2, 3 and 4 below shows the impact of lean and sustainable manufacturing: contribution, methodology, criteria and result on three bottom line performance.

Table 2. Impact of lean and sustainable manufacturing on operational & environment performance

| No | Ref. | Contribution | Methodology | Criteria | Result |
|----|------|--------------|-------------|----------|--------|
| 1  | [43] | Impact lean production and sustainable manufacturing on the competitive positions of firms. | Empirical with 3 cases | Manufacturing process, HRM, Supplier vs. profit, WIP, lead time and number of employee | Reduce lead time and WIP |
| 2  | [1]  | Minimize inventory and adopt quality standards reduction emissions of toxic chemicals | Empirical : survey : 17,499 US manufacturing | ISO 9000 & max inventory vs. total emission & ISO 14000 | Integrated lean production and ISO 9000 have lower emission than ISO 14000 |
| 3  | [2]  | Relationship between lean manufacturing practice & environmental performance. | Empirical: survey, 31 automobile | Buffer, work & HRM vs. water & energy use | Trade-off between lean and environment performance |
| 4  | [27] | Environment performance as a driver of superior quality | Surveys of 42 automotive assembly plants | Paint quality vs. resource utilization and emissions | Quality-related tools to environmental issues has implications for quality. |
Table 3. Impact of Lean and Sustainable Manufacturing on Operational & Economic Performance

| No | Ref. | Contribution                                                                 | Methodology                  | Criteria                                                                 | Result                                                                 |
|----|------|--------------------------------------------------------------------------------|------------------------------|-------------------------------------------------------------------------|------------------------------------------------------------------------|
| 1  | [53] | Relationships between operational practices and performance among early adopters of green supply chain management practices | Empirical: survey 186 company in Chinese manufacturing | GSCM vs. organizational performance moderated quality management & JIT. | Positive relationships in terms of environmental and economic performance |
| 2  | [54] | Impact of integrated lean tools and DES modeling on the environment and financial performance. | Discrete event simulation and Case study | Cell vs. lead time vs. environment performance, recycling vs. profit & Environment performance | Positive impact on operational and marketing performance |
5. Conclusion

Based on this above discussion, it concludes that it is clear there is the positive impact of lean and sustainable manufacturing on three bottom line performance. Many frameworks developed and empirical studies done to strengthen the synergies. There is lack of clear and adequate measure for lean and sustainable manufacturing. The past research that provide strong evidence that plants with lean systems yield higher green results supports the philosophical of Lean and sustainable synergy. But the research cannot determine how much its impact is. When it is not possible to fully quantify through sustainable measures, lean and sustainable manufacturing on performance and its related core characteristics need to be represented within modeling. However, the numerous approaches relevant research gap have been identified as follows:

- integrated lean and sustainable model to improve performance firm
- develop mathematical or simulation modeling for examine impact lean and sustainable manufacturing for performance firm
- social performance has not been explored widely.

References

[1] A. A King and M. J. Lenox, “Lean and green? An empirical examination of the relationship between lean pr ...,” Prod. Oper. Manag., vol. 10, no. 3, pp. 244–256, 2001.

[2] S. Rothenberg, F. K. Pil, and J. Maxwell, “Lean, green, and the quest for superior environmental performance,” Prod. Oper. Manag., vol. 10, no. 3, pp. 228–243, 2001.

[3] G. Bergmiller and P. McCright, “Are Lean and Green Programs Synergistic,” Proc. 2009 Ind. ..., pp. 1–6, 2009.

[4] B. Verrier, B. Rose, E. Caillaud, and H. Remita, “Combining organizational performance with sustainable development issues: the Lean and Green project benchmarking repository,” J. Clean. Prod., vol. 85, pp. 83–93, Dec. 2013.

[5] A. Chiarini, “Sustainable manufacturing-greening processes using specific Lean Production tools: an empirical observation from European motorcycle component manufacturers,” J. Clean. Prod., vol. 85, pp. 226–233, Aug. 2014.

[6] A. Brown, J. Amundson, and F. Badurdeen, “Sustainable value stream mapping (Sus-VSM) in different manufacturing system configurations: application case studies,” J. Clean. Prod., vol. 85, pp. 164–179, Jun. 2014.

[7] U. Dombrowski, T. Mielke, and S. Schulze, “Sustainable Manufacturing,” pp. 17–22, 2012.

[8] S. A. Akuado, R. Alvarez, and R. Domingo, “Model of efficient and sustainable improvements in a lean production system through processes of environmental innovation,” J. Clean. Prod., vol. 47, pp. 141–148, May 2013.

[9] W. Faulkner and F. Badurdeen, “Sustainable Value Stream Mapping (Sus-VSM): methodology to visualize and assess manufacturing sustainability performance,” J. Clean. Prod., pp. 1–11, Jun. 2014.

[10] G. G. Bergmiller, P. R. Mccright, and S. Florida, “Lean Manufacturers ’ Transcendence to Green Manufacturing,” Ind. Eng. Res. Conf., pp. 1144–1148, 2009.

[11] C. Liu, F. Dang, W. Li, J. Lian, S. Evans, and Y. Yin, “Production planning of multi-stage multi-option serial production systems with sustainable measures,” J. Clean. Prod., 2014.

[12] J. Bhamu and K. S. Sangwan, “Lean manufacturing: literature review and research issues,” Int. J. Oper. Prod. Manag., vol. 34, no. 7, pp. 876–940, 2014.

[13] D. Simons and R. Mason, “Firms are under pressure to prove their environmental credentials. Now a win-win way of weaving ‘ green’ considerations into business decisions is emerging Lean and green : doing more with less ,” Ecr, pp. 84–91, 2003.

[14] C. J. Corbett and R. D. Klassen, “Extending the horizons: Environmental excellence as key to improving operations,” Manuf. Serv. Oper. Manag., vol. 8, no. 1, pp. 5–22, 2006.

[15] G. B. Verrier, B. Rose, and E. Caillaud, “Optimal manufacturing-remanufacturing policies in a lean production environment,” Comput. Ind. Eng., vol. 55, no. 1, pp. 234–242, 2008.

[16] C. Liu, F. Dang, W. Li, J. Lian, S. Evans, and Y. Yin, “Production planning of multi-stage multi-option serial production systems with sustainable measures,” J. Clean. Prod., 2014.

[17] S. G. Deshmukh, N. Upadhye, and S. Garg, “Lean Manufacturing for Sustainable Development,” Glob. Bus. Manag. Res. Int. J, vol. 2, no. 1, p. 125, 2010.

[18] A. Galeazzo, A. Furlan, and A. Vinelli, “Lean and green in action: interdependencies and performance of pollution prevention projects,” J. Clean. Prod., vol. 85, pp. 191–200, Oct. 2013.

[19] C. Herrmann and L. Bergmann, “Lean production system design from the perspective of the viable system model,” 41st CIRP Conf. Manuf. Syst., pp. 309–314, 2008.

[20] R. Dhingra, S. Das, and R. Kress, “Making progress towards more sustainable societies through lean and green initiatives,” J. Clean. Prod., vol. 37, pp. 400–402, Dec. 2012.

[21] G. G. Bergmiller and P. R. Mccright, “Parallel Models for Lean and Green Operations,” in Industrial Engineering Research Conference, 2009, pp. 1138–1143.

[22] R. Dhingra, R. Kress, and G. Upreti, “Does Lean mean Green?,” J. Clean. Prod., vol. 85, pp. 1–7, Oct. 2014.

[23] R. S. Wadhwa, “Quality Green , EMS and lean synergies: sustainable manufacturing within SMEs as a case point,” International Journal of Computer Science Issues, Vol 11, Issue 2, No 2, 2014.

[24] W. P. Wong and K. Y. Wong, “Synergizing an echocore of lean for sustainable operations,” J. Clean. Prod., vol. 85, pp. 51–66, Jun. 2014.

[25] C. Biggs, “Exploration of the integration of Lean and environmental improvement,” PhD Thesis, Cranfield University, 2009.

[26] G. Johansson and E. Sundin, “Lean and green product development: two sides of the same coin?,” J. Clean. Prod., vol. 85, pp. 104–121, Apr. 2014.

[27] F. P. Pil and S. Rothenberg, “Environmental performance as a driver of superior quality,” Prod. Oper. Manag., vol. 12, no. 3, pp. 404–415, 2003.

[28] W. J. Glover, J. a. Fareis, E. M. VanAken, and T. L. Doolen, “Critical success factors for the sustainability of Kaizen event human resource outcomes: An empirical study,” Int. J. Prod. Econ., vol. 132, no. 2, pp. 197–213, 2011.

[29] N. Diaz-Elsayed, A. Jondral, S. Greinacher, D. Dornfeld, and G. Lanza, “Assessment of lean and green strategies by simulation of manufacturing systems in discrete production environments,” CIRP Ann. - Manuf. Technol., vol. 62, no. 1, pp. 475–478, 2013.

[30] T. L. Doolen and M. E. Hacker, “A review of lean assessment in organizations: An exploratory study of lean practices by electronics manufacturers,” J. Manuf. Syst., vol. 24, no. 1, pp. 55–67, 2005.

[31] A. Chong, H. Cheah, W. P. Wong, and Q. Deng, “Challenges of Lean Manufacturing Implementation: A Hierarchical Model,” Proc. 2012 Int. Conf. Ind. Eng. Oper. Manag. Istanbul, Turkey, no. 1997, pp. 2091–2099, 2012.
[32] T. R. Browning, T. C. U. Box, F. Worth, and R. D. Heath, “Reconceptualizing the Effects of Lean on Production Costs with Evidence from the F-22 Program Reconceptualizing the Effects of Lean on Production Costs with Evidence from the F-22 Program,” 2009.

[33] A. Gurumurthy and R. Kodali, Design of lean manufacturing systems using value stream mapping with simulation: A case study, vol. 22, no. 4, 2011.

[34] M. A. Almoman, A. Abdelhadi, A. Mumani, A. Momani, and M. Aladecemy, “A proposed integrated model of lean assessment and analytical hierarchy process for a dynamic road map of lean implementation,” Int. J. Adv. Manuf. Technol., vol. 72, no. 1–4, pp. 161–172, 2014.

[35] K. S. Sangwan, J. Bhantu, and D. Mehta, “Development of lean manufacturing implementation drivers for Indian ceramic industry,” Int. J. Product. Perform. Manag., vol. 63, no. 5, pp. 569–587, 2014.

[36] R. R. Fullerton and W. F. Wempe, “Lean manufacturing, non-financial performance measures, and financial performance,” Int. J. Oper. Prod. Manag., vol. 29, no. 3, pp. 214–240, 2009.

[37] J. a. Farris, E. M. Van Aken, T. L. Doolen, and J. Worley, “Critical success factors for human resource outcomes in Kaizen events: An empirical study,” Int. J. Prod. Econ., vol. 117, no. 1, pp. 42–65, 2009.

[38] S. Taj and C. Morosan, “The impact of lean operations on the Chinese manufacturing performance,” J. Manuf. Technol. Manag., vol. 22, no. 2, pp. 223–240, 2011.

[39] M. Ghosh, “Lean manufacturing performance in Indian manufacturing plants,” J. Manuf. Technol. Manag., vol. 24, no. 1, pp. 113–122, 2013.

[40] S. J. Thakki and J. Thakkar, “Status of lean manufacturing practices in Indian industries and government initiatives: A pilot study,” J. Manuf. Technol. Manag., vol. 25, no. 5, pp. 655–675, 2014.

[41] G. L. Tortorella, G. A. Marodin, R. Miorando, and A. Seidel, “The impact of contextual variables on learning organization in firms that are implementing lean: a study in Southern Brazil,” Int. J. Adv. Manuf. Technol., 2015.

[42] G. A. Marodin and T. A. Saurin, “Classification and relationships between risks that affect lean production implementation”, Journal of Manufacturing Technology Management, Vol. 26 Iss 1 pp. 57 - 79 , 2015.

[43] M. A. Lewis, “Lean production and sustainable competitive advantage,” International Journal of Operations & Production Management, Vol. 20 Iss 8 pp. 959 - 978 , 2000.

[44] J. González-benito, “Environmental Proactivity and Business Performance: an Empirical Analysis Environmental Proactivity and Business Performance: an Empirical Analysis”, Omega, vol. 33, no. 1, pp. 1–15, 2005.

[45] R. Sawhney, P. Teparakul, A. Bagchi, and X. Li, “En-Lean: a framework to align lean and green manufacturing in the metal cutting supply chain,” Int. J. Enterp. Netw. Manag., vol. 1, no. 3, p. 238, 2007.

[46] A. B. Pampanelli, P. Found, and A. M. Bernardes, “A Lean & Green Model for a production cell,” J. Clean. Prod., vol. 85, pp. 19–30, Jun. 2013.

[47] C. J. C. Jabbour, A. B. L. D. S. Jabbour, K. Govindan, A. A. Teixeira, and W. R. D. S. Freitas, “Environmental management and operational performance in automotive companies in Brazil: the role of human resource management and lean manufacturing,” J. Clean. Prod., vol. 47, pp. 129–140, May 2013.

[48] S. Hajmohammad, S. Vachon, R. D. Klassen, and I. Gavronski, “Lean management and supply management: their role in green practices and performance,” J. Clean. Prod., vol. 39, pp. 312–320, Jan. 2013.

[49] M. Dora, M. Kumar, D. Van Goubergen, A. Molnar, and X. Gellynck, “Operational performance and critical success factors of lean manufacturing in European food processing SMEs,” Trends Food Sci. Technol., vol. 31, no. 2, pp. 156–164, 2013.

[50] T. Khanchanapong, D. Prajogo, A. S. Sohal, B. K. Cooper, A. C. L. Yeung, and T. C. E. Cheng, “The unique and complementary effects of manufacturing technologies and lean practices on manufacturing operational performance,” Int. J. Prod. Econ., vol. 153, pp. 191–203, 2014.

[51] T. Bortolotti, P. Danese, B. B. Flynn, and P. Romano, “Leveraging fitness and lean bundles to build the cumulative performance sand cone model,” Int. J. Prod. Econ., pp. 1–15, 2014.

[52] M. Bourlakis, G. Maglaras, E. Aktas, D. Gallear, and C. Fotopoulos, “Firm size and sustainable performance in food supply chains: Insights from Greek SMEs,” Int. J. Prod. Econ., vol. 152, pp. 112–130, 2014.

[53] Q. Zhu and J. Sarkis, “Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises,” Int. J. Oper. Manag., vol. 22, no. 3, pp. 265–289, Jun. 2004.

[54] G. Miller, J. Pawlowski, and C. R. Standridge, “A case study of lean, sustainable manufacturing,” J. Ind. Eng. Manag., vol. 3, no. 1, pp. 11–32, Jun. 2010.

[55] A. M. Deif, “A system model for green manufacturing,” J. Clean. Prod., vol. 19, no. 14, pp. 1553–1559, 2011.

[56] M. G. (Mark) Yang, P. Hong, and S. B. Modi, “Impact of lean manufacturing and environmental management on business performance: An empirical study of manufacturing firms,” Int. J. Prod. Econ., vol. 129, no. 2, pp. 251–261, Feb. 2011.

[57] P. Hong, J. Jungbue Roh, and G. Rawski, “Benchmarking sustainability practices: evidence from manufacturing firms,” Benchmarking An Int. J., vol. 19, no. 4/5, pp. 634–648, Jul. 2012.

[58] P. Puvanasvaran, R. K. S. Tian, V. Suresh, and M. R. Muhamad, “Lean principles adoption in environmental management system (EMS): A survey on ISO 14001 certified companies in Malaysia,” J. Ind. Eng. Manag., vol. 5, no. 2, pp. 406–430, 2012.

[59] A. Azadeeghan, P. C. Patel, A. Zangoueinezhad, and K. Linderman, “The effect of environmental complexity and environmental dynamism on lean practices,” J. Oper. Manag., vol. 31, no. 4, pp. 193–212, May 2013.

[60] R. R. Fullerton, F. A. Kennedy, and S. K. Widener, “Lean manufacturing and firm performance: The incremental contribution of lean management accounting practices,” J. Oper. Manag., vol. 32, no. 7, pp. 414–428, Sep. 2014.

[61] N. M. P. Bocken, S. W. Short, P. Rana, and S. Evans, “A literature and practice review to develop sustainable business model archetypes,” J. Clean. Prod., vol. 65, pp. 42–56, Feb. 2014.