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ORIGINAL CONTRIBUTION

Assessment of Drivers and Barriers of Green Manufacturing Practices in Indian Manufacturing Companies

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Abstract Manufacturing is an important sector in the world economy which supports several industrial segments, such as retail, construction, and transportation. Nevertheless, manufacturing firms have been causing significant harm to the natural environment throughout different phases of their transformational journey that comprise the manufacturing cycle for goods. Therefore, it is imperative to have a greater focus on reinventing manufacturing that is efficient and less polluting so that the development is viable, equitable, and acceptable. As India aims toward becoming one of the biggest manufacturing hubs in the world, it becomes very important to understand what practices it would require for progressing as well as being green at the same time. Green manufacturing emerges as a feasible solution for addressing environmental issues. However, numerous factors influence the adoption of green manufacturing practices, and they all play a role in implementation. For those in the industry who have not been exposed to green manufacturing techniques, it is vital to understand the elements that will influence their organization's adoption of these practices. These factors are divided into two different categories: drivers and barriers. The manufacturing organizations primarily focus on both the category factors as one category factor supports the implementation process, and other category factors oppose it. Also, due to demographic and other effective differences, tested parameters in foreign markets are not necessarily applicable in India or any other country. Therefore, this study reports the findings on drivers and barriers faced by Indian manufacturing organizations during the adoption of green manufacturing practices and ranks them based on their effectiveness. Through expert consensus, this study used a literature review and survey technique to identify, select, categorize, and rank the drivers and constraints of green manufacturing processes. The study findings that this study will help industries to form a structured action plan for green manufacturing implementation while knowing the supporting and opposing factors and their effectiveness.

Keywords Green manufacturing practices · Barriers · Survey · Indian manufacturing organizations

Introduction

Manufacturing is an important sector in the world economy which has been playing a pivotal role in generating employment, comforts, and economies of nations ever since the industrial revolution [1]. This trend is likely to continue due to an increased demand for goods by the world's ever-growing population [2, 3]. Nonetheless, advancements in the manufacturing sector have also had adverse effects on our planet in the form of global warming, resource depletion and local waste disposal, and related catastrophes [4, 5]. A growing awareness of the threats associated with the deterioration of the natural environment has developed an added interest in tracking the negative consequences of manufacturing [6–8]. As a solution to this problem, green manufacturing (GM) was introduced; it strives for renewing production processes while establishing environment-friendly operations within the manufacturing field [9]. Given this, manufacturing industries have been forced to reconsider their current manufacturing methods [1, 10]. Therefore, there is a need to

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adopt a viable manufacturing process that helps to overcome such problems and produce green products or services [11]. Collected evidence by researchers [12] shows that green alternatives or application of green manufacturing practice (GMP) in vulnerable industries seems to be a viable option as of now. To reduce the adverse effects of traditional manufacturing practices, it is quite essential to apply GMP. Green manufacturing (GM) has been introduced as the process of implementing any alternative or substitution in the current traditional manufacturing process, which leads to energy reduction, resource utilization, water consumption, and waste by-products [13, 14]. "GM is a concept used to identify those manufacturing techniques that do not cause damage to the environment at any stage of the production process and emphasize primarily the use of environmentally friendly methods that are not hazardous to consumers, employees, or other sections of the community" [15]. However, there have been several different definitions provided by various researchers in their studies. The primary objective of GM is to reduce resource consumption and emission to the environment during the various manufacturing processes [16]. The uniformity in the definition of GM has also been seen in previous studies [1], 1417–20. Further, the implementation of GMP in the organization is a structured process that follows a systematic process cycle based on what the implementation is to be done [13]. The process begins with the design, then comes procurement, followed by manufacturing, packaging, distribution, customer use to a product's end-of-life, and then remanufacture [21]. While implementing the entire process cycle, some factors might promote the cycle, while some might oppose it. In other words, several factors affect the adoption process of GM, where some factors support the implementation of the GM process, and some oppose it. The factors that support GM's implementation are called drivers, whereas the factors that oppose the implementation process are known as barriers [20]. However, every effort that makes the company's successful production, a part of a system more bearable followed by being feasible and in the end proceeds toward being sustainable can be said to be nearing for GM [22]. For example, a food joint starts using wholly recyclable and reusable paper bags instead of plastic bags for serving its dry snacks. Similarly, a disinfectant-producing company comes up with a model of collecting empty bottles from consumers and refilling them for further usage. India is on the verge of becoming a manufacturing powerhouse [23]. It becomes essential to consider GMP to ensure that no harm is done to the environment at the cost of mass manufacturing. Before applying the green manufacturing process cycle in any organization, it becomes essential to be aware of the drivers and barriers in the field beforehand. An unawareness about drivers and barriers of GMP might emerge as an unknown risk for the upcoming companies and their management. In addition to this, nowadays, several developing companies are getting aware of their responsibilities toward developing green products, processes, and services [13] 24. As a result, some are pretty interested in applying GMP while some are having a hard time understanding and using them. The attention, as well as a desire for the topic of GM as a step toward green manufacturing, has driven a great deal of research and exploration in this complex subject [1] 14, 15. Though, it is tough for companies in India to identify GM factors that support them or oppose them. There has been a lack of availability of reliable data for individuality associated with the environmental factors and social factors from different nations and cultures [25]. Furthermore, there has been a lack of feasible research in the field of GM, which directly interacts with respondents of various companies in India and suggests the factors that either support or oppose the application of GMP in existing and upcoming manufacturing industries.

The Indian government's 'Make in India' campaign encourages global investment in Indian manufacturing industries. This clearly states the government of India's intent and the current industrial ecosystem to transform India into a manufacturing hub that becomes a major exporter in the future [23]. The main idea behind this is to produce goods or services with zero defects that reduce product replacement and return. Also, based on the objective of the "Make in India" campaign, no environmental harm is to be encouraged while manufacturing and green practices should be made one of the prime goals [1], 23 26]. From the above statement, it is clear that Indian manufacturing industries are aiming to create a manufacturing hub in the near future and green manufacturing is going to be a major factor in the prosperity of the industry as well as the nation. Hence, it becomes essential to prepare and think of such manufacturing practices which are as productive as the traditional practices or else more productive than them but at the same time are green. A typical step toward this can be attained by employing technology solutions through new processes and machines [27]. There is a separate domain of manufacturing that takes care of the sustainability factor, and the measures manufacturers need to take to attain sustainability. This domain is known as green manufacturing. Based on previous studies, it is found that very few studies have identified the enablers and barriers of green manufacturing in Indian manufacturing industries [28] and have provided a generic list. Moreover, there is an absence of studies in India on GM that focus on identifying drivers and barriers that affect the application of GMP in the Indian manufacturing industries. Though most of the studies in this field seem to be highly constrained toward literary work, the authors thought of doing something which bridges the gap between the real world and the literary world. In addition to this, this also observed that a very handful of studies have systematically analyzed and ranked drivers and barriers of

GM in terms of Indian manufacturing industries. Those who have tried to provide a systematic ranking-based framework are confined to a specific region [21], and as per [25] there is a lack of data for individuality associated with the environmental factors and social factors from different nations and cultures. Moreover, few studies have reported the systematic adoption of enablers and barriers to GM in the Indian manufacturing context.

Therefore, it is critical to identify and assess the GM drivers and barriers as well as examine their importance. Hence, the need for a ranking-based list of factors that affect GM practices both as supporting factors(drivers) and opposing factors (barriers) is felt which will help create a structured action plan for the adoption of GM practices in Indian manufacturing industries. Thus, this study identifies and examines the list of "drivers and barriers" of GMP and prioritizes them based on their importance. The authors employed an exploratory survey approach to collect the perspectives of specialists recruited from the manufacturing industries, academics, non-governmental entities, and government sectors on the drivers and barriers in GMP.

Research Methodology and Data Collection

Research Framework

The first important step of research is the exploration the survey research which means explore about phenomena or situations that appear focusing on collecting data only (do not create the situation) and then analyzing to explain what it is, how factors are related, what impact [29], hence understanding the research framework and the more suitable methodology for any study is critical aim for researchers. Furthermore, the first stage in any research is to recognize the nature of the research topic, which leads to the selection of an acceptable research technique [30]. In this research, the authors are taking an exploratory approach focusing on the factors which are affecting the implementation of GMP specifically in the Indian industry, which will help industries to further be aware of the factors (which affect the execution of GMP) while creating a transformation strategy. The researcher in our study will do this by collecting data, performing analysis, and enlisting those factors as drivers or barriers based on the results.

Research Methodology

Research methodology is the systematic, theoretical analysis of the procedures utilized in a field of study [31]. The study questions and goals now decide the optimal research strategy [32]. The purpose of this study was to identify the factors which act either as drivers or barriers for Indian manufacturing companies which have already implemented GM Practices. The idea was to provide companies (not adopted GMP) and researchers with a clear understanding of what factors will support or oppose the implementation of GMP in Indian manufacturing companies. To answer this query, the authors have structured a questionnaire that was circulated to 55 respondents through social media platforms (LinkedIn) and email. Survey research is used to answer definite questions, fix problems or issues that have been posed or observed, assess, and analyze needs and set targets, determine whether relevant objectives have been met, establish a framework against which future correlations can be made, and examine trends over time, and, in general, to define what exists, in what quantity, and in what context [33].

Steps of Research Methodology

Step 1: Literature Review

The research begins with a comprehensive search of relevant literature in the field of "green manufacturing." The article was searched from three different databases (i.e., SCOPUS, Google Scholar, and EBSCO) using the following keywords: "Green Manufacturing Driver," "Green Manufacturing Enablers," "Green Manufacturing success factors," "green manufacturing barriers," and "green manufacturing failure factors."

Step 2: Identifying Factors as Drivers and Barriers

The list of "drivers and barriers" were shortlisted from literature and categorized into different categories, namely legislation, organization, environmental knowledge, business atmosphere, social influences, innovation, and technology, thorough brainstorming discussion with industrial experts.

Step 3: Developing Survey Instrument

After categorizing the "drivers and barriers" of GM, a survey instrument was developed containing those drivers and barriers. A 5-point Likert scale ranging from disagree to agree was used to ask the rate of shortlisted enablers and barriers from a group of experts. Further, the survey questionnaire was validated by the five experts to check the consistency and accuracy of the questions. Experts also evaluated the contents and clarity of asked questions. After that, questionnaires were piloted by 55 experts. These experts include industry personnel, consultants, academicians, and research scholars from similar backgrounds. The selected experts had excellent knowledge of the concerned field. A total of 26 responses were received from experts out of which 7 responses were incomplete and 19 were complete and hence were considered for further calculations.

Step 4: Analyzing the Data

Following the collection of data from respondents, the data was analyzed to determine the mean score of each driver and barrier based on the Likert scale. This ranking will highlight the effectiveness of those selected drivers and the barriers provided in the list. The analysis results provided the mean score of those drivers and barriers, which help to prioritize them based on their importance score. The survey's reliability was further validated by Cronbach's alpha, which ensured that the survey is reliable. Figure 1 depicts the research steps used in this study.

Survey Structure

The survey conducted in this research consisted of the following sections:

- Background information of the respondents.
- Rating Factors that may operate as drivers for GMP in the manufacturing industries.
- Rating Factors that may operate as barriers for GMP in manufacturing industries.

There were 19 questions in the survey instrument, including all three categories, with a total of 15 questions covering all 53 aspects to be scored and 4 questions for gathering background information from our respondents. The first part of the questionnaire collected data about the profession of our respondents, organization type, and their seniority level in their organization. The second part of the questionnaire covered 7 questions containing categories named legislation, organizational, environmental knowledge, business atmosphere, social influences, monetary influences, and innovation which had 24 subcategories to be rated as Drivers. Whereas the third part of the questionnaire had 8 questions containing 29 subcategories named organizational structure, environmental knowledge, business atmosphere, social influences, technology, legislation, and monetary influences to be rated as barriers.

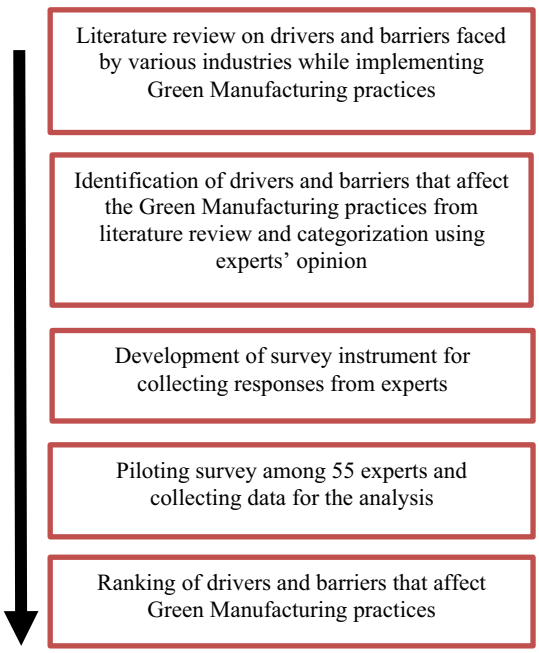


Fig. 1 Research methodology applied in the research

Types of Questions

In a survey, closed-ended questions are easy for respondents and research scholars to analyze data in a survey [34]. Closed-ended questions need the respondents to opt for one of the multiple possibilities. Hence, the survey format of this research paper consists of close-ended questions for analysis. In the second and third parts of the questionnaire, it has been used the Likert scales to collect data on 53 subcategories (drivers or barriers). A Likert scale is a set of assertions (items) presented for a real or hypothetical situation under investigation that gives precision in measuring [35, 36]. A 5-point Likert scale was employed in this study, with 1 = Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, and 5 = Agree. Here, a symmetric Likert scale has been used to reduce the chances of biasing. Asystometric Likert scale is one in which the Neutral point is exactly at the center which provides a participant some freedom to pick any balanced and symmetric answer in either direction [36]. Later, to examine the data, which was received, Microsoft Excel was used.

Sampling Method and Procedure

The questionnaire was circulated electronically via social media sites (such as LinkedIn). It was distributed among 58 specifically targeted experts from various industries and academia. A total of 28 responses were received out of which 9 were incomplete and 19 were complete which seemed to be satisfactory as the overall response rate was 50.9%. According to maximum likelihood estimation [37], the sample size should be between 100 and 10 for the sample to be effective.

Breakdown of Survey Respondents

The type of respondents, their profession, and their company were chosen strategically to align with our field of study. 53.5% of all our respondents were from various sectors of the Indian manufacturing industries whereas 46.42% of our respondents were from academia.

Background of Respondents

Our respondents from academia are researchers who are updated with studies in green manufacturing and are involved in various other research. They are professors, lecturers, or research scholars of India's best colleges that are focused on research studies linked with Industrial Engineering, Mechanical Engineering, and others.

The following chart (Fig. 2) represents the background of our respondents from the Indian manufacturing industry:

The backgrounds of academic responders are depicted in Fig. 3:

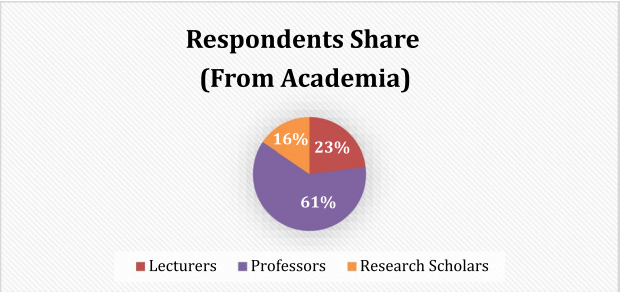


Fig.3 Background of respondents from Academia

Reliability Test

A reliability test was carried out to assess the survey's internal consistency. Reliability is a critical quality of any test, whether it is a written test, a performance assessment, or an informal observation or question [38].

Cronbach's alpha, Cohen's kappa, and Ebel's intraclass correlation are the three most commonly used tests for determining data dependability [39]. The Cronbach alpha test for this poll was performed in excel. According to research [40, 41], a threshold value of >0.6 is suitable for the formation of new measures (exploratory studies), whereas values >0.70 can be considered satisfactory in more advanced phases of research. In operational or management research, values above 0.8 are extremely dependable [42]. The Cronbach alpha value determined for this survey was 0.918, indicating that the data acquired through this survey was appropriate for analysis.

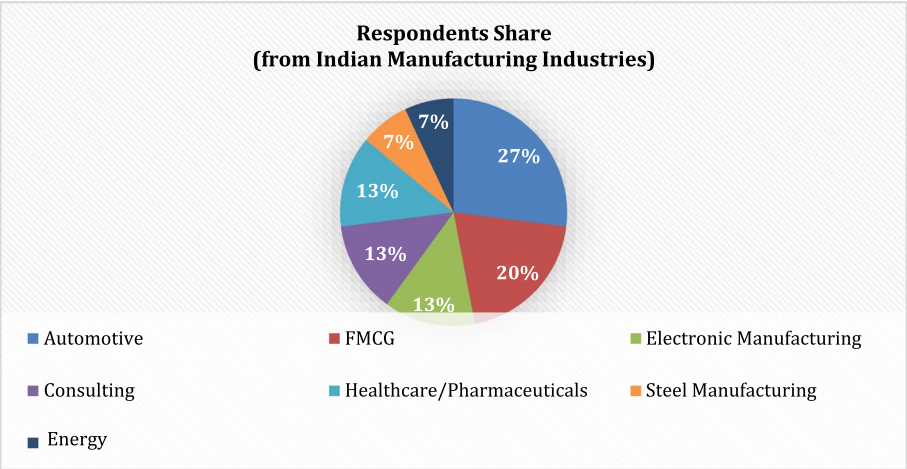
Implications of the study

The major implications of this work have been discussed in two sections below. The first section discusses the implications for theoretical knowledge that have been deduced from the present literature. The second section discusses the implications that will help industrialists, organizations, and other relevant stakeholders to create a structured plan to implement GMP in their organizations. This plan will help them to be aware of supporting and opposing factors while creating a plan.

Implication for Theoretical Knowledge

Manufacturing companies improve people's quality of life while also contributing significantly to the environmental challenge [43]. But, by considering Make in India, the need is to adopt green practices instead of traditional practices that are majorly involved in resource exploitation. The current research [28] on drivers and barriers in GMP in Indian industries only examines drivers and barriers in the Indian context and is unable to determine if one aspect is more successful than another or which factors companies must consider first while trying to eliminate the risks related to the implementation of GMP? Also, the present literature has already ranked the factors that are affecting GMP as drivers and barriers [21], but it is confined to Malaysian SMEs only, whose result details will be very different from that

Fig.2 Background of respondents from Industry



of India. Overall, the literature suggested that none of the previous studies have tried to assess drivers and barriers of GMP in the Indian context with a ranking-based approach. As a result, the current study assists in identifying the drivers and barriers of GMP in Indian manufacturing industries and rates them based on their efficacy.

Implications for Practitioners and Researchers

For GM practitioners or organizations that are focused on the implementation of GMPs, the present study provides a ready reference of what factors are going to affect their company while they are trying to adopt GMP. It not only gives them the idea of factors that will hamper or promote their performance regarding the application of GMP but also suggests the extent up to which it can be effective. For example, the manager of a certain company who is aiming to implement GMP in their organization is unsure what factors of his/her company are going to support his plan and what factors are going to oppose it. He/she will be able to refer to the list in Tables 1 and 2 and can create an action plan accordingly being aware of what challenges and advantages the company might receive during the implementation of GMP. This will increase the efficiency of the overall operation of transforming from traditional practices to GMPs.

In this study, exploratory research has been conducted just to form a base for other researchers or scholars to proceed ahead in this field. For those academicians working in the green manufacturing field, it would be easy to identify the enablers and barriers and their extent, which they can use further to study another field linked with this subject. They can research constructing a framework or model for the implementation of GMP in Indian manufacturing industries using the factors that have been identified in this study.

Results and Discussion

Findings from our survey are presented in Tables 1 and 2 for drivers and barriers, respectively. The drivers and barriers are listed in the concerned table, where a ranking methodology has been followed. According to research [44], a simple strategy incorporating descriptive statistics such as mean and standard deviation may be used in questionnaire surveys for concept validation. Hence, the mean value of individual responses was calculated. The ranks are provided to the factors based on their mean score obtained on the Likert scale through all our respondents. For numerical clarity and lucidness of the mean score, all the scores have been multiplied with the constant digit "100." Finally, rank is provided to all the drivers and barriers to examine the priority and importance of those factors.

Table 1 List of drivers that motivate the implementation of GMP

No	Drivers	Mean	Rank
Legislation			
1	Non-mandatory standards/regulations	237	14
2	Mandatory regulations	426	2
3	Financial incentives/penalties (tax/rebate)	389	8
4	CSR activities pushed by authorities	395	7
Organizational			
5	Culture of organization	405	5
6	Commitment of organization	431	1
7	Internal organizational capabilities	395	7
8	Awareness regarding GMP within management	410	4
9	Availability/access to GMP knowledge and training	389	8
Environmental knowledge			
10	Availability of Information regarding cofactors	405	5
11	Emerging opportunities in the field of GMP	421	3
Business atmosphere			
12	Competitor's pressure	358	11
13	Stakeholder's pressure	405	5
14	Arising market opportunities newly from market	379	10
15	B2B pressures in bigger organizations	347	13
Social influences			
16	Awareness in the public regarding green initiatives	389	8
17	Customer's demand for green products/services	400	6
18	Socio-cultural practices	353	12
Monetary influences			
19	Monetary incentives (penalties/support)	405	5
20	GMP can lead to cost reduction	353	12
Innovation			
21	GMP can lead to new innovations	405	5
22	GMP can provide better competitiveness	389	8
23	GMP improves company image	431	1
24	GMP improves product quality	384	9

Calculation and Data Analysis

After obtaining survey instrument replies, all data was extracted into a spreadsheet. Following were the steps that were covered to get a quantitative result out of our survey:

Step 1: Calculating Individual Mean

An Individual mean score was calculated for each factor separately to get an idea of the average response value.

On Microsoft Excel, the standard arithmetic mean formula was used which is as follows:

Table 2 List of Barriers to the Implementation of GMP

No	Barriers	Mean	Rank
Organizational structure			
1	Weak organizational structure due to GMP	326	17
2	Lack of approval for GMP	374	11
3	Restriction of management toward GMP	379	10
4	Hesitation in transforming traditional practices into GMP	400	5
5	Lack of resources	395	6
6	Trouble in allocating resources	384	9
Environmental knowledge			
7	Lack of knowledge	405	4
8	Shortage of external tech support for GMP	410	3
9	Lack of information for potential improvements	395	6
Business atmosphere			
10	Less demand of GMP-based products/services	310	19
11	Nature of industry bound to less usage of GMP	321	18
12	Lack of knowledge regarding the effect of GMP on business	389	8
13	Shortage of effective GMP measures	400	5
Social influences			
14	Lack of awareness among public	400	5
15	Low public pressure for green Products/services	442	1
Technology			
16	Shortage of new technology for GMP	389	8
17	Lesser GMP-based alternatives	363	13
18	Complications in technical design	384	9
19	Less flexibility in switching to GMP-based systems	405	4
20	Less flexibility in executing GMP	395	6
Legislation			
21	Lesser environment enforcements	405	4
22	Lack of GMP-based training/consulting provided by the Govt	416	2
23	Lack of SOPs (guidelines for implementing GMP)	390	7
Monetary influences			
24	Retrospective costs that result in a loss in GMP	342	16
25	Trouble in Financial capital acquisition for GMP	389	8
26	Requirement of excessive initial capital for GMP	368	12
27	Lesser financial gains after implementing GMP	347	15
Suppliers			
28	Lack of access to supply for GMP	374	11
29	Trouble in regular maintenance of GMP awareness	358	14

$$\boldsymbol{Mean}(\boldsymbol{X}) = \sum_{i=1}^{n} \frac{x_n}{n} = \frac{x_1 + x_{2+} x_3 \ldots ..x_n}{n} \quad (1)$$

where x_n refers to the sum of scores of all individual responses for a factor.

n refers to the total number of responses.

Step 2: Internal Consistency Test

To evaluate internal consistency, a reliability test was performed, and Cronbach's alpha was determined using the following equation:

$$\boldsymbol{Cronbach's\ Alpha\ (\alpha)} = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum_{i=1}^{k}\sigma_{y_i}^2}{\sigma_x^2}\right) (2).$$

where k refers to the number of scale items.

The variation associated with scores of individual factors (i) is referred to as $\sigma_{y_i}^2$

The variance associated with the observed total scores is denoted by σ_x^2

Further standard deviation was calculated out of the calculated variance to determine whether the ratio of 2:1 is maintained between maximum standard deviation and

minimum standard deviation so that the test analysis can be done through the calculation of the mean [44].

Step 3: Simplifying Data for Ranking

To simplify the data for readability and ranking, each mean has been rounded off up to 2 decimal places. After rounding off, all mean scores were multiplied by a common constant (100) to reduce complexity.

After simplifying the data, a rank was provided for each factor based on the simplified mean value. A higher mean value refers to a higher rank whereas a lower mean value refers to a lower rank.

The provided list may be used to compare the relevance of each factor to others.

Refer to Table 1 for the list of drivers and Table2 for the list of barriers to the implementation of GMP.

The present study has shortlisted 24 drivers and 29 barriers through the literature review, followed by a thorough discussion with the experts. The goal was to concentrate on the factors that impact the adoption of GMP in Indian manufacturing firms. The selected drivers are categorized into 7 different categories. Similarly, the barriers are categorized into 8 different categories. Few authors have classified the enablers and barriers in suitable clusters but no authors have grouped a large set of enablers and barriers for green manufacturing adaptation in the Indian manufacturing context [45–50]. Previous studies such as [45] have reported a total of 7 enablers and barriers to sustainable manufacturing to encourage SMEs to make environmental improvements. Similarly, [46] discussed three enablers of green supply chain initiatives. Thereafter, [47] analyzed a list of 10 enablers and barriers to sustainable manufacturing from the perspective of researchers and industry professionals. [48] reported 15 enablers of green manufacturing from the perspective of Indian manufacturing SMEs. Further, [49] have selected 11 barriers and developed an implementation model to adopt green manufacturing in the Indian automotive industry. Thereafter, [50] selected a bunch of 10 enablers and prioritized using AHP from the perspective of Indian manufacturing companies. Hence, the outcome of the present study will contribute more to researchers and managers working in the field of green manufacturing.

Next to the finalization of enablers and barriers, the questionnaire was developed considering those drivers and barriers and piloted among a group of experts to collect their inputs. The analysis was carried out using the inputs supplied by the experts. The findings of the present study reveal that the commitment to the organization and the image of the company are equally important and are the prime drivers of GMP in various organizations. [45] have also reported organization commitment and loyalty prioritized as the most important enablers to implementing green manufacturing in the organization. Followed by mandatory regulations laid by regulatory bodies and the emerging opportunities in the field, which also prove to be prime drivers of GMP in Indian industries. Based on [15, 47] the regulations made by the government enforce organizational managers regularly to adopt green manufacturing in their organizations. The results indicated that the above-discussed drivers can help to implement GMP in organizations.

In case of barriers, lower public demand, and low public pressure from the people for Green Products/Services seem to prevent or hinder the companies from adopting GMP. It has been observed that manufacturing organizations, especially in India, do not take much interest in developing a green manufacturing environment until the government and the public do not enforce them to adopt it [51]. Also, lack of relevant training and consulting from the government and shortage of external technical support to implement GM Practices act as prime barriers to the implementation of GMP. Poor training provided to employees is one of the most important barriers which affect the implementation of any initiatives [11, 45]. All these barriers obstruct GMP execution in specific Indian sectors. The study's findings reveal additional factors and constraints that impact and affect the implementation process. The findings of this study will help organizational managers to focus on those drivers and barriers based on priority and take necessary actions to implement GMP in their organizations. The authors believe that the present study results will also help researchers identify new drivers and barriers and perform further analysis by considering a large group of experts and comparing the results with the current findings.

Conclusion, limitations and directions for future research

This study showcased several drivers and barriers to GMP execution in certain Indian manufacturing companies. These drivers and constraints were discovered after a thorough assessment of the literature review and extensive discussions with specialists. The list of selected drivers and obstacles was further rated with the assistance of a specialist's expertise. The ranking is done as per the scores assigned by experts after performing the necessary calculations. The scope of this study is constrained only to enterprises in India. The results of this study will help various existing or upcoming companies aiming to adopt GMP in India to identify the leading drivers and barriers beforehand and know their effectiveness. Companies will be able to construct a systematic step-by-step action plan using the rated criteria, which will decrease and eliminate the likelihood of failures in the execution of green manufacturing practices. Furthermore, the findings will be useful to academics doing future studies

in this sector. Furthermore, researchers can investigate new drivers and barriers and analyze them by considering a large group of experts and comparing their results with the present findings. Researchers can also develop a separate structured hierarchical model using these drivers and barriers and suggest solutions to implement GMP in organizations successfully. Further, it can be concluded from the results that mentioned factors in Tables 2 and 3 are potential drivers and barriers whose effectiveness can be compared as per their ranks. More such factors can be added through case studies or surveys conducted in targeted industries.

This study is confined to specific demography (i.e., India). It will be tough to apply findings from this study to different geography as there is a huge difference between the socio-economic conditions, business atmosphere, legislation, etc. Hence, a need for global research can be done but the challenge is to overcome the difference in various Social, Legal, and Business factors that are very diverse globally. The number of factors considered as Drivers and Barriers are limited as per the current manufacturing scenario but can increase due to more modernization in manufacturing practices and with the introduction of new technologies. Following are the research directions that will help researchers to proceed ahead in this field:

1. Researchers can investigate new drivers and barriers and analyze them by considering a large group of experts and comparing their results with the present findings.
2. Researchers can also develop a separate structured hierarchical model using these drivers and barriers and suggest solutions to implement GMP in organizations successfully.
3. More case-study-based research can be conducted in the same field by visiting a specific type of industry and analyzing the ground-level factors.
4. Researchers can restrict the factors to a specific niche of industry and perform a study on it.
5. Researchers can conduct surveys or interviews to find solutions to barriers in this study.

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Declarations

Conflict of interest The authors have no conflicts of interest to declare that are relevant to the content of this article.

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