Ranking of Identified Barriers in Implementation of Six Sigma in Indian Industries

Mahadev Naik[1], Usama khan [2], Asad-Ali Mukadam [3], Farid Kazi [4], Naved Nakhwa [5],

[1] *Prof. Mahadev Naik ,Mechanical Engineering Dept & Finolex Academy Of Management & Tech, Ratnagiri, India.*
[2] *Usama khan,Mechanical Engineering Dept & Finolex Academy Of Management & Tech, Ratnagiri, India*
[3] *Asad-Ali Mukadam,Mechanical Engineering Dept & Finolex Academy Of Management & Tech, Ratnagiri, India*
[4] *Farid Kazi,Mechanical Engineering Dept & Finolex Academy Of Management & Tech, Ratnagiri, India*
[5] *Naved Nakhwa,Mechanical Engineering Dept & Finolex Academy Of Management & Tech, Ratnagiri, India*

--***---

Abstract - From last decade, six sigma is a primary statistical tool for process improvement and also quality improving techniques. The main aim is to study the six sigma methodology and the barriers affecting its implementation and finding solutions to this barrier in Indian MSMEs. This study proposes a composite framework using Modified Step-Wise Weight Assessment Ratio Analysis (SWARA). The SWARA is used to determine the factors (i.e. barriers) weightings. Which recognize the six sigma barriers and to prioritize the barriers in six sigma implementation. As this methods is among the recent member of Multi-Criteria Decision Making (MCDM)-family and have found its approach in straighten out number of MCDM problems. Stepwise Weight Assessment Ratio Analysis (SWARA) method- SWARA is a Simplistic and less monochrome method as compared with other MCDM methods .The judgement of SWARA method is based on expert's capability and experience. This method considers the facts that one attribute is of higher or lower significance than other attributes .This method finds significance ratio of attributes for making decisions. This Study may give remarkable statute to the decision-makers and domain experts to build up their arrangement of organizational activity for short terms as well as for the long haul for MSMEs in implementing six sigma in Indian Industries. Barriers were prioritise and then ranked by using SWARA method.

*Key Words***:** Six sigma, Barriers, MCDM and SWARA.

INTRODUCTION

For the organizations to improve the capability of their business six Sigma provides various tools. After implementing Six Sigma there can be seen increase in performance and decrease in process variation. The main objective of Six Sigma is to reduce the defects and improve the profits. It also increases employee morale and quality of services or products that company is providing. Continuous improvement and development should be the main objective of the company and six Sigma can help in achieving this objective. To identify and eliminate the defects Organizations should focus on the performance characteristics of business. This defects can be of critical importance to the customers. To increase the profits organizations should optimize their operations and improve the quality. This is a business strategy that helps organization in continuous development. By understanding needs of customers through this work philosophy commercial success can be achieved, maximized and maintained. While virtually

eliminating all the internal deficiencies delivering the top quality products and service is known as embarking on six Sigma. Any company that is delivering a product or service can implement six sigma. Rather than just a quality initiative Six Sigma is an overall business improvement initiatives. To bring awareness and interest in this breakthrough methodology the issues faced by MSMEs in manufacturing sector should be studied and addressed. Solutions should be found out for the issues and the factors that are acting as barriers that are faced by MSMEs. Most of the companies do not have a well action planed for implementing Six Sigma. There is also lack of awareness among them about the benefits of implementing it. SWARA method helps here to priorities and rank those barriers listed by company. This article consists of three phase methodology. In the first phase the barriers that affect the implementation of Six Sigma were identified. In the second phase this barriers were categorized and solutions were found out. In third phase this barriers were evaluated using SWARA method. This study may help the field experts to know the ranking of their barriers according to their significance and help them overcome this and easy implementation of Six Sigma.

Through literature survey 12 most sighted barriers were prioritized and then barriers were further categorized into 4 main categories which were organizational barriers (OB) implementation barriers (IB) skills required (SR) and financial barriers (FB).Each main categories further had 3 sub barriers which are:

Table - 1 : Identified barriers

OB1 -lack of top management support.
OB2-insufficient organization alignment
OB3-lack of organizational infrastructure
IB1-poor six sigma project selection
IB2-wrong identification of process parameters
IB3-poor handling of six sigma tools.
SR1-lack of trained professionals
SR2-poor awareness of six sigma

SR3-lack of education and training

FB1-lack of resources

FB2-lack of estimation of executing cost

FB3-cost required for special training

LITERATURE SURVEY

Six sigma implementation includes numerous monetary and operational issues, which ultimately decide its efficiency and execution of it. A basic examination of the factors influencing six sigma implementation can provide helpful data to decision-makers. This section discusses available literature on barriers and its solution to implement six sigma, the research frameworks used to prioritize the barriers which are to be tackled first to implement six sigma in MSME.

Review of six sigma barriers and their solutions

Knowledge of barriers is essential before six sigma implementation. From the analysis of literature, several articles were found that studied barriers to implementing six sigma across the globe.

[1] Himanshu Prajapati , Ravi Kant , Ravi Shankar (2019)_ Prioritizing the solutions of reverse logistics implementation to mitigate its barriers: A hybrid modified SWARA and WASPAS approach_ in this paper ,author have explained about MCDM techniques SWARA ,WASPAS in detail, it's steps-procedure to do and its importance and how to rank barriers as per weighed global values.

[2] Raghunath A, Dr. Jayathirtha R V (2013)_Barriers for implementation of Six Sigma by Small and Medium Enterprises Barriers to implementation of Six Sigma by Small and Medium Enterprises _According to author the SMEs to be globally competitive and cost-effective they should employ six Sigma methodologies to improve efficiency and effectiveness. Concepts of six Sigma are equally applicable for both small scales and OEMs. There are limitations to six Sigma implementation for small scales. These main barriers are due to a lack of knowledge and improper understanding of six Sigma.

[3]Ghaith M. Al-Abdallah(2008)Barriers to Six Sigma implementation in Chinese small and medium steel enterprises investigate 5 major barriers in the Chinese small-scale industry from this paper found that the external barriers include the environment and the nature of Six Sigma itself. The environment is another aspect that blocks Chinese small and medium steel enterprises from implementing Six Sigma. The overall low employee educational levels found in China suggest that it can be difficult for these enterprises to train their employees in Six Sigma knowledge. Another external barrier is the nature of the Six Sigma methodology which required a long period before the enterprise can see actual results. Mohamed

[4] Gamal Aboelmaged (2010)_Reconstructing Six Sigma barriers in manufacturing and service organizations _ identifies the most influential barriers to Six Sigma implementation measures the relative importance of these barriers and examines how the effectiveness of these barriers may vary in relation to dimensions of specific organizational factors.

[5] Rhonda L Hensley, Kathryn Dobie (2005) _Assessing readiness for six sigma in a service setting _ the proposed model is applied in an urban public transit company. The application includes an analysis of the transit company's readiness for six sigma, the design and administration of a survey to identify perceptual differences between customers and the organization and the statistical analysis of the survey. The survey analysis is then used to identify differences in perceptions between service employees and customers. These differences provide the basis for the development of a process improvement that employees should be able to undertake.

[6] Jiju Antony (2009) _Six Sigma in the Indian software industry _ some observations and results from a pilot survey _ This paper begins with a review of literature on Six Sigma and its role in the software industry, followed by the importance of Six Sigma in the software business and finally the presentation of results from an empirical investigation of Six Sigma in the Indian software industry.

[7] Martin brikett wai ming Cheung (2008) _Identifying the barriers behind lack of use of six Sigma _ author highlighted 4 major barriers. This paper includes investigations of barriers while implementing six sigma in LMCs. These findings will be used together with the outcomes of the literature review to develop a questionnaire for distribution to LMCs to obtain the quantitative data and then this data will be used to develop a framework for implementation of six Sigma in LMCs to improve the quality and competitiveness of such companies.

[8] Taina Savolainen, Arto Haikonen (2007) _ Dynamics of organizational learning and continuous improvement in six sigma implementation _ author suggested 2 important barriers according to him. The findings suggest that the learning process is characterized by measurement, detection and correction of errors, and cost reduction. In six sigma implementation, learning is a single-loop type of learning. It is an incremental change process that reminds a technical variant of the learning organization. Continuous improvement occurs through procedural practices (the DMAIC-cycle) which forms a structure for sustaining learning.

[9] Mohamed Gamal Aboelmaged (2010) _ a structured review and implications for future research_A number of key findings emerged: Six Sigma research is growing rapidly, covering various disciplines and domains with a great focus on Six Sigma tools and techniques; empirical research is dominant with more emphasis on the case study approach, and the growing gap between manufacturing- and service-focused

articles implies the return of Six Sigma to manufacturing as its initial base. Although a large volume of literature is available on Six Sigma, the topic is still under development and offers potential opportunities for further research and applications.

[10] Jiju Antony(2008) _Can Six Sigma be effectively implemented in SMEs? _ the results of the study clearly indicate that Six Sigma is equally applicable to both large corporations and small companies. In fact, the results are quicker and much more visible in smaller companies than in larger corporations.

[11]Tony Bendell(2006) _ A review and comparison of six sigma and the lean organizations _The paper contends that the current literature on the compatibility and combination of six sigma and lean is limited and disappointing when examined for a common model, theoretical compatibility or mutual content or method, but that they can be effectively combined into one system.

[12] Andrew Thomas, Richard Barton, Chiamaka Chuke-Okafor (2009) _ Applying lean six sigma in a small engineering company _ a model for change_authers investigate few barriers. This paper proposes an integrated approach to the six sigma model. Its development, refinement and implementation have been achieved through working closely with a subject company. The effectiveness of the approach is consequently evaluated highlighting the benefits the host organization received through this new approach by measuring the effects of implementation against internal company measures.

METHODOLOGY

This paper part presents the proposed research methods used to recognize the six sigma barriers and to prioritize the barriers to six sigma process implementation. The Modified SWARA is used basically to determine the factors i.e. barriers weightings as per experts ratings given. SWARA has gained tremendous attention for solving various problems such as corporate responsibility and training and awareness factors and product designing. SWARA is integrated with different problem solving as it is Multi Criteria decision making technique(MCDM).MCDM method are the most accurate in all trending techniques.

Modified Stepwise Weight Assessment Ratio Analysis (SWARA) method; SWARA is a trending and more accurate method as compared with other MCDM methods. The decision of SWARA rating is based on expert's knowledge and experience. This method considers the facts that one barriers is of higher or lower significance than other barriers. This method search significance ratio of ratings for taking decisions. The following is proposed 5 steps to find the relative weights of the following barriers. Step 6 is added as for modification to the conventional SWARA method.
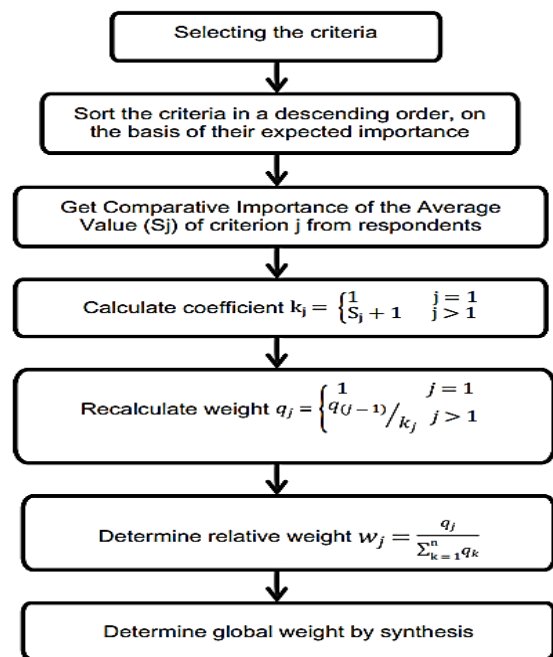

Fig - 1: SWARA Steps

The steps are given below.

Step 1: Sort the barriers in a descending order, on the basis of their significance impact importance based on literature review.

Step 2: Secondly barriers, and their relative significance of the criterion j w. r to the early (j-1) barriers was expressed by the reading and similarly for each single barriers. This ratio is termed as the Comparative Importance of the Average Value, sj .

Step 3: The coefficient kj is determined as follows.

$$k_j = \begin{cases} 1 & j = 1 \\ Sj + 1 & j > 1 \end{cases} \qquad (1)$$

Step 4: The recalculated weight qj is determined as follows:

$$qj = \begin{cases} 1 & j = 1 \\ q_{(j-1)}/k_j & j > 1 \end{cases}$$

(2)

Step 5: Determine the Relative weights of the evaluation barriers as follows:

$$w_j = \frac{q_j}{\sum_{k=1}^{n} q_k} \qquad (3)$$

Where wj represents the relative weight of the jth criterion, and n represents barriers number.

Step 6: The wj value obtained for major category is multiplied with their individual sub category wj values and a new global wj value for each individual factor is obtained. This will show the effect of major category into their sub-category. The number of weight for each barriers will be equal to as many experts weights. Then geometric mean of Global wj is calculated. The ranking of barriers is made based on this mean global wj values.

After categorizing the barriers they were sorted into descending order on the basis of their significance impact and importance through literature survey. The relative significance of the barriers with respect to previous (j-1) barriers was given by experts for main categories and each sub categories. Table 2 shows the relative weights given by three experts.

Table - 2: Relative Importance by Experts

Barriers	Sj1 (expert 1)	Sj2 (expert 2)	Sj3 (expert 3)
Main Criteria			
Organizational barriers (ob)	0	0	0
Implementation barrier (ib)	0.95	0.85	0.9
Skills required (sr)	0.9	0.95	0.95
Financial barriers (fb)	0.85	0.8	0.8
Sub criteria			
Lack of top management support : OB1	0	0	0
Insufficient organizational alignment : OB2	0.9	0.85	0.9
Lack of organizational infrastructure : OB3	0.8	0.7	0.75
Poor six sigma project selection : IB1	0	0	0
Wrong identification of process parameters : IB2	0.8	0.85	0.85
Poor handling of available six sigma tools. : ib3	0.75	0.7	0.75
Lack of trained professional : SR1	0	0	0
Poor awareness about six sigma : SR2	0.7	0.75	0.75
Lack of education and training : SR3	0.8	0.85	0.8
Lack of resources : FB1	0	0	0
Lack of estimation of execution cost : FB2	0.75	0.7	0.75
Cost required for special training : FB3	0.8	0.85	0.85

Table - 3: Calculation of Wj for major barriers

	Calculation of major criteria				
S.N	**Major Criteria**	**S_j**	**$K_j = S_j + 1$**	**q_j**	**w_j**
1	OB	0.00	1.00	1.0000	0.5185
2	IB	0.95	1.95	0.5128	0.2659
3	SR	0.90	1.90	0.2699	0.1399
4	FB	0.85	1.85	0.1459	0.0756
					1.9286

Relative weights for both the categories was calculated using the equation (3). Then relative weight of main categories is multiplied by relative weight of each categories to get the global weight. This global weight is termed as E1. This calculations are repeated for each experts.

Table - 4: Global Weight Calculation

Major Criteria	Relative Weight	Sub-criteria	Relative Weight	Global Weight
	0.5185	OB1	0.5498	0.2851
	0.5185	OB2	0.2894	0.1501
	0.5185	OB3	0.1608	0.0834
	0.2659	IB1	0.5389	0.1433
	0.2659	IB2	0.2966	0.0789
	0.2659	IB3	0.1695	0.0451
	0.1399	SR1	0.5222	0.0731
	0.1399	SR2	0.3072	0.0430
	0.1399	SR3	0.1706	0.0239
	0.0756	FB1	0.5294	0.0400
	0.0756	FB2	0.3025	0.0229
	0.0756	FB3	0.1681	0.0127

RESULT & DISCUSSION

The modified SWARA technique made it progressively, deliberate and supportive for the management to see the ranking and accordingly plan their implementation. Organizing the barriers made it increasingly consistent and helpful for management.

After calculating E1, E2 and E3 geometric mean of that values was calculated. Based on this values ranking was assigned to this barriers. This barriers were sorted in descending order previously. After assigning the rankings of these barriers using geometric mean it was observed that OB organizational barrier has highest weightage Followed by IB SR and FB. Ranking of the sub barriers is provided in the adjacent coloumn. The weights obtained for specific barriers is very less but it is only for this specific study. Different results may be acheived for different data from different companies.

Table - 5: Ranking of Barriers

Major Criteria	Sub-criteria	Global Weight (SJ1)	Global Weight (SJ2)	Global Weight (SJ3)	Mean	Ranking	BARRIERS
	OB1	0.2851	0.2729	0.2812	0.2797	1.0000	lack of top management support
	OB2	0.1501	0.1475	0.1480	0.1485	2.0000	insufficient organizational alignment
	OB3	0.0834	0.0868	0.0846	0.0849	4.0000	lack of organizational infrastructure
	IB1	0.1433	0.1475	0.1462	0.1457	3.0000	wrong identification of process parameters
	IB2	0.0789	0.0797	0.0790	0.0792	5.0000	poor six sigma project selection
	IB3	0.0451	0.0469	0.0452	0.0457	7.0000	Poor handling of available six sigma tools.
	SR1	0.0731	0.0748	0.0734	0.0738	6.0000	poor awareness about six sigma
	SR2	0.0430	0.0427	0.0420	0.0426	8.0000	lack of trained professional
	SR3	0.0239	0.0231	0.0233	0.0234	11.0000	lack of education and training
	FB1	0.0400	0.0410	0.0409	0.0406	9.0000	lack of estimation of execution cost
	FB2	0.0229	0.0241	0.0234	0.0235	10.0000	lack of resources
	FB3	0.0127	0.0130	0.0127	0.0128	12.0000	cost required for special training

CONCLUSION

This work aims to find the ranking of the categorized barriers which are faced by Indian industries while implementing Six Sigma. Four main categories and twelve sub categories were used in this study. Also, the opinion of experts was taken and weightage was calculated as per SWARA technique. The study successfully prioritizes the barriers for mitigating impact of barriers to six sigma implementation. The SWARA technique was a new technique used as a powerful tool capable of determining the weights of main categories and sub-categories. This ranking of barriers can be used as input for industries while implementing Six Sigma.

VI. APPENDIX

Table - 6: A1

Calculation for Organizational Barriers (OB)					
Sr No	Sub-Criteria	S_j	$K_j = S_j + 1$	q_j	w_j
1	OB1	0.00	1.00	1.0000	0.5498
2	OB2	0.90	1.90	0.5263	0.2894
3	OB3	0.80	1.80	0.2924	0.1608
				1.8187	

Table - 7: A2

Calculation for Implementation Barriers (IB)					
Sr No	Sub-Criteria	S_j	$K_j = S_j + 1$	q_j	w_j
1	IB1	0.00	1.00	1.0000	0.5339
2	IB2	0.80	1.80	0.5556	0.2966
3	IB3	0.75	1.75	0.3175	0.1695
				1.8730	

Table - 8: A3

Calculation for Skills Required (SR)					
Sr No	Sub-Criteria	S_j	$K_j = S_j + 1$	q_j	w_j
1	SR1	0.00	1.00	1.0000	0.5222
2	SR2	0.70	1.70	0.5882	0.3072
3	SR3	0.80	1.80	0.3268	0.1706
				1.9150	

Table - 9: A4

Calculation for Financial Barriers (FB)					
Sr No	Sub-Criteria	S_j	$K_j = S_j + 1$	q_j	w_j
1	FB1	0.00	1.00	1.0000	0.5294
2	FB2	0.75	1.75	0.5714	0.3025
3	FB3	0.80	1.80	0.3175	0.1681

References

[1] Himanshu Prajapati , Ravi Kant , Ravi Shankar (2019)_ Prioritizing the solutions of reverse logistics implementation to mitigate its barriers: A hybrid modified SWARA and WASPAS approach, 2019/12/10 ,Journal of Cleaner Production,Volume,240,Pages,118219,Publisher,Elsevier

[2] Raghunath A, Dr. Jayathirtha R V (2013)_Barriers for implementation of Six Sigma by Small and Medium Enterprises Barriers to implementation of Six Sigma by Small and Medium Enterprises

[3] Saeid Jafarzadeh Ghoushchi,Mohd Nizam Ab Rahman,Diba Raeisi,Elnaz Osgooei,&Majid Jafarzadeh Ghoushji(Feb 2021)Integrated Decision-Making Approach Based on SWARA and GRA Methods for thePrioritization of Failures in Solar Panel Systems underZ-Information,symmetry 2020,12,v 310

[4] Ghaith M. Al-Abdallah(2008)Barriers to Six Sigma implementation in Chinese small and medium steel enterprises_investigate 5 major barriers in the Chinese small-scale industry

[5] Taina Savolainen, Arto Haikonen (2007) _ Dynamics of organizational learning and continuous improvement in six sigma implementation,January 2007,The TQM Magazine 19(1), DOI:10.1108/09544780710720808,Project: Trust in Organizations

[6] Rhonda L Hensley, Kathryn Dobie (2005) _ An International Journal, Vol. 15 No. 1, pp. 82-101. https://doi.org/10.1108/09604520510575281, Publisher: Emerald Group Publishing Limited,Copyright © 2005, Emerald Group Publishing Limited

[7] Rupa Mahanti, Jiju Antony (pp. 549-564)Six Sigma in the Indian software industryVolume 21, Issue 6, 2009Martin brikett wai ming Cheung (2008)_Identifying the barriers behind lack of use of six Sigma

[8] Osama Elgadi, Martin Birkett, Wai Ming Cheung(2007)Identifying the barriers behind lack of use of six sigma, doi.org/10.5281/zenodo.1124353

[9] Bendell, T. (2006), "A review and comparison of six sigma and the lean organisations", The TQM Magazine, Vol. 18 No. 3, pp. 255-262. https://doi.org/10.1108/09544780610659989Andrew Thomas, Richard Barton, Chiamaka Chuke-Okafor (2009) _ Applying lean six sigma in a small engineering company

[10] Jiju Antony(2008) _Can Six Sigma be effectively implemented in SMEs? June 2008International Journal of Productivity and Performance Management 57(5):420-423, DOI:10.1108/17410400810881863