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Classification of Attributes on Green Manufacturing Practices: A Systematic Review

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ABSTRACT

This systematic review article aimed to identify the classification of the firm behaviour attributes in influencing firm decision on green manufacturing (GM). Firms as profit-oriented entities must identify critical features in implementing an environmental-friendly business practice. However, investment in the GM initiative often leads to extra costs and benefits that require attention in making an optimal decision. Thus, it is necessary to highlight the attribute of GM as the potential prospect of advantages and disadvantages of sustainable manufacturing for the firm. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was adapted to study related articles using two major databases, Scopus and Web of Science, from 2002 to 2021. The results revealed four classifications of firm behaviour attributes that influence firm decisions on GM, namely (i) type of green manufacturing initiative; (ii) environmental impact; (iii) operating costs; and (iv) legislative requirement. Also, we found that GM practices impacts on benefits and losses for certain attributes. The study's findings suggest further study to determine in-depth industries' decisions in implementing the green manufacturing practices based on the attributes are presented.

1. INTRODUCTION

Major environmental problems were caused by industrial activities [1, 2]. Unmonitored industrial activity led threat to environmental degradation. Statistically manufacturing industry released a ton of CO_2 that increased around 18 per cent to 20 per cent over a decade in 2014. This concept of sustainability needs to be adopted to maintain the same outcome, process, and capacity through time without giving negative impact in environmental degradation [3].

Many businesses have already started to take important steps towards economic, social continuity, and environmental issues [4]. At this level, firms aim to achieve Goal-12 of the Sustainable Development Goal (SDG) to promote sustainable consumption with less material, energy, pollution, and the transition towards a low-carbon atmosphere [5, 6]. It is a process of innovation that evolves from the organisation's traditional environmental prevention management practices called Green Manufacturing (GM) [7].

GM is a well-known concept, and many studies have been conducted in various fields such as science [8], management [9], engineering [10], and economy [11]. GM is a method in a comprehensive all the process that have impact on environmental degradation. According to Shrivastava and Shrivastava [9] GM is known as a method to reduce environmental pollution. GM is also known as a technique that ensures environmental sustainability [10]. Other than that, there are also many studies that use the SLR technique related to GM. Study the effects of GM performance [11], the importance of GM [12], advantages and disadvantages [13], and driving factors and obstacles in implementing GM [14].

The value in green manufacturing investing are considers as topic of argumentative in firm's decision makers. There are many factors that firm need to consider such as cost and benefit obtain from investing in GM. Studies conducted by Salem and Deif [15] stated that a firm belief in the importance of a company chooses input that gives a return to output. GM must capture the move towards a new market with low-cost production. There are positive associations between GM and direct production costs, such as return on investment, market share, profitability, and sales [16]. Other than that, they can achieve good quality, cost and production [17]. However, the firm must integrate the GM requirement through technological and product innovation approaches to get this benefit. For example, energy-saving technology innovation has a better performance in an environment that can save energy usage and raw material, but it is not conducive to financial performance [6, 18]. It tends to give the firm a higher technology investment cost, resulting in a higher entail selling cost and availability [19]. So, the implementation of GM is not only based on profit motivation but also on various other motivations.

Business makes decision to become a green to promotes a certain value. Strategically, firm intentionally minimise the negative environmental impact by reducing a pollutant that causes by production activities [20]. According to Setyaningsih et al. [8], the firm pays attention to all environmental aspects of manufacturing activities, such as inputs, processes, and outputs. It is because there is willing to go beyond mandatory and benefit from it [21]. Besides that, due to the increasing market competition, the firm must reconsider the environmental element in production [22]. Hence, it is important to examine the factors that motivate the firm and encourage them to implement GM practices [23]. This benefit and factors are called as attributes of GM for firm

making decisions.

Although, the role of criteria and attributes of GM are rarely investigated in detail in a previous study Using SLR. Still, it is important to consider the preference attributes that impact the firm's sustainability decision-making. This study identifies GM's attributes as preliminary, but it is important to find the preference attributes. The paper begins with a discussion on the attribute-based search using Systematic Literature Review (SLR). Subsequently, the paper discusses and interprets the results based on research of the previous study.

2. METHODOLOGY

This study uses a Systematic Literature Review (SLR) method to identify and define the GM attributes through a philosophy on the basis of previous studies. This study is explored through articles, literature, dissertations, and papers. Firstly, this study was conducted by searching through the titles of the article. Searching was focused on two primary data search engines, Scopus and Web of Science (WoS), from years 2002 to years 2021 and prioritised English. All searches were performed in October 2021. This section explains five main sub-sections, such as the need for SLR, uses of PRISMA as a standard reporting protocol, resources, the systematic review process, data abstraction and analysis, which are employed in the current research.

2.1 Need for systematic literature reviews method

SLR is a well-known literature method used to review previous writing to answer specific Research Questions (RQ). Mainly, SLR will contribute to analyses, report the evidence, and get conclusions by searching existing studies [24]. Besides that, systematic reviews help reduce implicit researcher bias toward conducting a literature review. It happens to be better than traditional literature reviews, which are often restricted and do not produce reliable evidence [25]. In addition, the narrative type of conventional literature has fewer critics and does not contribute to the informed debate on the issue, which is less helpful in guiding policy [26].

This study chooses a research method based on Systematic Literature Review (SLR) to improve the validity, rigour, and transparency of studies related to GM applications. The SLR method discusses the steps in running an SLR using the methods and protocols referenced [27]. According to Tikito and Souissi [28], this protocol aims to answer some research questions by reducing the errors of the various references evaluated. This paper aims to gain critical skills in synthesising existing literature, answering research questions based on knowledge of the subject area of interest, and developing new research ideas.

2.2 Preferred reporting items for systematic reviews or meta-analyses (PRISMA)

Preferred Reporting Items for Systematic Reviews or Meta-Analyses (PRISMA) is a standard protocol used by combining the results of studies sought based on previous studies by presenting statistical analysis and thematic analysis. This publication standard is required to guide the author in obtaining related information and improve the critical reporting of SLR. In addition, reporting standards emphasise the importance of information on review reports that can be used to report systematic reviews for other types of research [29].

Sierra-Correa and Kintz [30] claimed that PRISMA is also suitable for environmental management and minimises some bias in reporting by providing reliable findings. Besides that, Meta-analysis uses the thematic analysis method to summarise and combine the results of independent studies based on the selected theme [31]. Typically, PRISMA performs four important steps: Search using appropriate keywords and databases, screening through inclusive and exclusive features, data synthesis by categorising the data, and finally, data analysis that can explain the paper's results [32].

2.3 Resources

The paper used two major databases, Scopus and Web of Science (WoS), to retrieve relevant previous studies. The Scopus and WoS are widely used as search strings to increase probability searching as they cover more than 240 disciplines, including environmental economics studies. However, it should be noted that no database is perfect or comprehensive, including Scopus and Web of Science [33].

2.4 The systematic review process for selecting the article

The survey sources of previous studies used several strong major database sources, namely Scopus and Web of Science (WoS), consisting of three main stages. (i) identification, (ii) screening, (iii) eligibility.

Table 1. Relevant research keywords through a thesaurus, dictionary, and past studies

Topic	Green manufacturing	Attribute
Synonym	Eco-management, green system, green process and, green management	Green attribute, benefit, advantage, strength, interest, criteria, parameter, factors, green meter, credit, allowance, and characteristic
Related studies	Green Manufacturing, Clean Production, Green Innovation, Green Production, Sustainable Manufacturing, Greening Manufacturing, Green Management, Environmental Management, Environmental-Friendly, Ecological Friendly (Mittal & Sangwan, 2014)	Mainly focus on reducing environmental impact and material, water, and energy, waste based on environmental management certificate. On the other hand, green attribute basely main on credit or benefit gains in sustainable practical (Mendoza-Fong et al. 2019).

Table 2. Green manufacturing and attribute research based on two major database

Topic	Scopus	Web of Science
Green manufacturing (article)	101,248	6919
Green attribute (article)	17,028,020	547 874
Green manufacturing and attribute	263	73

2.4.1 Identification

The systematic review process selects several relevant articles for the present study. The first stage is the identification of keywords, followed by the process of searching for related and similar terms. The identification phase is explored based on appropriate and relevant keywords retrieved and applied through the thesaurus dictionary, paper review, and search. Accordingly, search strings on Scopus and the Web of Science database were developed in October 2021 once relevant keywords managed to be determined (Table 1). The next step is identifying the keyword of GM and attribute from databases, SCOPUS, and WOS (Table 2). Finally, two keywords and related terms are combined to create keyword research (Table 3).

Table 3. Green manufacturing attribute identification of research

Resource	Identification
Scopus	(TITLE (("green manufacturing" OR "clean production" OR "green production" OR "green industry" OR "sustainable manufacturing" OR "green management" OR "environmental management" OR "environmental friendly" OR "green system" OR "green process" OR "green management")) AND TITLE (("green attribute" OR "attribute" OR "benefit" OR "advantage" OR "strength" OR "interest" OR "criteria" OR "parameter" OR "greenometer" OR "credit" OR "characteristic)
WOS	TITLE ("green manufacturing" OR " greening manufacturing" OR " cleaner production" OR "sustainable production" OR " green management" OR " green strategy" OR "environmental management" OR " eco-management" OR " green process" OR " green industry" OR "environmental friendly" OR "ecological friendly") AND TITLE ("green attribute" OR "attribute" OR "credit" OR "benefit" OR "criteria" OR "greenometer" OR "parameter")

According to Mittal and Sangwan [34], green manufacturing is used interchangeably with a few keywords that have the same meaning: Clean Production, Green Innovation, Green Production, Sustainable Manufacturing, Greening Manufacturing, Green Management, Environmental Management, Environmental-Friendly, Ecological Friendly. Cleaner production was used as a Green Manufacturing practice. After all, it presented many environmental requirements. Although it uses interchangeably as the concept, it still has a different idea: Cleaner production integrates a preventive environmental strategy with processes, products, and services to increase eco-efficiency and reduce risks to man and the environment [35]. Other than that, GM is synonymous with Eco-management, green systems, green processes and management.

Meanwhile, the attribute is defined as green attributes, attributes, benefits, advantages, strengths, interests, criteria, parameters, factors, greenometer, credit offsets, allowance, and characteristics. Besides that, the attribute mainly focuses on reducing environmental impact and material, water, and energy on the environmental management certificate. On the other hand, green attributes are basely main on credit or benefit gains in sustainable practical [36].

Table 2 displays the current search successfully retrieved 101,248 articles in Scopus and 6,919 in WoS that discussed green manufacturing. Meanwhile, 17,028,020 articles in Scopus and 547,874 in WoS on the attribute or green attribute. However, only 263 articles in Scopus and 73 in WoS are selected based on green manufacturing and attributes. The research excluded 7 of the same recorded articles and made it a total of 329 relevant papers. Therefore, researchers took the initiative to use various keywords and relevant concepts to narrow the search.

Table 3 captures the GM attribute identification of research using keywords. It showed numerous searches, and the synonyms were adopted through dictionaries and past studies.

2.4.2 Screening

This process is a protocol to be identified by considering the inclusion and exclusion criteria related to this study. The acknowledged characteristic is shown in Table 4. Next, selecting the journalistic studies (research articles) as the main source and excluding systematic reviews, surveys, meta-analyses, meta-syntheses, book series, book chapters, and conferences in current research. Second, the data evaluated period was 20 years from 2002 to 2021 in developing and developed countries.

Table 4. Characteristics of inclusion and exclusion

Characteristic	Inclusion	Exclusion
Language	Prioritise the full text of the English paper	Other than that
Time series	Between 2002- 2021	
Subject area	Business management and accounting, energy, environmental science, social science, economic, econometrics and finance, environmental science, economics, business	
Type of studies	Journal (article)	
Objective	Based on keyword related into Green Manufacturing (production perspective) and attribute in the same studies	

This study prioritises the full text of the English paper except for the title, abstract, and keywords. It is crucial to note that a study was conducted over 20 years. It is to acknowledge new studies and, most importantly, not be missed by old studies published in social science, business management accounting, energy, environmental science, economics, econometrics, and finance. They were selected to increase the possibility of retrieving some related articles. If study represent no evidence is excluded.

2.4.3 Eligibility

At this stage, the author acknowledges the title, abstract, and content discussing a green manufacturing attribute or similar to fulfil the objective.

Figure 1 describes the process diagram of SLR and indicates that 263 articles in Scopus and 73 articles in WoS. The research excluded 7 of the same recorded articles (n=329). Secondly, most 290 articles were excluded on non-inclusion criteria. Meanwhile, 276 articles were excluded as not fulfilling the production perspective and the GM attribute. Finally, 14 remaining articles are ready to be analysed.

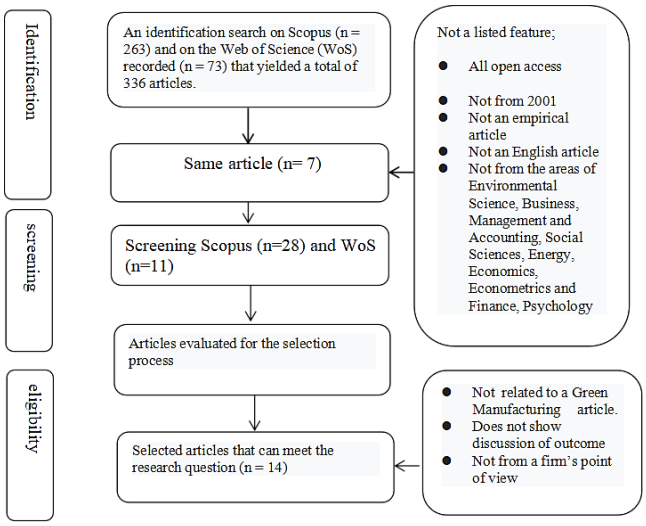

Figure 1. Process diagram of systematic literature review [29]

2.4.4 Data abstraction and analysis

The answer to the research question based on the thematic analysis involves depth reading of the data set and identifying patterns across the data. The process is to create the appropriate themes and the sub-themes based on related studies. In this phase, chosen research is analysed by extracting data or statements to answer the research question and meet the objective. The data was extracted by identifying themes, concepts, or ideas. Next, appropriate sub-themes were developed by looking at the same character during the data synthesis and analysis. Eventually, the process has resulted in four main themes, namely (i) type of Green Manufacturing initiative; (ii) environmental impact; (iii) operating costs; and (iv) legislation requirement.

2.5 Quality assessment of SLR

This SLR article uses a study quality assessment suggested by Mao et al. [19] and Denyer and Tranfield [24] to increase the accuracy of the data extraction result.

Table 5. Quality assessment of the SLR

Reference	Q1	Q2	Q3	Q4	Q5	Total score
Noranarttakun and Pharino [37]	1.0	1.0	0.5	1.0	1.0	4.5
Kunene and Chung [38]	1.0	1.0	1.0	0.5	0.5	4.0
Somjai et al. [39]	1.0	1.0	1.0	1.0	0.5	4.5
Yang et al. [40]	1.0	1.0	1.0	1.0	1.0	5.0
Matos et al. [41]	1.0	1.0	1.0	0.5	0.0	3.5
Ma et al. [18]	1.0	0.5	1.0	1.0	1.0	4.5
Salem and Deif [15]	1.0	0.5	1.0	1.0	1.0	4.5
Schmidt and Osebold [42]	1.0	1.0	0.5	0.0	0.5	3.0
Ding et al. [43]	1.0	1.0	0.5	0.5	0.5	3.5
Owolana and Booth [44]	1.0	0.5	1.0	0.0	0.5	3.0
Sadiq and Khan [45]	1.0	0.5	1.0	1.0	0.5	4.0
Debbarma et al. [46]	1.0	0.5	1.0	1.0	1.0	4.5
Kassinis and Soteriou [47]	1.0	0.5	1.0	1.0	0.5	4.0
Shu et al. [48]	1.0	0.5	1.0	0.0	1.0	3.5
Average Score	1.0	0.8	0.9	0.7	0.7	
Total Quality Score				4.0		

Table 5 shows the SLR quality assessment. Label Q1 indicated of level of evidence in article, Q2 indicated that is it clear the benefit of the study, Q3 indicated are indicator clearly used in the study, Q4 indicated that are there clear improvement to quality attributes? Q5 indicated are explicitly discussed the limitation in the study? And the level determined by L1: 1: Yes, L2: 0.5: Partially and L3: 0: No.

3. RESULTS

The discussion of this study is to focus on the general findings and background of the studies included in the review to categorise the theme and sub-theme of the related studies (Table 5) and discuss the pattern of the data set. The analysis produced four themes and nine sub-themes related to green manufacturing attributes (Table 6). The four themes are a type of green manufacturing initiative (3 sub-theme), environmental impact, operating costs, and the legislation requirement (two sub-themes each). Next, the table of the discussion is divided into three descriptive analyses; years of studies (refer to Figure 2), the country where the studies publish (refer to Figure 3) and organised in the theme of the studies (refer to Table 6).

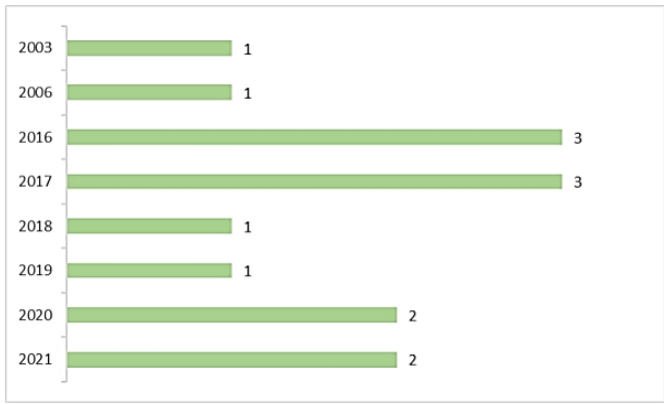

Figure 2. Years of publication

In the case of the present study, Figure 2 displays the year of publication, two articles in 2021 (e.g., Noranarttakun and Pharino [37], Debbarma et al. [38]), two articles in 2020 (e.g., Kunene and Chung [48], Somjai [39]), one article in 2019 (e.g., Yang et al. [40]), one article published in 2018 (e.g., Matos et al. [41]). Next, three articles were published in years 2017 (e.g., Ma et al. [18], Salem and Deif [15], Schmidt and Osebold [42]) same with 2016 (e.g., (Ding et al. [43], Owolana and Booth [44], Shu et al. [47]), finally, one article was published in 2006 (e.g., Sadiq & Khan [45]), same with 2003 (e.g., Kassinis and Soteriou [46]).

Figure 3 displays the pattern of the past studies examined through Thailand Green Manufacturing [37], two studies through Indonesia Green Manufacturing [39, 48], one study into Brazil Green manufacturing [42], and four studies into China Green Manufacturing [19, 46, 49], one study in North America and Europe Green manufacturing [15], one study in German Green Manufacturing [42], one study in Nigerian Green Manufacturing [44], one study in Canada Green Manufacturing [45], one in India Green Manufacturing [38], and lastly one study in European Green Manufacturing [46].

Table 6 shows twelve studies mention the type of initiative in green manufacturing, where are seven studies mention green energy [15, 37, 38, 41, 43, 46, 48]. While five green

processes [15, 18, 39, 44, 45] and four green products [39, 41, 45, 47]. Other than that, all fourteen studies focused on the relationship between Green Manufacturing and environmental impact, thirteen studies on less environmental impact [15, 18, 37, 38, 40-48] and other three about an increase in environmental impact [18, 39, 40]. Furthermore, 14 studies are mention cost in green manufacturing where seven decreases [15, 37, 40, 42-44, 48] and ten increase in firm cost [18, 38, 39, 41, 42, 45-47]. Lastly, there seven mention GM and compliance legislation requirements [18, 37, 39, 43, 47, 48] and five are complied [46-48].

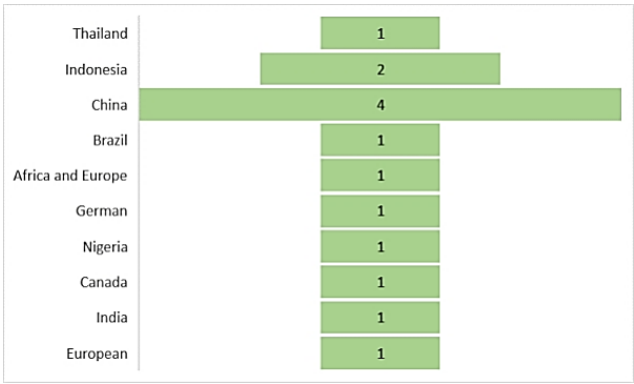

Figure 3. Country where the studies were conducted

Furthermore, 14 studies are mention cost in green manufacturing where seven decreases [14, 36, 38, 39, 41-43] and ten increase in firm cost [17, 37, 40, 41, 44, 45, 47, 48]. Lastly, there seven mention GM and compliance legislation requirements [17, 36, 38, 42, 44, 48] and five are complied [38, 44, 45].

Table 6. Characteristic of inclusion and exclusion

Author	GMI			ENV impact		Cost		Legislation	
	1	2	3	4	5	5	4	6	7
Noranarttakun and Pharino [37]	✓			✓		✓		✓	
Kunene and Chung [38]	✓			✓		✓		✓	✓
Somjai et al. [39]		✓	✓		✓		✓	✓	
Yang et al. [40]				✓	✓	✓	✓		
Matos et al. [41]	✓		✓	✓			✓		
Ma et al. [18]		✓		✓	✓		✓	✓	
Salem and Deif [15]	✓	✓		✓		✓			
Schmidt and Osebold [42]				✓		✓	✓		
Ding et al. [43]	✓			✓		✓		✓	
Owolana and Booth [44]		✓		✓		✓			
Sadiq and Khan [45]		✓	✓	✓			✓		
Debbarma et al. [46]	✓			✓			✓		
Kassinis and Soteriou [47]	✓			✓			✓		✓
Shu et al. [48]			✓	✓			✓	✓	✓

Notes: *GMI (Green Manufacturing Initiative) *Inc (Increase) * Dec (Decrease) * ENV impact (environmental impact) * COST (production cost)

4. MAIN FINDINGS

This section will mainly discuss four main themes and nine sub-themes resulting from data abstraction findings. Mainly 14 studies discuss environmental impact and cost of production. Secondly, 12 studies mention the Green Manufacturing Initiative, and seven discuss the requirement in legislation.

4.1 Type of green manufacturing initiative

Green Manufacturing includes two major practices: protection and operational effectiveness of the natural environment, resources, and energy consumption [37]. In response, the study indicates green manufacturing as a strategy to obtain certain organisational objectives through three initiatives or types of production: green energy, green product, and green process [15, 47]. Similarly, the firm's adoption of technologies in the process, product and management underlines the greater potential for improving organisational performance [39]. It is perceived as minimising waste production and reducing an ecological impact.

The practical use of Green Energy (GE) is identified through renewable energy or natural sources [37]. Practical application of this GE will take as an adaptation of Hydropower, Solar energy, Wind power, geothermal, landfill gas, biomass, and sun geothermal [47]. It uses materials and energy to produce the product [43, 48]. The selection of GE indicates fuel productivity, electrical efficiency, energy consumption rate, and adaptation of solar energy [15, 38]. According to Ma et al. [18], energy use with efficiency can increase productivity, material efficiency, and efficient waste treatment [46]. The results indicate that green energy can reduce 36 per cent of energy consumption, 51 per cent of water users, and 86 per cent of reduction of pollutant degradation [41].

Green process refers to new or modified production equipment, method, and procedure to reduce environmental impact [41, 45]. Essentially, the green process is an innovation introduced to change existing operating methods, reducing its negative impact on the environment [39]. The literature has found that green process technology such as clean production, pollution control, pollution prevention, eco-efficiency, and recirculation solve resource productivity and energy usage efficiency and decrease pollution during production [18]. It involves expenditure and environmental management through (i) total material consumption; (ii) total water consumption; (iii) total energy consumption; (iv) percentage of greenhouse gas emissions; (v) waste generation, (vi) level of pollutant discharge in water, (vii) and dust emission as pollution indicators [15]. On the other hand, the green process also can improve cost efficiency in the short run [47]. The cost of re-evaluating resource utilisation can save $1 billion for pollution prevention practices [18]. However, firms need to invest money to implement green process innovation in the long run to benefit the economic scale [18].

In addition, green product innovation is another modified product to reduce environmental impacts [41]. Green product aims to reduce energy consumption during product use, reduce pollution (air, water, noise), increase recycling material, and replace traditional materials with recycled materials and energy [39, 45, 47]. According to Shu et al. [47], more than 75 per cent of respondents are very likely to buy a green product, and 95 per cent are willing to pay (WTP) for a green product.

Despite all the attributes, one of the attributes that mainly influenced the organisation's decision is legislation requirements. According to Shu et al. [47], policy is one factor that affects a firm's decision to carry out the sustainability agenda. The government can provide support and incentives for firms through pollution tax, abatement subsidy, tradeable permits, government procurement, and green public purchase [18]. Sustainable accomplishment can be achieved through formal regulation (such as laws, regulations, and rules) or informal regulation (including norms, cultures, and ethics). Companies must make strategic decisions and pursue their interests within formal and informal institutional constraints [26]. So, based on studies, firms can enhance compliance with law or regulation or be a burden to comply with the law.

More than 50 per cent of firms set environmental policies on environmental impact reduction and pollution [26]. According to Ma et al. [18], having a strict environmental policy with a good environmental parameter measurement is necessary. The firm will likely do better in sustainability to boost its compliance with environmental policy. Implementing sustainability becomes a point to reach compliance by reducing the complexity of environmental law or tax [26, 29]. Past studies found that a firm that did the sustainable process is likely to avoid some punishment or revoke 'companies' licenses for failure to comply [28, 35]. It is essential to promote green management policy through publicity and access through stakeholders to increase awareness and education while improving a pay-as-you-throw policy [33].

Meanwhile, Mendoza-Fong et al. [36] mentioned that a sustainable policy could burden the firm since it must comply with strict regulations than conventional regulations. It notes that all firms are the same; some bigger firms cannot comply since it gives a considerable cost to production [28]. Other than that, though green process innovation can reduce costs by improving energy and material efficiency and avoiding penalties, this innovation always needs a significant investment in equipment and Research & Development (R&D) [35].

4.2 Environmental impact

Environmental change is one of the major challenges for firms implementing sustainability practices. Creating environmentally conscious and environmentally friendly manufacturing [50]. So, firms are mainly committed to coping with environmental problems and economic and social benefits. However, environmental management performance can be uncertain, positive, or negative.

Being an eco-friendly and eco-efficient business give high expectation on managing environmental performance. This technique is one of the alternatives that can reduce environmental impact and improve efficiency in waste management and environmental protection [38, 40, 42, 44, 45, 48]. They acknowledge that this method can reduce the emission of hazardous substances, the waste treated and re-used material [37, 43, 47]. On the other hand, the positive impact can be seen by decreased carbon release and significantly improved surrounding areas like soil fertility, good quality of water, and clean air [18].

Furthermore, GM can decrease industry waste elements, for example, solid waste, effluent, and gas emissions [41]. Therefore, if the firm commits to reducing the environmental impact, it will benefit the firm in the long term [39, 46]. According to Ma et al. [18], a positive environmental impact can build a good relationship with the government as their environmental performance consistently exceeds the standard environmental regulation. From an economic point of view, less pollution means lower liability costs, treatment costs, fines, and litigation costs [18].

In addition, environmental uncertainties occur in tandem with economic movements as this process cannot directly benefit the cost. According to Ma et al. [18], it is caused by the lack of transparency in information regarding a policy. In addition, Somjai [39] clarify that this sustainable innovation has no significant environmental impact. The firm's failure to achieve good environmental management is due to environmental uncertainties from an external point of view. Studies by Yang et al. [40] found that the eco-method in manufacturing is increasing methane (CH4) emission, creating Global Warming Potential (GWP) and Greenhouse Gas Intensity (GHGI) by 11.1 per cent, 8.1 per cent, and 14.3 per cent each. Thus, the GM method or system not only creates a positive impact but also can indirectly negatively impact the environment.

4.3 Cost of production

The cost of production is the primary driver associated with firms' green manufacturing practices [49]. Green manufacturing adopted by the firm significantly differs between economic and financial factors [48]. It depends on decision-making toward direct cost and indirect cost. While early research suggests that going green might increase costs because of investment. Other than that, more studies specify that green management contributes to stronger firm performance by cutting costs and possibly increasing revenue [51].

The implementation of GM can increase production costs [42, 44]. The cost of production to adopt green manufacturing goes higher as the green method is issued to be complied with by law. According to Kunene and Chung [48], as the policy in sustainability is mandatory to comply, the cost of production can go higher and significantly reduce the financial performance of the firms. The policy may have forced firms to invest in clean, expensive technologies impacting the environment [44]. To be a comparison, the cost of implementing the green method higher than the traditional (end pipe-technology) method [37, 40]. According to Yang et al. [40], input costs can increase by 32.9 per cent of the total production costs, labour expenses by 23.7 per cent, expenses by 23.4 per cent, and reduce equivalent to USD 5250 in profit. The significant increment in the cost is caused due to traditional policies that are not strict and inflexible. The reason is that firms can avoid the cost of landfills or other disposal costs by dumping waste illegally instead of using an authorised method [43].

On the other hand, the implementation of GM can be seen as a benefit as it could be decreased the cost of the production process [38, 39, 41, 42, 45]. Precisely, a GM system can increase productivity and likely reduce a cost in the production process. Along with that, pollution treatment has greater potential for cost reduction and consequently improves the profitability of an operation [40, 46]. According to Salem and Deif [15], reduced production cost indirectly influences a firm through high return on environmental investment, avoidance of environmental penalties cost, and decreased environmental expense. Similar to Ma et al. [18], GM implementation can

reduce production costs and be profitable as firms gain efficient returns in product production processes in the short run. However, if a firm commits to adopting the green method, the firm tends to get more profit through income-generating and environmentally friendly in the long run [40, 47].

5. CONCLUSIONS

In conclusion, this systematic literature review gives a better understanding of green manufacturing attributes based on the relevant literature. The evaluating green manufacturing attribute allows us to facilitate the common characteristics of implementing GM practices. Based on the studies conducted, four main themes represent GM's attributes with nine sub-themes based on present studies. This theme is based on the benefit, factor, advantage, impact, and driver toward GM. All the attributes are the firm's behaviour toward the adaptation of GM. The attributes can define a firm's problem and constrain while making a decision, including direct and indirect barriers. Other than that, all the selected attributes express positive and negative impacts on firm decision-making. It is curial information chosen to determine the firm's behaviour in deciding on GM practices.

However, there are drawbacks in using SLR it is more time consuming other than type of literature method and it is not included a Grey literature such as government reports and policy document. It is may be bias in making bias discussion in the literature. Searches for keywords may be inadequate and insignificant due to the variety of synonyms used during the search phase. However, the study results sought and selected are sufficient. Using SLR method are the type of review that considered a credible source. Other than that, researchers can answer specific research question through the multiple research studies. Thus, it provides helpful information for future research development to explain the attribute preference for green manufacturing. So, the results are expected to provide useful information for policymakers, government, and future studies toward a green environment.

6. RECOMMENDATION FOR FUTURE RESEARCH

A systematic review of these findings may be useful for future review, managers, or policymakers. This process has led to several recommendations for future studies. First, future studies should focus more on the classification of GM attributes as there is still a lack of past studies discussing it. Furthermore, it is essential to know which traits in GM are anticipated by the firm or the most ignorant. To lead toward sustainability, researchers need to understand how firms make decisions in adapting GM despite the good or bad benefits they receive. It will help managers realise the potential benefits their firms can reap from making proactive decisions to support their innovation programs.

Next, it leads to in-depth research on the firm's behaviour towards GM. Research recommendations on willingness to pay are important to learn value for money based on the listed attributes. So, it is easy to assume how much a firm will pay to implement GM practices in production activities. The environment environment-conscious is an important element that needs to be embedded in an organisation before it decides to carry out its production process. Therefore, it can help solve the problem of environmental pollution and the lack of energy resources. Furthermore, this research may be helpful for Government authorities to understand the importance of assimilating green competencies among firms and engaging through plans and actions. In strengthening the action, the implementation can be in the form of motivation and incentive support efficiently and effectively.

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REFERENCES

[1] Le Heron, R., Hayter, R. (2018). Knowledge, Industry and Environment: Institutions and Innovation in Territorial Perspective. Routledge.

[2] Nawawi, M.N., Samsudin, H., Saputra, J., Szczepańska-Woszczyna, K., Kot, S. (2022). The effect of formal and informal regulations on industrial effluents and firm compliance behavior in Malaysia. Prod. Eng. Arch., 28(2): 193-200. https://doi.org/10.30657/pea.2022.28.23

[3] Tomislav, K. (2018). The concept of sustainable development: From its beginning to the contemporary issues. Zagreb Int. Rev. Econ. Bus., 21(1): 67-94. https://doi.org/10.2478/zireb-2018-0005

[4] Thomas, A.J., Byard, P., Evans, R. (2012). Identifying the UK's manufacturing challenges as a benchmark for future growth. J. Manuf. Technol. Manag., 23(2): 142-156. https://doi.org/10.1108/17410381211202160.

[5] Schröder, P., Antonarakis, A.S., Brauer, J., Conteh, A., Kohsaka, R., Uchiyama, Y., Pacheco, P. (2019). SDG 12: responsible consumption and production–potential benefits and impacts on forests and livelihoods. Cambridge University Press Cambridge, UK.

[6] Fathihani, F., Saputra, J. (2022). A review of sustainable finance and financial performance literature: Mini-review approach. Int. J. Financ. Econ. Bus., 1(1): 1-17. https://doi.org/10.56225/ijfeb.v1i1.1

[7] Rainanto, B.H., Bon, A.T., Purba, J.H.V. (2022). Environmental management system and pro-environmental behavior in realizing sustainable industry performance: Mediating role of green marketing management. Int. J. Glob. Optim. Its Appl., 1(1): 12-21. https://doi.org/10.56225/ijgoia.v1i1.9

[8] Setyaningsih, I., Ciptono, W.S., Indarti, N., Kemal, N.I.V. (2019). What is green manufacturing? A quantitative literature review. In E3S Web of Conferences, 120: 1001. https://doi.org/10.1051/e3sconf/201912001001

[9] Shrivastava, S., Shrivastava, R.L. (2017). A systematic literature review on green manufacturing concepts in cement industries. Int. J. Qual. Reliab. Manag., 34(1): 68-90. https://doi.org/10.1108/IJQRM-02-2014-0028

[10] Malhotra, V., Kumar, S. (2017). The literature review of lean and green manufacturing system. Int. J. Theor. Appl. Mech., 12(3): 389-393.

[11] Abualfaraa, W., Salonitis, K., Al-Ashaab, A., Ala'raj, M. (2020). Lean-green manufacturing practices and their link with sustainability: A critical review. Sustainability, 12(3): 981. https://doi.org/10.3390/su12030981

[12] Sihag, N., Sangwan, K.S. (2020). A systematic literature

review on machine tool energy consumption. J. Clean. Prod., 275: 123125. https://doi.org/10.1016/j.jclepro.2020.123125
[13] Saglam, Y.C., Çankaya, S.Y., Sezen, B. (2020). Proactive risk mitigation strategies and supply chain risk management performance: An empirical analysis for manufacturing firms in Turkey. J. Manuf. Technol. Manag., 32(6): 1224-1244. https://doi.org/10.1108/JMTM-08-2019-0299
[14] Paul, I.D., Bhole, G.P., Chaudhari, J.R. (2014). A review on green manufacturing: It's important, methodology and its application. Procedia Mater. Sci., 6: 1644-1649. https://doi.org/10.1016/j.mspro.2014.07.149
[15] Salem, A.H., Deif, A.M. (2017). Developing a Greenometer for green manufacturing assessment. J. Clean. Prod., 154: 413-423. https://doi.org/10.1016/j.jclepro.2017.03.196
[16] Kazancoglu, Y., Kazancoglu, I., Sagnak, M. (2018). A new holistic conceptual framework for green supply chain management performance assessment based on circular economy. J. Clean. Prod., 195: 1282-1299. https://doi.org/10.1016/j.jclepro.2018.06.015
[17] Tan, C.L., Yeo, S.F., Low, C.H. (2018). Green supply chain management practices and organizational performance: An empirical study in Malaysian manufacturing firms. J. Pengur., 52: 19-32. https://doi.org/10.17576/pengurusan-2018-52-02
[18] Ma, Y., Hou, G.S., Xin, B. (2017). Green process innovation and innovation benefit: The mediating effect of firm image. Sustainability, 9(10): 1778. https://doi.org/10.3390/su9101778
[19] Mao, S., Wang, B., Tang, Y., Qian, F. (2019). Opportunities and challenges of artificial intelligence for green manufacturing in the process industry. Engineering, 5(6): 995-1002. https://doi.org/10.1016/j.eng.2019.08.013
[20] Li, Y., Zhang, M. (2018). Green manufacturing and environmental productivity growth. Ind. Manag. Data Syst., 118(6): 1303-1319. https://doi.org/10.1108/IMDS-03-2018-0102
[21] Tan, C.L., Yeo, S.F., Goh, Y.N., Chan, H.S. (2017). An examination of the factors influencing the green initiative and competitiveness of private higher education institutions in Malaysia. J. Pengur., 51: 1-20. https://doi.org/10.17576/pengurusan-2017-51-08
[22] Hafizuddin-Syah, B.A.M., Shahida, S., Fuad, S.H. (2018). Sustainability certifications and financial profitability: An analysis on palm oil companies in Malaysia. J. Pengur., 54(2018): 143-154. https://doi.org/10.17576/pengurusan-2018-54-12
[23] Salim, N., Ab Rahman, N.M., Wahab, D.A. (2021). Enhancing green product competitiveness through proactive capabilities of manufacturing firms. J. Kejuruter., 33(1): 73-82. https://doi.org/10.17576/jkukm-2020-33(1)-08
[24] Denyer, D., Tranfield, D. (2009). Producing a Systematic Review. Sage Publications Ltd.
[25] Jesson, J., Matheson, L., Lacey, F.M. (2011). Doing Your Literature Review: Traditional and Systematic Techniques. Sage.
[26] Torgerson, C. (2003). Systematic Reviews. Bloomsbury Publishing.
[27] Centobelli, P., Cerchione, R., Esposito, E. (2017). Environmental sustainability in the service industry of transportation and logistics service providers: Systematic literature review and research directions. Transp. Res. Part D Transp. Environ., 53: 454-470. https://doi.org/10.1016/j.trd.2017.04.032
[28] Tikito, I., Souissi, N. (2019). Meta-analysis of systematic literature review methods. Int. J. Mod. Educ. Comput. Sci., 11(2): 17-25. https://doi.org/10.5815/ijmecs.2019.02.03
[29] Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., the PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. Ann. Intern. Med., 151(4): 264-269. https://doi.org/10.7326/0003-4819-151-4-200908180-00135
[30] Sierra-Correa, P.C., Kintz, J.R.C. (2015). Ecosystem-based adaptation for improving coastal planning for sea-level rise: A systematic review for mangrove coasts. Mar. Policy, 51: 385-393. https://doi.org/10.1016/j.marpol.2014.09.013
[31] Shamseer, L., Moher, D., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P., Stewart, L.A (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: Elaboration and explanation. Bmj, 349: 1-25. https://doi.org/10.1136/bmj.g7647
[32] Mengist, W., Soromessa, T., Legese, G. (2020). Method for conducting systematic literature review and meta-analysis for environmental science research. MethodsX, 7: 100777. https://doi.org/10.1016/j.mex.2019.100777
[33] Shaffril, H.A.M., Samah, A.A., Samsuddin, S.F., Ali, Z. (2019). Mirror-mirror on the wall, what climate change adaptation strategies are practiced by the Asian's fishermen of all? J. Clean. Prod., 232: 104-117. https://doi.org/10.1016/j.jclepro.2019.05.262
[34] Mittal, V.K., Sangwan, K.S. (2014). Prioritizing barriers to green manufacturing: Environmental, social and economic perspectives. Procedia Cirp, 17: 559-564. https://doi.org/10.1016/j.procir.2014.01.075
[35] United Nations Industrial Development Organization, "UNIDO green industry: Policies for supporting green industry," UNIDO Vienna. (2011). https://www.unido.org/sites/default/files/2011-05/web_policies_green_industry_0.pdf.
[36] Mendoza-Fong, J.R., García-Alcaraz, J.L., Díaz-Reza, J.R., Jiménez-Macías, E., Blanco-Fernández, J. (2019). The role of green attributes in production processes as well as their impact on operational, commercial, and economic benefits. Sustainability, 11(5): 1294. https://doi.org/10.3390/su11051294
[37] Noranarttakun, P., Pharino, C. (2021). How does the green industry policy impact a developing country? A case study of the electronic products and electrical equipment manufacturing sector in Thailand. Environ. Nat. Resour. J., 19(5): 402-412. https://doi.org/10.32526/ennrj/19/2021028
[38] Debbarma, J., Lee, H., Choi, Y. (2021). Sustainable feasibility of the environmental-friendly policies on agriculture and its related sectors in India. Sustainability, 13(12): 6680. https://doi.org/10.3390/su13126680
[39] Somjai, S., Fongtanakit, R., Laosillapacharoen, K. (2020). Impact of environmental commitment, environmental management accounting and green innovation on firm performance: An empirical investigation. International Journal of Energy Economics

and Policy, 10(3): 204-210. https://doi.org/10.32479/ijeep.9174
[40] Yang, B., Ma, Y.C., Zhang, C.X., Jia, Y.F., Li, B., Zheng, X.Q. (2019). Cleaner production technologies increased economic benefits and greenhouse gas intensity in an eco-rice system in China. Sustainability, 11(24): 7090. https://doi.org/10.3390/su11247090
[41] Matos, L.M., Anholon, R., Silva, D., Ordoñez, R.E.C., Quelhas, O.L.G., Filho, W.L., de Santa-Eulalia, L.A. (2018). Implementation of cleaner production: A ten-year retrospective on benefits and difficulties found. J. Clean. Prod., 187: 409-420. https://doi.org/10.1016/j.jclepro.2018.03.181
[42] Schmidt, J.S., Osebold, R. (2017). Environmental management systems as a driver for sustainability: State of implementation, benefits and barriers in German construction companies. J. Civ. Eng. Manag., 23(1): 150-162. https://doi.org/10.3846/13923730.2014.946441
[43] Ding, Z.K., Wang, Y.F., Zou, P.X.W. (2016). An agent based environmental impact assessment of building demolition waste management: Conventional versus green management. J. Clean. Prod., 133: 1136-1153. https://doi.org/10.1016/j.jclepro.2016.06.054
[44] Owolana, V.O., Booth, C.A. (2016). Stakeholder perceptions of the benefits and barriers of implementing environmental management systems in the Nigerian construction industry. J. Environ. Eng. Landsc. Manag., 24(2): 79-89. https://doi.org/10.3846/16486897.2016.1127251
[45] Sadiq, R., Khan, F.I. (2006). An integrated approach for risk-based life cycle assessment and multi-criteria decision-making: selection, design and evaluation of cleaner and greener processes. Bus. Process Manag. J., 12(6): 770-792. https://doi.org/10.1108/14637150610710927
[46] Kassinis, G.I., Soteriou, A.C. (2003). Greening the service profit chain: The impact of environmental management practices. Prod. Oper. Manag., 12(3): 386-40. https://doi.org/10.1111/j.1937-5956.2003.tb00210.x
[47] Shu, C.L., Zhou, K.Z., Xiao, Y.Z., Gao, S.X. (2016). How green management influences product innovation in China: The role of institutional benefits. J. Bus. Ethics, 133(3): 471-485. https://doi.org/10.1007/s10551-014-2401-7
[48] Kunene, N., Chung, Y.C.Y. (2020). Sustainable production policy impact on palm oil firms' performance: Empirical analysis from Indonesia. Sustainability, 12(20): 8750. https://doi.org/10.3390/su12208750
[49] Sukono, Saputra, J., Subartini, B., Purba, J.H.F., Supian, S., Hidayat, Y. (2019). An application of genetic algorithm approach and cobb-douglas model for predicting the gross regional domestic product by expenditure-based in Indonesia. Eng. Lett., 27(3): 411-420.
[50] Luo, Y., Jie, X.W., Li, X.P., Yao, L.M. (2018). Ranking Chinese SMEs green manufacturing drivers using a novel hybrid multi-criterion decision-making model. Sustainability, 10(8): 2661. https://doi.org/10.3390/su10082661
[51] Rainanto, B.H., Bon, A.T., Purba, J.H.V. (2022). Developing the conceptual model of sustainable industrial performance in the hospitality industry. Int. J. Glob. Optim. Its Appl., 1(2): 80-89. https://doi.org/10.56225/ijgoia.v1i2.17