Green Manufacturing Adoption on SME: A review of theories

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Abstract

There are many theoretical frameworks that attempt to describe adoption of green manufacturing (GM). The literature review is one of a tool to finding the pattern of previous research and looking for research gaps, so that further researchers can further develop the field of knowledge. The objective of this paper is to provide an extensive literature review on green manufacturing adoption on SME. We have reviewed 58 articles that spread from 2001 to 2017 (16 years). We collected the articles through systematic literature review and snowball technique from Scopus database. Mendeley software was used to manage and resume the references. We have identified and reviewed this database and try to make classification using coding criteria adapted from Siva et al. (2016). The coding criteria are publication year and journal, data collection method, data analysis method, and contextual (size, country origin and type of industry). We have identified, reviewed and compared constructs theorized of green manufacturing adoption concept in SME.

Keywords
SME’s adoption, green manufacturing, theory

1 Introduction

Today, many companies and organizations spend their money to improve their capabilities in environmental protection and sustainable development. Beside, companies attempt to increasing their profit by make their operations more efficient and effective. Increasing of customers awareness and pressure on the environmental practice, became one of the factors driving the company to adopt green issues (Govindan, Diabat, & Madan Shankar, 2015). One of the strategies to improve the efficiency of resources and the effective of environmental impact in manufacturing is green manufacturing (GM). The term ‘green manufacturing’ was first used in the article title by Dickinson et al. pada tahun 1995 (Sangwan & Mittal, 2015). In line with company attention, scholars interest increasing also. They propose many definition of GM. Shrivastava and R.L.Shrivastava stated that GM is a method for manufacturing that minimizes waste and pollution for all industries (Shrivastava & R.L., 2017). While, Govindan et al. addressed the definition of GM as a system that integrates product and process design issues with issues of manufacturing planning and control in such a manner as to identify, quantify, assess and manage the flow of environmental waste with the goal of reducing and ultimately minimizing environmental impact while also trying to maximize resource efficiency (Govindan, Diabat, & Madan Shankar, 2015). Chuang and Yang mentioned that GM as a manufacturing method that minimises waste and pollution and is a subset of sustainable manufacturing (Chuang & Yang, 2014). We can justify that the most critical thinking of GM is minimizing negative effect on environment, by eliminating waste/pollution, efficiency input/resources and product design.

Adoption and implementation of GM in the company requires considerable cost and effort. Researchers and practitioners attempt to increase the understanding of the GM adoption process. As GM is considered as innovation (Dornfeld, 2014), theories based on innovation adoption may apply in empirical studies on GM adoption. "An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption” (Rogers, 2003). The most widely used theory in adoption innovation is ‘diffusion of innovation theory’ (Chou, Chen, & Wang, 2012). In fact, there are many theories that studied innovation adoption. Based on Wolfe, there are three research approach on innovation, diffusion of innovation (DI), organizational innovativeness (OI) and process theory (PT) (Wolfe, 1994). The differences of these three approach is presented in Table 1.
Table 1. Difference features of three research approach on innovation

<table>
<thead>
<tr>
<th>Research Stream</th>
<th>Question</th>
<th>Innovation stage focus</th>
<th>Unit of analysis</th>
<th>Independent Variable</th>
<th>Dependent Variable</th>
<th>Research Model</th>
<th>Major data collection methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffusion</td>
<td>What is the pattern of diffusion of an innovation through a population of potential adopters?</td>
<td>Adoption</td>
<td>An innovation</td>
<td>Organizational characteristics; Innovation characteristics; Promoter characteristics</td>
<td>Diffusion pattern; Diffusion extent; Diffusion rate</td>
<td>Logistic growth model.</td>
<td>Cross sectional surveys; Secondary data</td>
</tr>
<tr>
<td>Innovativeness</td>
<td>What determines organizational innovativeness</td>
<td>Adoption or implementation</td>
<td>Organizational</td>
<td>Organizational characteristics; Innovation characteristics; Managerial Characteristics; Environmental characteristics</td>
<td>Innovativeness</td>
<td>Variance/regression models</td>
<td>Cross sectional surveys</td>
</tr>
<tr>
<td>Process A-Stage</td>
<td>What are the stages organization go through in implementing innovations?</td>
<td>Adoption through implementation</td>
<td>Innovation process</td>
<td>Innovation characteristics</td>
<td>Stage</td>
<td>Stage models</td>
<td>Cross sectional retrospective surveys</td>
</tr>
<tr>
<td>Process B-Process</td>
<td>What factors explain the chain of events which result in innovation implementation?</td>
<td>Adoption through implementation</td>
<td>Innovation process</td>
<td>Precursor: Organizational context: strategy, structure, resources, technological strength; Organizational politics</td>
<td>Outcome: The Innovation process.</td>
<td>Process Models</td>
<td>In-depth field studies</td>
</tr>
</tbody>
</table>

Source: (Wolfe, 1994)
Although, there are many study discuss about adoption innovation, there is still a lack of research that offers a literature review of GM adoption theory. To fill this gap, this research attempt to review the existing literature and to provide an extensive literature review on GM adoption theory. To achieve this purpose, we explore past literature on GM adoption, and theories of GM adoption for organizational adoption with factors considered to influence GM adoption. There are five steps of literature review will be presented based on studies of Tranfield, et al. (Tranfield, Denyer, & Smart, 2003) and Reyes (Garza-Reyes, 2015). First, question formulation, stated in section 1; Second, locating studies and third, study selection and evaluations, will be explained in section 2 that discussed about methodology, followed by the fourth step, analysis and synthesis on section 3 and wrapping by fifth step reporting and using the results, and future directions on section 4.

2 Methodology

The literature covered studies dated from 2001. The study selection criteria for the literature search were: (a) the study was a manufacturing context, we exclude study from service context, (b) it examined GM adoption in organizations. (c) The source was from reputable journal (Q1 and Q2) based on scimagojr website. We reviewed 58 relevant published studies on GM adoption. We searched from SCOPUS database with the key words ‘adoption green manufacturing’ to gather the relevant articles. Beside, we use snowball technique to enrich the finding. The overview of paper selection process is presented in Figure 1.

![Figure 1. Overview of paper selection process](Adapted from Siva,et al., 2016)

2.1 Research Method

This study presented an exhaustive literature search for green manufacturing adoption. We used Systematic Literature Review (SLR) that developed by Tranfield et al. (Tranfield et al., 2003), and used by many scholars (Dubey & Ali, 2015; Garza-Reyes, 2015; Geng, Mansouri, & Aktas, 2017; Geng, Mansouri, Aktas, & Yen, 2017). SLR is mapping and emphasize the boundary of knowledge (Tranfield et al., 2003). A literature review consists of a method which is systematic, explicit, and reproducible (Fink, 2005 in (Garza-Reyes, 2015)). Figure 2 embraces the systematic literature review (SLR) and step by step of the process. First, the authors setting the goals of research, as has been disclosed in section 1. Second, we were searching the articles from Scopus database. A literature search was performed on October-November 2017, using the search path ‘adoption green manufacturing’. We collected some articles from the web and continued searching by snowballing technique. Third, we were noted the references from the articles that appeared noteworthy and seem correlated to the topic. We reach, 308 papers and after reading the abstracts and eliminating duplicates, 58 articles from reputable journal (Q1 and Q2) based on scimagojr website were considered relevant and used in this review. Mendeley software was help to manage and resume the references. Table 2 is presented the detailed criteria of selected process. We have not distinguished the research whether in SME or large companies in this initial screening.

![Table 2. Detailed Search Screening Criteria (Scopus database)](Article, Conference Paper, Conference Review, Review, Book Chapter,)

<table>
<thead>
<tr>
<th>Search screening</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search word</td>
<td>Adoption green manufacturing</td>
</tr>
<tr>
<td>Exclude Subject Area</td>
<td>&quot;CENG&quot;, &quot;CHEM&quot;, &quot;PHYS&quot;, &quot;AGRI&quot;, &quot;BIOC&quot;, &quot;EART&quot;, &quot;PHAR&quot;, &quot;MEDI&quot;.</td>
</tr>
<tr>
<td>Exclude Language</td>
<td>Polish, Portuguese, Japanese</td>
</tr>
<tr>
<td>Include Document Type</td>
<td>Article, Conference Paper, Conference Review, Review, Book Chapter,</td>
</tr>
</tbody>
</table>
3. Analysis and Synthesis

We then read the abstracts from those 58 papers and reviewed them based on various codes adapted from Siva et al., that showed in Table 3. From this review we can find that there are many term used to express the green manufacturing concepts, such as, green supply chain management, cleaner production, and eco-innovation, that shown in Table 4. This fact, appropriate with Sangwan and Mittal research that investigating and comparing eight similar frameworks (Sangwan & Mittal, 2015) and there are closely related concept between green innovation, sustainable innovation, ecological innovation and environmental innovation (Schiederig, Tietze, & Herstatt, 2012). It is showed that the GM coverage is very broad (Rehman & Shrivastava, 2013).
Figure 3a. Year of Publication. It is showed that in last two years, there is a significant increase research of green manufacturing adoption. While figure 3b. presents the proportion of the publication sources in relation to whether the articles were published by journals. In terms of the number of publications per journal, Journal of Cleaner Production was the most powerful journal that contributes in green manufacturing topic. From Figure 3c, we were surprised by the fact that the highest research is conducted in China, followed by Europe, Brazil and India. In South East of Asia, Malaysia leading for the amount of research in adoption of green manufacturing.

Data collection method is presented in Figure 4a. Questionnaire is the most familiar method that is used to collect the data, followed by interview (21%) and review literature (12%). It means that, empirical study is still dominated. From this empirical study, the majority of scholars utilize SEM to analysis the data (45%). It is shows on Figure 4b., that EFA method is in second place (20%), followed by ANOVA and AHP method (15%).

Table 3. Classification Criteria

<table>
<thead>
<tr>
<th>Coding criteria</th>
<th>Description of coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publication Year</td>
<td>The year in which the article was published</td>
</tr>
<tr>
<td>Publication Journal</td>
<td>The Journal in which the article was published (Q1-Q2) based on scimagojr</td>
</tr>
<tr>
<td>Type of article</td>
<td>Empirical, conceptual or review</td>
</tr>
<tr>
<td>Data collection method</td>
<td>Survey, Questionnaire, review, case study, interview study, action research, experiment</td>
</tr>
<tr>
<td>Data analysis method</td>
<td>SEM, AHP, Fuzzy</td>
</tr>
<tr>
<td>Term used</td>
<td>Green manufacturing, cleaner production, eco-innovation</td>
</tr>
<tr>
<td>Contextual (Company Size)</td>
<td>Large, SME</td>
</tr>
<tr>
<td>Contextual (Company Origin)</td>
<td>US, Europe, Japan, India, China, Asia Tenggara, Others</td>
</tr>
</tbody>
</table>

Adapted from Siva, et al., (Siva et al., 2016)
In general, there are differences between small and large companies. Firms size has a positive effect on green activity (Handfield, Walton, Sroufe, & Melnyk, 2002). SMEs have simple systems and procedures, and shorter decision making chain compare to large companies which make them more flexible (Liu et al., 2017). But, it is more difficulties to introducing green technologies in small and medium-sized organizations (Liu et al., 2017). From 58 papers that we have reviewed, there are only seven research conducting in small company (Andrews et al., 2002; Ki-Hoon Lee, 2009; Liu et al., 2017; Marin et al., 2015; Mittal, 2017; Oxborrow & Brindley, 2013; Zeng et al., 2011). In the next discussion, we will focused on these papers.
<table>
<thead>
<tr>
<th>Author/s</th>
<th>Title</th>
<th>Research Stream</th>
<th>Objective</th>
<th>Innovation stage focus</th>
<th>Unit of analysis</th>
<th>Independent Variable</th>
<th>Dependent Variable</th>
<th>Research Model</th>
<th>Data collection methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrews et al., 2002</td>
<td>Awareness and adoption of cleaner production in small to medium-sized businesses in the Geelong region, Victoria, Australia</td>
<td>Process A-Stage</td>
<td>to determine the extent of the awareness and implementation of cleaner production practices within small to medium-sized businesses</td>
<td>Awareness, adoption</td>
<td>Organization</td>
<td>-</td>
<td>-</td>
<td>Descriptive Model</td>
<td>Cross sectional surveys</td>
</tr>
<tr>
<td>Ki-Hoon Lee, 2009</td>
<td>Why and how to adopt green management into business organizations?: The case study of Korean SMEs in manufacturing industry</td>
<td>Process B-process</td>
<td>to explore and investigate the process of green management adoption in small and medium-sized enterprises.</td>
<td>Adoption through implementation</td>
<td>Innovation Process</td>
<td>organizational structure, innovation capability, human resources, cost savings and competitive advantage</td>
<td>The innovation process</td>
<td>Process Models</td>
<td>in-depth interviews and document analysis</td>
</tr>
<tr>
<td>Marin, Marzucchi, &amp; Zoboli, 2015</td>
<td>SMEs and barriers to Eco-innovation in the EU: Exploring different firm profiles.</td>
<td>Innovative ness</td>
<td>To investigate whether the firms’ engagement in eco-innovation is related to their awareness of eco-innovation barriers and difficulties</td>
<td>Adoption</td>
<td>Organization</td>
<td>Barriers to eco-innovation</td>
<td>eco-innovation adoption</td>
<td>Regression Model</td>
<td>Interview, secondary data from cross sectional surveys</td>
</tr>
<tr>
<td>Mittal, 2017</td>
<td>Adoption of green manufacturing in Indian manufacturing industry: A fuzzy analytical hierarchy process approach for inhibitors.</td>
<td>Innovative ness</td>
<td>to apply fuzzy AHP to rank the factors inhibiting the adoption of GM in India</td>
<td>Adoption</td>
<td>Organization</td>
<td>Inhibiting factor</td>
<td>GM adoption</td>
<td>multi-criteria decision method (MCDM)</td>
<td>Experts interview</td>
</tr>
<tr>
<td>Oxborrow &amp; Brindley, 2013</td>
<td>Adoption of “eco-advantage” by SMEs: emerging opportunities and constraints.</td>
<td>Process B-process</td>
<td>to identify the capabilities, resources, knowledge and awareness from exogenous and endogenous sources that enable the SME to generate competitive advantage by addressing sustainability issues</td>
<td>Adoption through implementation</td>
<td>Innovation Process</td>
<td>-</td>
<td>Adoption of eco-advantage</td>
<td>Process Models</td>
<td>Interview</td>
</tr>
<tr>
<td>Zeng et al., 2011</td>
<td>How environmental management driving forces affect environmental and economic performance of SMEs: A study in the Northern China district.</td>
<td>Innovative ness</td>
<td>to explore how the driving forces of environmental management affect environmental and economic performances of SMEs of different levels of pollution.</td>
<td>Implementation</td>
<td>Organizational</td>
<td>government, market, society, and enterprise</td>
<td>environmental performance; business performance</td>
<td>Regression Model</td>
<td>Cross sectional surveys</td>
</tr>
</tbody>
</table>

(Source: Author, 2017)
4. Conclusion

4.1 Result

This literature research is based on Tranfield et al. study (Tranfield et al., 2003). In this review, we found that 58 articles appropriate for this study. Surprisingly, there are only seven study conducted in small organizations. We further analysis these studies, to gather research streams and features based on Wolfe (1994). Innovativeness and prosess (B-process) research stream are dominate the studies, whether diffusion stream is not studied yet. In these seventh studies, are not declared the theory clearly. Only one study based on stakeholder theory to gain an overview of the stakeholders involved in the research (Liu et al., 2017).

4.2 Conclusion, Limitations and Future Directions

In this study, we used the word ‘green manufacturing’ for searching, however, the results obtained various kinds of word findings, such as gscm, cleaner production, eco-innovation, green practice, green innovation, etc. This causes less focus on understanding the concept of green manufacturing in this research. But, in this literature review we emphasize on adoption term of green manufacturing. Beside, the database is limited. In future research, we suggest to broaden the database such ISI Web of Knowledge and Google Scholar. Future study can enrich the research by extend the type of document, not only article or journal paper but also books, conference paper, newspaper, book review, report, and so on.

Empirical study is still dominated the trend of GM adoption issue. Meanwhile, questionnaire method is still the most commonly used to collect the data. This provides the opportunity to future research, to used another method such as interview, and exploratory study.

In the context of firm size, research in small business is still rare. This is evidenced by the fact that there are only seven of 58 articles covering small firm. There are many chances to explore small firm in term of green manufacturing adoption in future studies.

Acknowledgment

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