WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Recognization and Priortization of Lean Six Sigma Barriers through Gray Relational Analysis from the Perspective of Manufacturing Sector

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ABSTRACT:

The proposed research aims to identify the barriers in the implementation of Lean Six Sigma (LSS) in the manufacturing industry. The research findings indicate several common barriers to LSS implementation in the manufacturing industry. These barriers include the lack of top management support, employee involvement, training, culture of resistance to change, and inadequate allocation of resources. The literature review reveals that these barriers can significantly hinder the successful implementation of LSS initiatives. Additionally, various surveys and studies conducted on LSS implementation in different contexts provide valuable insights into the challenges faced by organizations. The comprehensive analysis of the literature enables the identification and categorization of barriers based on their impact and severity. By adhering to rigorous research methodology and criteria for inclusion of research papers and articles, the research ensures the credibility and relevance of the findings. The findings of this research have practical implications for organizations seeking to implement LSS in the manufacturing industry. The identified barriers provide organizations with a better understanding of the challenges they may encounter during implementation. Furthermore, the identified LSS barriers prioritized by Gray Relational Technique.

Keywords: Barriers, Lean Six Sigma, Gray Relational Analysis

1. Introduction:

1.1 LEAN

Lean is an administration reasoning that spotlight on distinguishing and killing waste in all parts of a business (Aggogeri, 2014). The objective of lean is to make a more productive and compelling activity that can convey more worth to clients at a lower cost. Lean was created in the mid-1900s by Henry Portage, who spearheaded the idea of large-scale manufacturing (Singh & Rathi, 2019). Portage's sequential construction system framework upset assembling by considering the proficient creation of huge amounts of normalized items. During the 1980s, Japanese automakers, for example, Toyota started to embrace lean standards and practices (Prasad et al., 2016). Toyota's way to deal with lean, known as the Toyota Creation Framework (TPS), depended on the accompanying standards:

- Esteem: Distinguish the worth that clients put on items and administrations.
- Esteem stream: Distinguish every one of the means expected to convey worth to clients.
- Stream: Wipe out squander by making esteem stream flawlessly through the worth stream.
- Pull: Produce items and administrations just when clients request them.
- Flawlessness: Ceaselessly further develop the worth stream to dispense with squander.

Lean standards have been taken on by organizations of all sizes in different enterprises. Lean can be utilized to further develop fabricating, administration conveyance, and even government tasks (Ecology's, 2007).

1.2 Lean Tools and Techniques:

There are different strategies and apparatuses accessible to set lean standards in motion. The absolute most generally involved apparatuses and strategies in lean philosophy include recognizing and disposing of inefficient practices (Wang et al., 2016). Basically, lean offers a scope of approaches and assets to smooth out cycles and upgrade productivity by limiting pointless components (G. Yadav et al., 2018). The absolute most normal instruments include:

Value stream mapping: Value stream mapping is like making a point by point guide that assists us with understanding each and every step engaged with making an item or offering a support (Gholami et al., 2021). This assists with picturing the progression of work and distinguish regions where waste can be wiped out.

- **5S**: 5S is a strategy for coordinating and keeping a workspace in a spotless, productive, and coordinated way. This assists with further developing work process and decrease mistakes.
- **Kaizen**: Kaizen is a strong course of continuous improvement that effectively draws in each individual from the association. By including everybody, it develops a culture where ceaseless upgrade and inventive reasoning are esteemed and energized. Kaizen guarantees that every individual plays a part to play in distinguishing potential open doors for development and effectively adds to the aggregate advancement of the association.
- **Just-in-time (JIT):** JIT is a creation approach that underscores delivering labor and products definitively when they are required, without collecting overabundance stock. Like having a finely tuned framework guarantees we just make what is essential with flawless timing. By taking on JIT, we can fundamentally diminish costs related with unnecessary stock while at the same time working on by and large productivity. This strategy permits us to improve assets, smooth out tasks, and answer immediately to client requests, bringing about upgraded efficiency and a less fatty, more light-footed creation process.
- **Kanban:** Kanban is a visual framework for overseeing work that utilizations cards to flag when work is required. This assists with further developing stream and decrease bottlenecks.
- **Total productive maintenance (TPM):** TPM is a framework for working on the unwavering quality and proficiency of hardware. This assists with decreasing margin time and further develop efficiency.

Lean instruments and methods can be utilized to work on a wide assortment of cycles, from assembling to support conveyance (Wang et al., 2016). When utilized successfully, Lean can assist associations with working on their proficiency, quality, and benefit.

1.3 Benefits of Lean Tools and Techniques:

Lean devices and procedures carry various advantages to associations, enabling them to:

- Upgrade Proficiency: By disposing of waste and smoothing out processes, Lean empowers associations to work all the more proficiently.
- Work on Quality: Lean assists associations with upgrading their quality norms by lessening deformities and mistakes all through their tasks.
- Diminish Expenses: Lean guides associations in cost decrease by taking out squander and upgrading productivity.
- Support Consumer loyalty: Through diminished lead times, worked on quality, and reliable encounters, Lean drives expanded consumer loyalty.
- Increment Productivity: By lessening costs, working on quality, and upgrading consumer loyalty, Lean makes ready for further developed benefit.
- Upgrade Representative Resolve: Lean encourages a more proficient and useful workplace, eventually further developing worker confidence and commitment.

1.4 Executing Lean Approach:

Lean is certainly not a one-size-fits-all arrangement. The most ideal way to execute incline in a business will differ contingent upon the particular conditionsm (Gadekar, A. and Gadekar, 2014). Nonetheless, there are various general advances that can be followed:

- Identify the worth that clients put on items and administrations. This should be possible by directing overviews, meetings, and center gatherings.
- Identify every one of the means expected to convey worth to clients. This should be possible by planning the worth stream.
- Eliminate waste from the worth stream. This should be possible by utilizing lean devices and methods.
- Continuously further develop the worth stream. This should be possible by utilizing a cycle called kaizen

1.5 SIX SIGMA

Six Sigma, which was at first evolved by Motorola in 1986, is an assortment of business the executives strategies pointed toward upgrading the nature of items and administrations (Antony et al., 2005). It achieves this by recognizing and dispensing with deformities and changeability in assembling and business processes (Rathi et al., 2015). While carrying out Six Sigma, associations ordinarily focus their endeavors on further developing pivotal cycles that considerably affect their general presentation and monetary outcomes (V. Yadav et al., 2022). By applying the standards of Six Sigma, organizations

take a stab at greatness and endeavor to accomplish close flawlessness in their tasks, guaranteeing top notch results and limiting varieties that could prompt failures or blunders (Ben Ruben et al., 2017).

1.5.1 The Six Sigma Methodology

The Six Sigma methodology is built upon the DMAIC (Define, Measure, Analyze, Improve, Control) cycle, which serves as a structured problem-solving approach enabling organizations to identify and eliminate the root causes of defects.

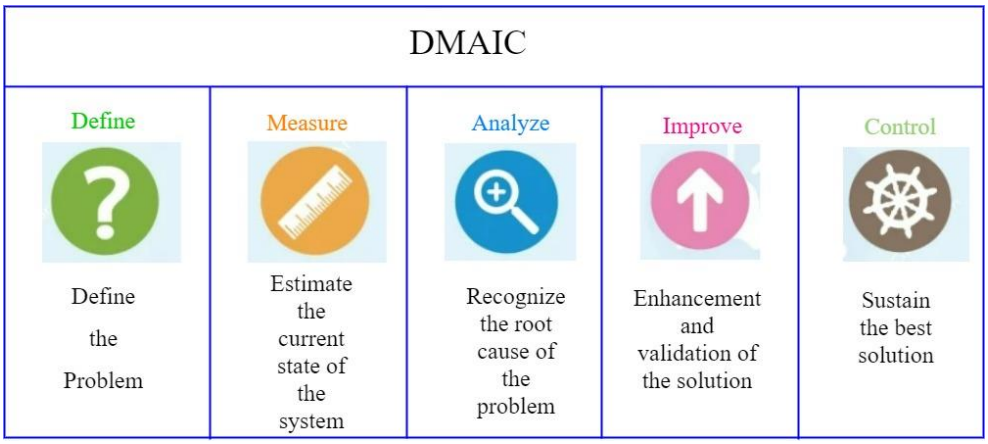

Figure 1.1: Six Sigma Methodology

Define: In the Define step, the group begins by obviously characterizing the issue they need to settle. They additionally find opportunity to comprehend their clients' expectation's and distinguish the basic perspectives that straightforwardly influence the nature of the item or administration.

Measure: The Measure step includes gathering information to survey the present status of the interaction. The group centers around estimating the basic angles distinguished in the past step. By utilizing factual procedures, they dive into the information to distinguish the basic reasons for the issue.

Analyze: In the Analyze step, the group fastidiously examines the information to distinguish the best answers for the central concern. They test various speculations utilizing measurable strategies and cautiously select the arrangement that holds the most noteworthy probability of accomplishment.

Improve: Continuing on toward the Further improve step, the group sets their distinguished arrangements in motion. They carry out the picked enhancements and intently screen the outcomes to guarantee their viability in resolving the issue.

Control: The Control step denotes the last phase of the DMAIC cycle. Here, the group lays out controls and measures to keep the issue from repeating. They additionally persistently screen the interaction to guarantee it reliably meets the client's prerequisites.

2. LITERATURE REVIEW

Albliwi, S.A., Antony, J. and Lim, (2015) provided a comprehensive review of the literature on Lean Six Sigma (LSS) as it applies to the manufacturing industry. The paper begins by providing an overview of LSS, including its history, philosophy, and key concepts. The authors then discuss the benefits of LSS for manufacturing companies, such as improved quality, reduced costs, and increased productivity. The paper also reviews the various tools and techniques that can be used to implement LSS in a manufacturing setting. Finally, the authors discuss the challenges of implementing LSS and provide recommendations for overcoming these challenges.

The paper concludes that LSS is a valuable tool for manufacturing companies that are looking to improve their performance. The authors argue that LSS can help companies to achieve significant improvements in quality, costs, and productivity. However, the authors also acknowledge that LSS is not a magic bullet and that it can be challenging to implement successfully. The authors provide a number of recommendations for overcoming the challenges of implementing LSS, such as providing adequate training, creating a supportive culture, and measuring the results of LSS initiatives. The paper by Siregar et al. (2019) is a valuable resource for manufacturing companies that are considering implementing LSS. The paper provides a comprehensive overview of LSS, its benefits, and the challenges of implementation. The authors also provide a number of recommendations for overcoming the challenges of implementation.

Wang et al., (2016) looked at 37 examination papers distributed somewhere in the range of 2000 and 2013 in driving and concentrated diaries, zeroing in on the subject of Lean Six Sigma (LSS). The goal is to assess the viability of LSS in further developing assembling execution and recognize regions where further examination is important to acquire a complete comprehension of its advantages and impediments.

The examination of these papers uncovers that LSS holds huge potential as a device for upgrading fabricating execution. The execution of LSS has reliably shown positive results, including eminent expense decreases, upgraded item quality, and expanded functional effectiveness. The writing likewise

features a different scope of LSS devices and procedures that can be utilized to drive enhancements in assembling tasks. It is vital to take note of that the best executions of LSS are those custom fitted to the particular requirements and qualities of every association.

Nonetheless, the exploration likewise distinguishes a few difficulties that can impede the fruitful execution of LSS. These difficulties incorporate factors, for example, deficient administration support, insufficient preparation of representatives, and ridiculous assumptions about the results of LSS drives. Conquering these difficulties is pivotal for opening the maximum capacity of LSS in assembling settings.

All in all, this study highlights the meaning of LSS in driving positive changes inside assembling activities. While the examination writing affirms the advantages of LSS, there are still holes in understanding that warrant further examination. Future exploration ought to zero in on investigating these holes to improve our insight into LSS and its possible applications in different assembling settings.

S. Mishra et al., (2017) presented an especially made and edifying examination that offers a broad framework of three specific ways of managing steady improvement: lean collecting, Six Sigma, and Lean Six Sigma (LSS). The makers proficiently explain upon the vital guidelines of every approach and give persuading examples regarding their productive application across various organizations. The makers effectively dive into an overall evaluation of these three techniques, including their specific resources and inadequacies. They reasonably highlight that the most sensible technique for a given association depends upon its specific necessities. In addition, the makers recognize the merciless necessities that drive ideal execution as a result of decisions made inside the picked approach's framework. Considering everything, the paper puts that LSS tends to the absolute most complete and convincing method for managing relentless improvement. By uniting the guidelines of lean gathering and Six Sigma, LSS offers an exact method for issue ID and objective. Different organizations have affirmed the ampleness of LSS in overhauling capability, quality, and advantage. It is very critical that a part of the models provided for frame the utilization of lean collecting, Six Sigma, and LSS may be dated. Furthermore, the paper doesn't contribute significant pieces of information or novel perspectives to the field of relentless improvement. Regardless, the paper's cautious assessment and thorough diagram go about as critical resources for perusers attempting to secure a more significant perception of these predictable improvement moves close.

Skawińska & Zalewski, (2018) crafted and informative piece that offers a thorough examination of the lean six sigma methodology and its potential impact on supply chain performance. The authors commence by providing concise introductions to lean and six sigma individually. Lean, as a management philosophy, centers on waste elimination and efficiency enhancement, while six sigma, as a data-driven quality improvement methodology, aims to minimize defects to an almost negligible level. Subsequently, the authors delve into the potential benefits derived from merging lean and six sigma, contending that these two approaches can mutually reinforce each other, resulting in substantial enhancements in supply chain performance.

Moreover, the authors present a compelling case study involving a manufacturing company that implemented lean six sigma. This case study vividly illustrates how the company achieved remarkable improvements in supply chain performance, notably cost reduction, heightened customer satisfaction, and increased profitability.

Antony et al., (2019) investigated by giving a succinct outline of Lean Six Sigma (LSS), which amalgamates Lean assembling and Six Sigma. Lean assembling incorporates an assortment of standards and practices pointed toward taking out squander and upgrading effectiveness, while Six Sigma is an information driven philosophy for quality improvement that endeavors to lessen imperfections to a pace of 3.4 per million open doors. Thusly, the creators present their created broadened DMAIC structure, which expands upon the ordinary five-step process: Characterize, Measure, Examine, Improve, and Control. Notwithstanding these means, their drawn out system consolidates two extra stages: Pre-Execution and Post-Execution. The Pre-Execution step involves assessing the current condition of the interaction and distinguishing the hidden reasons for issues, while the Post-Execution step includes checking the cycle to guarantee the supported adequacy of the carried out upgrades. To represent the use of the drawn out DMAIC structure, the creators present a convincing contextual investigation based on an Indian assembling association engaged with the development of Nut Chamber Heads (NCHs). The essential target of the venture was to decrease the event of imperfections. By using the lengthy DMAIC structure, the group effectively pinpointed the underlying drivers of imperfections and carried out designated enhancements. Thus, the quantity of imperfections was decreased by a noteworthy 90%, prompting cost reserve funds of $250,000 for the association.

Finishing up their paper, the creators talk about the functional ramifications of their discoveries. They affirm that the drawn out DMAIC system can be successfully utilized to further develop processes across different businesses. Moreover, they underline that the system can possibly improve representative spirit, correspondence, housekeeping, and dynamic abilities.

Venkatesh et al., (2020) used of a half and half structure to work with the execution of Lean Six Sigma (LSS) in an assembling organization. The system consolidates the joined use of fluffy logical pecking order process (AHP) and PROMETHEE II. Fluffy AHP is utilized to assess the general loads of the obstructions related with LSS, while PROMETHEE II guides in focusing on the answers for address these hindrances.

The review provides details regarding the results of a contextual analysis wherein the half breed structure was utilized to execute LSS in an assembling organization. The outcomes showed that the half breed structure really worked with the execution of LSS and added to the upgrade of the organization's presentation.

The paper is handily composed and coordinated. The creators give an unmistakable and compact outline of the LSS strategy, as well as the fluffy AHP and PROMETHEE II techniques. They likewise offer an exhaustive portrayal of the cross breed system and present nitty gritty discoveries from the contextual investigation.

The paper makes a prominent commitment to the current writing on Lean Six Sigma and the usage of mixture structures in hierarchical change. The discoveries have down to earth suggestions for professionals and specialists keen on carrying out LSS inside assembling organizations.

In any case, there are a couple of restrictions to think about in this paper. First and foremost, the contextual investigation was directed exclusively inside a solitary assembling organization, bringing up issues about the generalizability of the discoveries to other comparable organizations. Furthermore, the paper doesn't dive into the expense ramifications of executing the half breed system, which could be a critical component for certain organizations to consider.

Kaswan, M.S., & Rathi, (2021) examined the significance of Lean Six Sigma (LSS) for little and medium-sized ventures (SMEs) in India. LSS is a bunch of the board methods of reasoning and practices that can assist SMEs with working on their quality, efficiency, and benefit.

The creators recognize a few impediments to executing LSS in SMEs, for example, restricted monetary assets, deficiency of talented representatives, absence of the executives support, and deficient familiarity with LSS. To beat these boundaries, the creators recommend utilizing different systems. These incorporate looking for monetary help from government offices or different sources, preparing representatives in LSS procedures, teaching the board on supporting LSS execution, and bringing issues to light of LSS among workers and clients. These systems expect to work with effective LSS reception and execution in SMEs.

Gahlot & Yadav, (2022) The paper starts with a brief prologue to Incline Six Sigma (LSS), which incorporates an assortment of the board standards and practices pointed toward upgrading quality, diminishing expenses, and increasing consumer loyalty. The creators further dig into the meaning of LSS in Indian assembling enterprises, which face elevated contest from worldwide partners.

To acquire bits of knowledge into the execution of LSS in Indian assembling businesses, the creators directed an extensive writing survey. They carefully dissected 32 appropriate investigations distributed somewhere in the range of 2000 and 2016. The goal was to assess the viability of LSS execution regarding different execution pointers, including quality, cost, and consumer loyalty.

The discoveries of the survey uncovered that the execution of LSS can yield significant upgrades in execution inside Indian assembling businesses. The examinations uncovered normal enhancements of 20% in quality, 15% in cost decrease, and 10% in consumer loyalty. Regardless, the creators noticed that the adequacy of LSS execution changed in light of the particular business and the methodology took on for execution.

All in all, the creators underscored the worth of LSS as a significant device for supporting execution in Indian assembling businesses. Nonetheless, they likewise recognized that LSS execution doesn't ensure general achievement and highlights the significance of careful preparation and execution for ideal results.

Sharma & Dash (2022) investigated the impacts of executing Lean Six Sigma (LSS) on the functional execution of Indian assembling firms. To research this, the creators gathered information from an example of 100 firms and utilized an underlying condition model to investigate the connections among LSS execution, functional execution, and firm qualities.

The review's discoveries uncovered a positive effect of LSS execution on functional execution, explicitly regarding quality, conveyance, and cost. Besides, the creators found that the impact of LSS was more articulated in firms with more significant levels of representative contribution and a steady hierarchical culture.

This study contributes altogether to the current writing on LSS in more ways than one. Right off the bat, it gives experimental proof of LSS's constructive outcomes on functional execution inside a non-industrial nation setting. Furthermore, it distinguishes worker contribution and authoritative culture as urgent elements that moderate the effect of LSS. In conclusion, it offers experiences into the components through which LSS can improve functional execution.

Notwithstanding its important commitments, the review has a few restrictions. The example, first and foremost, size is moderately little, which might influence the generalizability of the discoveries. Also, the information gathered is cross-sectional, restricting the capacity to lay out causal connections. Finally, the review doesn't represent different variables that might actually impact functional execution, for example, the usage of other improvement devices or the particular business in which the organizations work.

Katoozian & Zanjani (2022) examined the adoption of Lean Six Sigma (LSS) in small and medium-sized manufacturing enterprises (SMEs) in India. The authors posit that implementing LSS can lead to enhanced performance for SMEs by reducing costs, enhancing quality, and increasing efficiency.

To investigate this, the authors conducted a case study on an Indian manufacturing SME that implemented LSS. The company utilized various LSS tools and techniques such as value stream mapping, process analysis, and kaizen. Additionally, the company embraced cultural changes that emphasized continuous improvement and employee empowerment.

The findings of the case study revealed substantial improvements in the company's performance following the LSS implementation. The company successfully reduced costs by 20%, improved quality by 15%, and increased efficiency by 10%.

In conclusion, the authors emphasize the value of LSS as a beneficial tool for SMEs seeking performance enhancements. However, they caution that LSS is not a magical solution and necessitates a strong commitment from management and employees alike.

Singh et al., (2023) presented an efficient survey of the writing to look at the difficulties looked by little and medium-sized assembling endeavors (SMEs) in India while carrying out lean six sigma (LSS). The writers directed a careful inquiry across four information bases and distinguished 27 pertinent articles for their examination.

The creators recognized a few normal hindrances experienced by Indian SMEs during LSS execution. These boundaries incorporated an absence of responsibility from top administration, inadequate representative preparation and understanding, asset requirements, protection from change, nonattendance of a reasonable vision and technique, ineffectual coordination and correspondence, and the shortfall of an estimation and input framework.

On the other hand, the creators likewise featured key achievement factors related with LSS execution in Indian SMEs. These elements included solid initiative and responsibility from top administration, exhaustive preparation and understanding for representatives, sufficient asset distribution, a clear cut vision and methodology, successful coordination and correspondence, as well as the foundation of an estimation and input framework.

By tending to the recognized boundaries and embracing the achievement factors, Indian SMEs can improve the probability of a fruitful LSS execution. This approach will cultivate a culture of ceaseless improvement and empower them to accomplish functional greatness.

2.2 Objectives of Present Work

- To recognize Lean Six Sigma Performance improvement barriers in the manufacturing environment
- To rank these barriers by Grey Relational Analysis Technique.
- To discuss removal actions for these barriers.

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3. IDENTIFICATION OF LSS BARRIERS METHODOLOGY ADOPTED

3.1 Identification of Lean Six Sigma barriers

The effective execution of the LSS approach is hindered by some factors, called barriers to LSS. So, to cope with this, we identified 10 barriers (refer to Table 1) that can be proved to be the hindrance.

Table 3.1: Lean Six Sigma barriers in the context of Manufacturing Environment

No.	Name of the Barrier	Description of the barrier	Reference
BR1	Culture of resistance to change	While implementing any process, training plays the most important part and for this fund is very important	(Saumyaranjan Sahoo, 2017)
BR2	Lack of process thinking and the ownership of the process	It is an imperative issue and thus it is one of the barriers to the LSS implementation	(Dora et al., 2016)
BR3	Lack of top management support	Sometimes the management makes themselves satisfied with the current quality system just because of the wiriness and uncertainty of the new process implementation	(Singh et al., 2021)
BR4	Lack of resources	For the implementation of any process the management plays a vital role	(Saumyaranjan Sahoo, 2017)
BR5	Lack of training	To implement any new system, the old systems are needed to be modified and sometimes the authority have some doubts to modify the existing process	(Farias et al., 2019)
BR6	Lack of employee involvement	Sometimes the new process implementation may be costly due to which the organization tries to avoid any modification	(G. Yadav et al., 2018)
BR7	Insufficient resources	Any new process requires some resources viz., manpower, human, machines, etc. This may act as one of the barriers to LSS implementation	(Hussain et al., 2019)
BR8	Lack of consultants in the field	LSS implementation requires an expert who knows about its implementation process and the need of the organization	(Shamsi & Alam, 2018)

BR9	Lack of a clear vision and strategy	The different departments are working on a process, then clarity among the department is very important	(Yusup et al., 2016)
BR10	Time constraint	The LSS implementation is a time-consuming process so one has to be patient while implementing the process	(Mangla et al., 2017)

Methodology Adopted

The present study consists of a one-stage methodology in which the first step is to identify the barriers to the implementation of LSS in SMEs. Then further a questionnaire is built which is answered by the industry and academic experts. The second stage is the prioritization of the barriers by using Grey Relational Analysis (GRA). Figure 4.1 depicts the adopted research methodology.

In the first phase of the research, we identified the various barriers to manufacturing sector in the Indian sector through a detailed analysis of the various papers and research that has been conducted by the various scholars in this field and came out with the 19 barriers as described in section 3. After the identification of the barriers, a questionnaire was developed which was then sent to the various experts of the industry, scholars, academicians, and professionals (both at a mid and high level of the sectors) working in the different manufacturing sector of India. This questionnaire was established based on a rating from 1 to 5 in which 5 was marked as the strongest barrier which should be given first preference first while 1 being the weakest barrier and should be the least preference. First, about 220 manufacturing experts of Indian industries were approached through email, mobile, and personnel visits to describe the LSS concept in an organization. After a long discussion with the team, 130 out of 220 industrial experts have shown their interest in this study. So, 130 questionnaires were received, and out of that 110 were further selected for analysis. Correspondingly, seven academicians out of 20 decided to dispense their feedback. All professionals having vast experience of more than 17 years in their domain were selected. To validate this questionnaire purposive sampling technique has been used in the present study. Moreover, after studying the problem and discussing it with the decision-maker team, the GRA technique was presented.

Table 4.1: Demographic statistics of respondents

S. No.	Work profile	Number of People	Average Experience	Industry/Academia
1	Senior Manager	35	30	Industry
2	Manager	30	23	Industry
3	Deputy Manager	25	22	Industry
4	Senior Engineer	15	19	Industry
5	Academicians	11	18	Academia

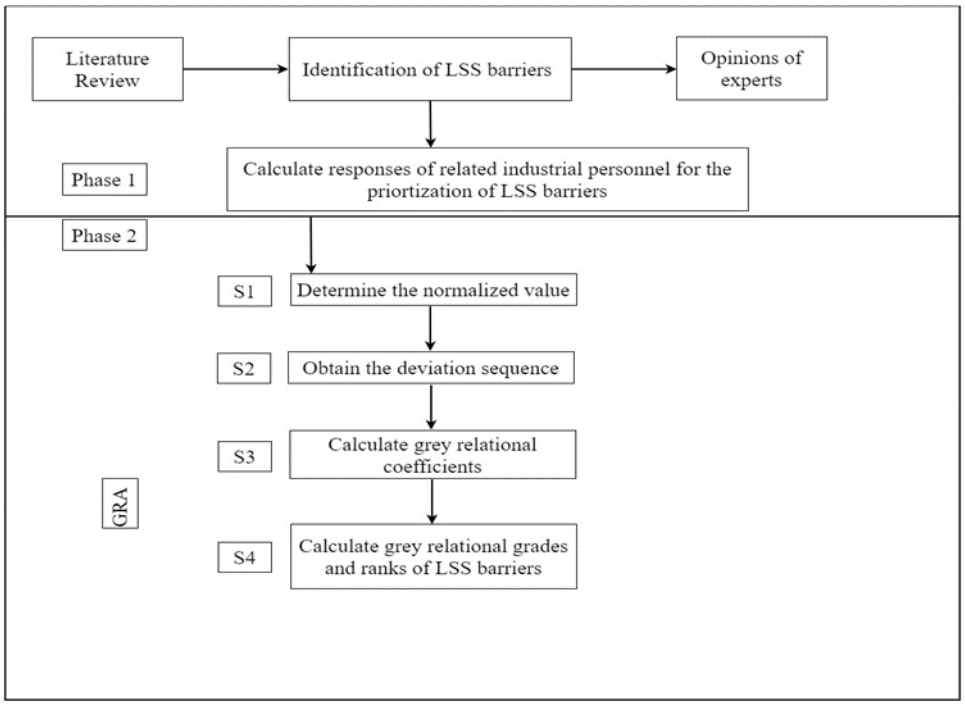

Figure 4.1: Research Methodology

GRA Technique:

Grey Relational Analysis (GRA) is a is a strategy that is utilized for frameworks that are dubious and fragmented. This specific strategy helps in acquiring the correlational position by examining the info factors and the result factors. This technique is broadly utilized in different fields as it requires no severe consistence with specific measurable regulations or any straight relationship among the articles or factors (Han et al., 2017). It doesn't help in giving the best arrangement yet helps in inferring or deciding the methods that can give us the best answers for tackle the issue which helps in taking care of the issues of this present reality. This strategy was first purposed by Deng Hotel 1989 (Ju-Long, 1982) and the main methodology is to change over every one of the options into the succession according to similarity. This succession is shaped a reference grouping is characterized which would be the objective arrangement (Kuo et al., 2008).

After the obstruction distinguishing proof and poll improvement, the need of the boundaries is finished through the GRA examination which would assist the SMEs with knowing which boundary they are expected to zero in on in the underlying phase of the LSS system execution in the firm. The means of GRA are as per the following:

Stage 1: Decide the standardized worth

The initial step is to standardize the information that we has collected with the assistance of specialists in the association. The reactions from the master 'o' on boundaries 'I' are summarized and are meant by 'Aio'.

Aio=(Aio-minAio)/(maxAio-minAio) (1)

We has taken the assessment and according to the reaction of the modern faculty which incorporates administrators (M), engineers (E), partner engineers (AE), and bosses (S) who has worked in these ventures. Table 3 portrays reactions from modern workers.

Table 5.1: Responses from Industrial employees

S. No.	Barriers	M	E	AE	S
1	BR1	25	31	24	29
2	BR2	27	30	34	35
3	BR3	32	27	27	30
4	BR4	31	30	30	28
5	BR5	42	30	29	40
6	BR6	30	32	27	25
7	BR7	33	36	40	43
8	BR8	28	32	32	35
9	BR9	35	40	32	28
10	BR10	30	35	32	44

Step 2: Obtain the deviation sequence

In this step of GRA, the deviation sequence (Δ) is obtained with the help of equation (2), Table 4 presents the calculated deviation sequence.

$\Delta = \max A' - A'$ (2)

Table 5.2: Calculated deviation sequence

Barriers	M	E	AE	S
BR1	1	0.307692	0	0.210526
BR2	0.882353	0.230769	0.625	0.526316
BR3	0.588235	0	0.1875	0.263158
BR4	0.647059	0.230769	0.375	0.157895
BR5	0	0.230769	0.3125	0.789474
BR6	0.705882	0.384615	0.1875	0
BR7	0.529412	0.692308	1	0.947368
BR8	0.823529	0.384615	0.5	0.526316
BR9	0.411765	1	0.5	0.157895
BR10	0.705882	0.615385	0.5	1

Step 3: Calculate Gray relational coefficients

In the third step, the Gray relational coefficients (K_{io}) are determined by using equation (3). Here $min(\Delta)$ designates the minimum value of the deviation sequence and $max(\Delta)$ depicts the maximum value of the deviation sequence. K value is taken as 0.5. Table 5 depicts Gray relational coefficients.

$$K_{io}=\frac{min(\Delta)+kmax(\Delta)}{\Delta io+kmax(\Delta)} \quad (3)$$

Table 5.3: Gray relational coefficients

Barriers	M	E	AE	S
BR1	0.333333	0.619048	1	0.703704
BR2	0.361702	0.684211	0.444444	0.487179
BR3	0.459459	1	0.727273	0.655172
BR4	0.435897	0.684211	0.571429	0.76
BR5	1	0.684211	0.615385	0.387755
BR6	0.414634	0.565217	0.727273	1
BR7	0.485714	0.419355	0.333333	0.345455
BR8	0.377778	0.565217	0.5	0.487179
BR9	0.548387	0.333333	0.5	0.76
BR10	0.414634	0.448276	0.5	0.333333

Step 4: Calculate the Gray relational grades and rank of LSS barriers

In the fourth step of GRA analysis, grey relational grade (Y_{io}) is calculated by using equation (4),

$$Y_{io}=1/n\sum_{1}^{n} Kio \qquad (4)$$

Here 'n' is the number of respondent groups in the case industry. In our case, it is 8. The grey relational grade is formed and then from that data, we will define the rank of the barriers. Table 6 presents Gray relational grades and rank of LSS barriers.

Table 5.4: Gray relational grades and rank of LSS barriers

Barriers	GRG	Rank
BR1	0.332011	4
BR2	0.247192	7
BR3	0.355238	1
BR4	0.306442	5
BR5	0.335919	3
BR6	0.338391	2
BR7	0.197982	10
BR8	0.241272	8
BR9	0.267715	6
BR10	0.21203	9

Conclusions

The examination on obstructions to Incline Six Sigma execution in the assembling business has been broad. Various investigations have distinguished a few obstructions that associations ordinarily face, including:

1. Lack of top management support: Without help from top administration, it becomes testing to get the important assets and responsibility for a fruitful Lean Six Sigma program.
2. Lack of employee involvement: Dynamic representative cooperation is essential for the progress of Lean Six Sigma. Representatives should be taken part all the while and view it as a chance to work on their work and add to the general outcome of the organization.
3. Lack of training: Viable preparation in Lean Six Sigma apparatuses and strategies is critical for representatives to proficiently use them. Without appropriate preparation, the devices can't be successfully applied, prompting fruitless results.
4. Culture of resistance to change: Numerous Indian manufacturing have a culture that opposes change, making it challenging to carry out new projects like Lean Six Sigma. Representatives might be reluctant to alter their laid out rehearses and impervious to embracing groundbreaking thoughts.
5. Lack of resources: Executing Lean Six Sigma can be asset serious, incorporating costs for preparing, apparatuses and programming, as well as representative time and exertion.
6. Lack of a clear vision and strategy: An unmistakable vision and technique are fundamental for effective Lean Six Sigma execution. They guarantee that the program is lined up with the right objectives and is executed in a viable way.

The examination on obstructions to Incline Six Sigma execution has given important experiences into the difficulties looked by assembling associations. These experiences can be utilized to assist associations with defeating these boundaries and accomplish effective Lean Six Sigma execution.

Notwithstanding the previously mentioned hindrances, a few different variables can add to the achievement or disappointment of Lean Six Sigma execution, including:

- The degree of responsibility from top administration
- The degree of worker commitment
- The nature of preparing gave
- The accessibility of assets
- The arrangement of Lean Six Sigma with the association's general objectives

Executing Lean Six Sigma effectively requires a cooperative exertion from all levels of the association. By grasping the difficulties and taking into account the variables that add to progress, associations can upgrade their possibilities receiving the rewards of Lean Six Sigma.

All in all, the fruitful execution of Lean Six Sigma in associations requires tending to and conquering different difficulties. These hindrances incorporate deficient help from top administration, restricted contribution of representatives, insufficient preparation and instruction, asset imperatives, protection from change inside the hierarchical culture, ill-advised project choice, lacking estimation and following of results, absence of compelling correspondence, inadequate change the executives, and muddled measurements and targets.

Prior to carrying out Lean Six Sigma, associations frequently face troubles, for example, an absence of mindfulness or confidence in its advantages among top administration, workers having restricted information and inspiration, deficient assets, protection from change inside the organization's way of life, ill-advised project determination, nonappearance of legitimate outcome estimation, unfortunate correspondence, lacking change the executives plans, and unclear measurements and targets.

In any case, the presentation of Lean Six Sigma can assist with defeating these difficulties. By getting responsibility and backing from top administration, associations can guarantee the designation of important assets and cultivate a culture that is prepared for change. Giving complete preparation and training to representatives outfits them with the information and abilities expected to actually use Lean Six Sigma instruments and strategies. In addition, executing clear measurements, adjusting project choice to hierarchical objectives, laying out powerful correspondence channels, and utilizing productive change the executives techniques all add to the progress of the program.

By tending to these difficulties and carrying out Lean Six Sigma, associations can encounter huge changes. Top administration responsibility prompts the arrangement of assets and backing, while worker association and preparing foster inspiration and limit with respect to progress. Satisfactory assets work with the smooth advancement of activities, and a versatile authoritative culture supports acknowledgment of progress. Clear measurements and targets guide project concentration and feature the advantages of the program. Through compelling correspondence and change the board, associations guarantee consistent advances and gain worker purchase in.

By recognizing and defeating these difficulties, associations can effectively carry out Lean Six Sigma and receive its rewards, including worked on functional execution, upgraded item quality, smoothed out processes, expanded consumer loyalty, and generally speaking hierarchical achievement.

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