iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** IV **Month of publication:** April 2022

DOI: https://doi.org/10.22214/ijraset.2022.41428

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue IV Apr 2022- Available at www.ijraset.com

A Literature Review of Maintenance Practices in SMEs

Gouraw Beohar[1], Dr. Anjaney Pandey[3], Dr. Rajesh Pd. Mishra[2]
[1]*SRIT, JBP*
[2]*M.G.C.G.V, Chitrakoot*
[3]*Mechanical, BITS, Pilani*

Abstract: Purpose- Aim of the research is to study the relevant available literature related to different maintenance system of the SMEs. Main objective of this paper is to review all types of maintenance models on different maintenance systems and associated case studies for SMEs and propose possible gaps from the point of view of practitioners and researchers.
Design/methodology/approach – In the process different approaches and models considered to check and also identified the gaps with proper classification. Various publications of database of published papers in last 20 years, was utilized for the purpose of this research.
Findings –Paper revealed the different kind of maintenance system adaptations given by different researchers world-wide. Purpose of literature review not only related to compare the available maintenance models of SMEs but also define various gaps and barriers presented in SMEs. Paper makes a pathway for development of maintenance framework for SMEs.
Practical implications – The Literature review indicates a very limited literature is available on this field. The Final derive indicates the necessity of maintenance system of SMEs in current scenario. In this context a maintenance model is proposed by author. Paper classifies different types of maintenance system uses for in SMs also helpful for future studies.
Originality/value – This Paper categorized the different types of maintenance work and case studies available on previous literature. It gives useful analysis for maintenance in SMEs and understands its worth.
Keywords: Maintenance, Literature, SMEs
Paper Type – Literature Review

I. INTRODUCTION

In modern manufacturing Maintenance is very important in all organization. According to Baglee., D., (2008) maintenance is an important element in quality assurance, which is another support for the successful competitive edge. Previously maintenance defined as “About preservation of physical resources” and now days “Maintenance is about preservation of working of resources”. Bamber, C., J. (1999) describes in 21 century Maintenance is an ‘art’, a ‘philosophy’ and a ‘science’. It is an Art means maintain the regularly varying demand of the Market. Nakajima (1988) attempts to summarize the Philosophy means to mix the strategies that ensure an item works as expected when needed. It is science means utilizes instantaneous and important data when fed to calculations, can model leading to failure across all systems. According to Pophaley, M. (2009) maintenance is a function of all the activities, approaches, interpretations and knowing and Un-knowing facts and methodologies to preserving the functions of assets.
Waeyenbergh, G.(2001) given the word Maintenance is generally an action, which is related with repairing of tools, equipments and machines at certain intervals, to extend their tool life during operation performed. Wireman (1991) suggests that maintenance influences all elements of business efficiency and risk- protection, energy efficient, quality of products, safety of environment and consumer services etc., not merely cost and availability of plant simply. Good maintenance system is also important for company explain by Ma´rquez, A.,C. (2009). It is not only increases the quality of the product but also helps to maintain the cost control of company.
In modern manufacturing Sharma, A., (2011) given the function of maintenance becomes more important, so now a days it is considered as a “profit generation tool” in place of ``necessary evil". These results, traditional approach used to describe maintenance appear to be outdated. It would arise that the objective of the maintenance function is to participate towards an enterprises profit, also shows definitely matching requirement for maintenance activities to be in agreement with enterprises business goals. Due to Worldwide competitiveness forces, Singh, J. et al. (2010) shows SMEs to improve their effectiveness by increase their manufacturing performance.

Hence, attention should be given by them to the trustworthiness of their process for production as well as their promises of excellence management exercises. Alsyouf, I. (2006) explain in current scenario the important elements of SME are on the basis of automatic machining, specious availability of plants, improved quality products and better tool life.

In order to achieve the above mentioned problems, practices and adoptions of preventive maintenance policies has become essential for organizations to bring down maintenance and production costs. Macchi, M., et al. (2014) explains the requirement of maintenance in production industries has been increased in the previous years. By Kulkarni, A. (2013) it considered the impact on the sustained improvements of availability of tools, quality products and cost of production the growing problem that marginal profit and production rates could be increased when maintenance potential is take advantage.

According to Cambridge University the meaning of "Practices" are "The act of doing something regularly or repeatedly to improve your skill at doing it", it means the traditional, habitual, or expected procedure or way of doing of something so we can say that, Simoes, J.(2011) describes

maintenance practices are basically the Maintenance activities which are essential to run the enterprises efficiently, profitably, continuously for optimum period of time.

Bamber, C., J. (1999) suggests that there is several maintenance practices which are being followed. These include routine or Wan, L. et al., (2017) reactive maintenance, preventive maintenance, predictive maintenance and reliability centered maintenance etc.

Maintenance strategies can be defined by Alsyouf, I., (2006) as a decision-making rule which provides a series of measures to be implemented with regard to the operation state of the considered system. Hadjiski, M. (2014) shows advantages of optimization in maintenance strategy includes extending tool life, decreasing failures, stop timing, minimize repairing costs, enhancing safety and health.

The role of maintenance in the industrial environment changed a lot in recent years, and today, it is a key function for long-term profitability in an organization.

Many contributions were recently written by researchers on this topic. A lot of models were proposed to optimize maintenance activities while ensuring availability and high-quality requirements. These models use different approaches and techniques to simplify the process of maintenance as well as to make are cost effective.

Maintenance model is a presentation of an idea, an object or even a process or a system that is used to characterize and define phenomena that cannot be experienced directly. Models are central to what scientists do, both in their research as well as when communicating their explanations. Models are presented concerning the organization of the maintenance process of a quality system.

II. DEFINITION OF SMES

Globally, small and medium enterprises (SMEs) has been recognized by Hussain, I., et al. (2011) as the prime mover of economical advancement, especially in the developing economies like India, and for promoting sustainable development their participation as an integral element to country's foundation is higher comparatively.

In our Country there was no official definition of SMEs till 1950. Lahiri, R.(2012) put some lights on Fiscal commission, New Delhi, for the first time defined a small-scale industry (SSI) as, one which is operated mainly with hired labor usually 5 to 25 workers.

During that time word used to defined small business was Small Scale Industry (SSI) as the concept of small business was mainly confined to manufacturing sector (www.msme.gov.in, Annual Report 2018-2019).

In year 1951 the central government of the country defines the SSI. The division of the SSI based on no of workers, cost and quality, nature of work, cost etc. In the SSI the government of india set up the central small-scale industries organization and the small-scale industries board (SSIB) in 1954-55. Initially the categorization of the small scale industries based on investment in gross value of fixed assets which is the actual value of machines in the plant. Ancillary's industries concept was introduced first time in 1960. In 1977 it will become concept of tiny industries. In the year 1985 first time the tiny industries known as (small and medium size enterprises) SMEs.

Extendedly in year 2006 the micro, small and medium enterprises development (MSMED) act was notified. This act has key provision for development of a national board for Micro, Small and Medium enterprises. Act permits the initial legal environment for recognition of "enterprise" concept of which includes both manufacturing and service subjects.

It defines medium enterprises on the first occasion and designed to integrate the 3 tiers of these enterprises, namely, Micro, Small and Medium

The act are classifies the MSMEs into two categories. Jain, M., K., Gandhi, S,K.(2016).

1) *Manufacturing Enterprises:* Manufacturing enterprises means to convert raw material into finished goods in term of value addition in it. The enterprises involved in the manufacturing or production of goods related to any industry described in the first schedule to the industries (Development and regulation) Act, 1951.
2) *Service Enterprises:* (Lahiri, R.,2012) explains the enterprises which involved in providing or rendering of services are defined as amount of investment in equipment.

The Definitions of SMEs may vary from country to country. Classification of SMEs is different for different kind of countries. Some country like India, it is based on investment on plants and machineries but other countries like Canada and Europe it is based on number of person's required or annual turnover which is applicable. According to Kaur, M. (2010) the SMEs sector plays a essential role in the growth of the country. It contributes almost 40% of the gross industrial value added in the Indian economy and 50% of total manufacturing exports.

Rao, N.,J.(2007) shows pictorial view that small and medium enterprises are the leading factors for the economic growth of a country. SMEs have contributed significantly to the Industrial and economic growth of India and have also been the prime-mover of the Industrial growth in world.

According to Mohanti., J., (2018) the definition criteria of SMEs in few countries are based on:

- Money Invested on Plant and Machineries.
- Number of Employees.
- Annual Turnover

Category	Investment (in INR)	Investment (in USD)	No of Employees	Cumulative Cost	Annul Turn over
Micro Enterprises			Europe Canada		
			< 5 < 10		
□ Service	Up to Rs. 10 Lakhs	Up to 25,000 $	….. ……	<10 Lakhs	Up to 2 Millions
□ Manufacturing	Up to Rs. 25 Lakhs	Up to 62,500 $	….. ……	<25 Lakhs	
Small Enterprises			10-49 5-99		
□ Service	10 Lakhs to 2 Crores	25000$ to 0.5 Million $	….. ……	10 Lakhs - 2 Cr	€2-€10 Millions
□ Manufacturing	25 Lakhs to 5 Crores	62500$ to1.25Millions$	….. ……	25 Lakhs - 5 Cr	
Medium Enterprises			50-249		
□ Service	2 Crores to 5 Crores	0.5Million to 1.25Millions	50-449	2 Cr- 5 Cr	€10-€50 Millions
□ Manufacturing	5 Crores to 10 Crores	1.25Million to 2.5Millions	50-399	5 Cr- 10 Cr	

Doshi, J. et al. (2013) explain that SMEs not only the back bone of the industrialization of a country but also provides the essential supply chain to the large industries. SMEs have a important role in the Indian manufacturing sector and have become engine of economic growth. Majumdar, J.,P., et al. (2019) highlight the contribution of SMEs in present scenario in terms of output, exports and employment. In production enterprises, SMEs act as expertise vendors of components, parts and sub-assemblies to larger enterprises because these items can be produced at a cheaper price compared to the price large companies must pay for in-house production of the same components. Approximate 42.5 million units are growing all over the country producing about 8000 items, from different variety of products i.e. simple to highly advanced products. The SMEs sectors are the biggest employment-providing sectors after agriculture, approx. providing employment to 106 million people.

Due to lower transportation costs, lower labour costs and easy workforce policies, SMEs utilized as major outsourcing tool. Singh, R., K., et al. (2010) shows the advantages in labour-intense manufacturing enterprises, normally production cost will lower as compare to running cost of production because workforce will complete mostly tasks. Firms can benefit from by utilizing low-cost labour as the job will likely be low skilled. Manjit (2013) also calculated that total number of about 90% of industrial units in India and 49% of value addition in the manufacturing sector. SMES has been one of the major infrastructures of Indian economic development strategy since Independence.

The SMEs has played a very important part in the social and economical progress of the country throughout the past five decades. It has significant contribution to the overall growth in terms of the gross domestic product (GDP), employment generation and exports.

The performance of the small scale sector therefore has a direct impact on the growth of the overall economy. The study has been carried out to measure the performance of SMEs in India for the period 2000-01 to 2017-18 based on various important performance variables like total working SMEs, employment generation, and market value of fixed assets, gross output and share of SMEs sector in total GDP trends over 18 years.

A. Complete Table for Total SMEs, Employment, GDP Contribution, Assets etc.

S. No	Year	Total Working Enterprise in Lakhs	Employment (Lakhs & Person)	Market Value of Fixed Assets (In Crores)	Gross Output (in Crores)	Share of SMEs Sector in total GDP (%)
1	2000-01	101.1	238.73	NA	NA	NA
2	2001-02	105.21	249.33	154349	282270	39.12
3	2002-03	109.49	260.21	162317	314850	38.89
S. No	Year	Total Working Enterprise in Lakhs	Employment (Lakhs & Person)	Market Value of Fixed Assets (In Crores)	Gross Output (in Crores)	Share of SMEs Sector in total GDP (%)
4	2003-04	113.95	271.42	170219	364547	38.74
5	2004-05	118.59	282.57	178699	429796	38.62
6	2005-06	123.42	294.91	188113	497842	45
7	2006-07	361.76	805.23	868543.79	868543.79	35.13
8	2007-08	377.36	842	868543.79	920459.84	35.41
9	2008-09	393.7	880.4	920459.84	977114.72	36.12
10	2009-10	410.8	921.79	977114.72	1038546.08	36.05
11	2010-11	428.73	965.15	1038546.08	1105934.09	36.69
12	2011-12	447.66	1011.8	1105934.09	1182757.64	30
13	2012-13	467.56	1061.52	1182757.64	1268763.67	30.4
14	2013-14	488.29	1114.29	1268763.67	1363700.54	30.2
15	2014-15	510.57	1171.32	1363700.54	1471912.94	29.7
16	2015-16	553.65	805.24	1363700.32	10772112.86	29.2
17	2016-17	613.24	1054.26	1363700.32 approximate	12234324.23 approximate	28.9
18	2017-18	633.88	1109.89	1412041.34 Approximate	1472356.71 approximate	30%

Research findings concluded that the success of SMEs has a direct impact on the economic development of the country, both in the case of developed countries and developing countries (Majumdar, 2016).

They have the ability to generate employment with minimum cost; they are pioneer in innovation realm and have high flexibility which allows them to meet the needs and expectations of the customers (Demirbag et al., 2006).

B. Types of Maintenance used in SME's

According to Ahuja, I. P. S. (2008) Maintenance is usually classified into the following types:

Planned Maintenance – This is a systematic class of maintenance by Hashim, S. (2012) in which work performed as per recorded processes having control.

To avoid failures, the maintenance assignments are preplanned considering "when used and which type of the maintenance works" and "whoever would handle the maintenance work".

Alexis,O. (2012) to fulfill the standard of the planned maintenance, "Work Study" has to be performed to take a decision the processing time of maintenance and performing the "Time Study" may also be helpful and suggestive for developing economical maintenance schedules for the equipments.

Predictive maintenance – Maintenance referred by Sezer, E., et al. (2018) ,Sharma, R.,K. (2013) as a process used for prediction of future breakdown, in tools, equipments or machine component so that the component can be replaced, based on a range, just before it fails. This is best suited method for maximized component lifetime and minimizes equipment downtime.

Preventive maintenance – This maintenance refers by Pattanawasanporn, P. (2014) as systematic, scheduled maintenance which helps to keep all equipments up and running condition to preventing them with unwanted equipment failure and reduced unplanned downtime, expensive costs etc. The checking and reconditioning of tools on regular, planned based.

Corrective maintenance – Robson, K., et al.(2013) shows this maintenance refers as unscheduled maintenance implemented to determine and repair a fault for restoring faulty system, machines and equipment. It can be restored the correct working circumstances within the margins of tolerance created during operation of services.

Running Maintenance – This maintenance referred by Robson, K., et al.(2012) as a part of planned maintenance. Running maintenance is performed by operator; it is done on a regular basis to keep the machine functioning efficiently and safely. Machine cleaning, lubrication, tool changing etc. are some example of running maintenance.

Schedule Maintenance – Attri, R., et al. (2013) referred scheduled maintenance is a part of preventive maintenance. It includes examinations, corrections, scheduled services, and planned shutdowns. It can either be a repeated work done at recurring intervals or a one-time task.

The main goals of scheduled maintenance are to decrease responsive time of maintenance, equipment breakdown, and maintenance delayed.

Shutdown Maintenance – Netto., R., J., k., et al. (2016) refers this maintenance as a part of preventive maintenance. This maintenance only be performed while machinery is not in use. To shut down equipment could be costly, but in some cases due to the nature of the affected part /machineries, shutdown maintenance is the only feasible maintenance process. Technical staff will repair it to prevent a complete shutdown.

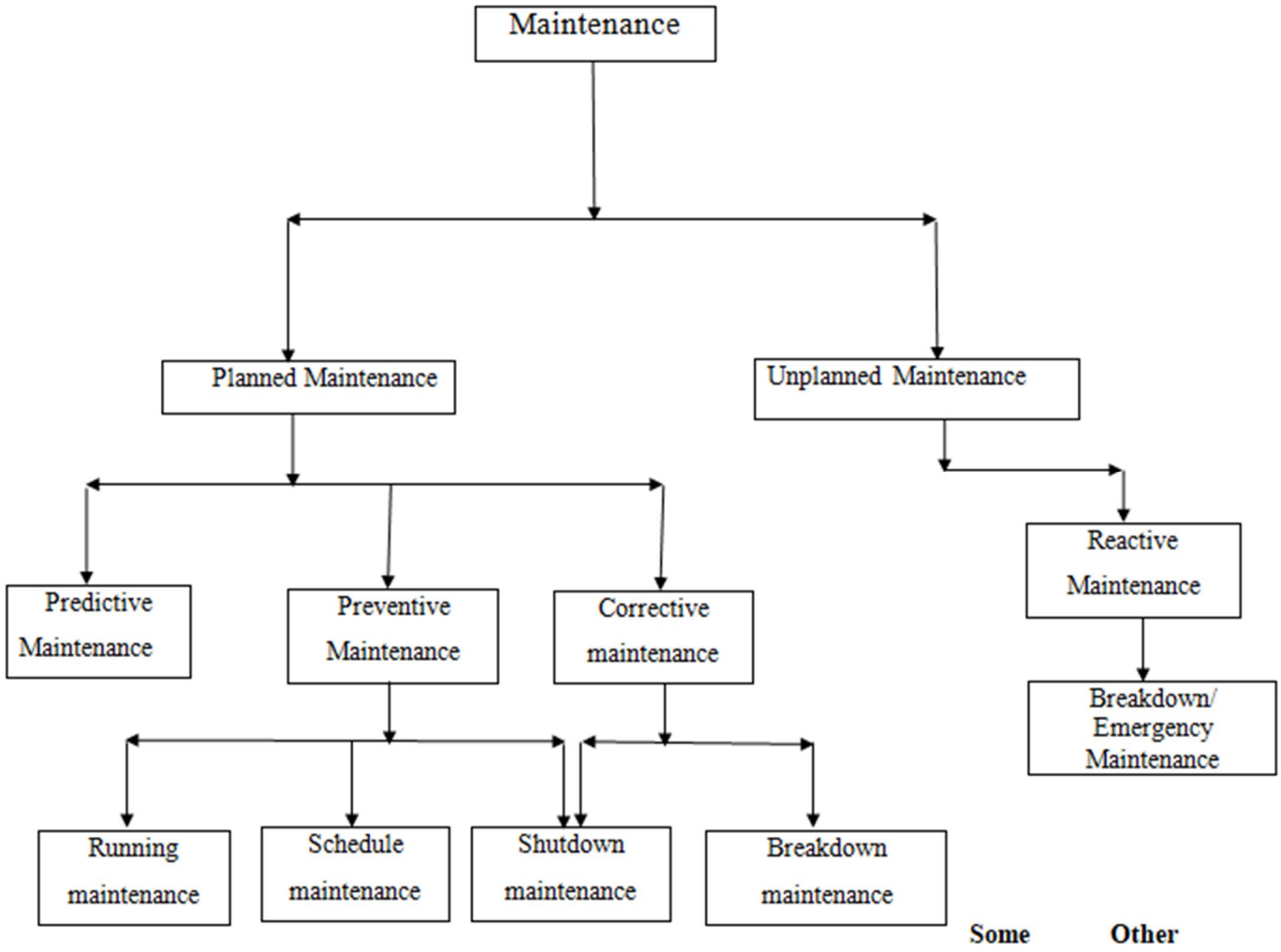
Breakdown Maintenance – Robson, K., et al. (2013) propose this maintenance refers as a part of corrective maintenance. In such maintenance repair is done after failure has already occurred.

It may be either planned or unplanned maintenance. The objective of breakdown maintenance is to repair something that has dysfunction.

Baglee., D., (2008) explains the reactive / emergency maintenance almost happen without warning, so emergency maintenance cannot be scheduled, but every maintenance program should include plans for dealing with emergencies when they do occur. It is essential when a sudden failure takes place.

Unplanned Maintenance – Joshi, K., M. (2018) defines an unsystematic kind of maintenance that occurs suddenly. This would happen when there is no proper approach in position to resolve a repair, replacement, or inspection before it's needed. Unplanned maintenance is commonly the result of equipment failure that was not expected.

C. Types Of Maintenance



D. Some Other Types – (Maintenance Strategy / System / Approach)

Condition Based Maintenance – Baglee., D.,(2017) suggested condition-based maintenance is a maintenance strategy that monitored the actual status of assets to determine requirements of maintenance to be done. CBM directs that maintenance should be executed when various direction indicators indicate signals of progressing breakdown or reducing performance. Fumagalli, L. (2009) defines the objective of condition based maintenance is to monitor and place forthcoming breakdown of equipment so maintenance can be planned proactively when it is required – and not earlier.

World Class Maintenance (WCM) – Cagliano, R., (2001) explains world class maintenance is a maintenance strategy, which is the ability to compete anywhere in the world; to be able to meet and beat any competitor anywhere in the world with product, price, quality and on-time delivery. Mishra, R.,P. (2015) explain world class maintenance is not just about the maintenance practices of the maintenance organization in a vacuum. It is about the way the entire organization uses all the means at its disposal to protect its ability to produce exceptional value for its customers.

Total Productive Maintenance – Seow, C., (2006) defines TPM is a creative procedure of maintenance that optimizes performance of equipment, avoids failures, and encourages autonomous maintenance by machine operators by day to day activities involving the total workforce. Shah. B. (2012) found TPM is an innovative approach of plant maintenance that supplementary to Total Quality Management (TQM), Just-in-Time Manufacturing (JIT), Continuous Performance Improvement, Lean Manufacturing, 5S etc.

Reliability Centered Maintenance – Fraser, K., (2011) given Reliability centered maintenance (RCM) is a strategy of organizational maintenance which used to optimize the maintenance schemes of an organization. This is a concept of maintenance planning finally results in terms of reliability assets of the facility.

The formation of this paper is as follows:

1) In the very first section a brief introduction considered on maintenance. Section defines meaning of maintenance with its type, strategy, models, activity, objectives etc.
2) This section related with SMEs definitions and their categorization with various parameters e.g investment cost and number of employees.
3) Next section related with classification of existing literature with maintenance definitions in SMES to be considered.
4) Next section shows a clear outline of different methodologies available on SMEs. Different tools utilized for maintenance methodology presented by suitable excel sheet.
5) It has been classified; detailed analysis of all maintenance models exists in association with crucial perceptions on each, carried out in the next section.
6) This section related with Barriers, gaps in maintenance of SMEs.
7) In the final section, changing trends in the area of maintenance optimization models or enablers have been identified along with the directions for future research work

III. VARIOUS DEFINITION / STRATEGIES (METHODOLOGY BASED) OF MAINTENANCE IN SMES

The role of SMEs is vital for the economic growth of all the developing as well as developed countries across the world. In India, SMEs are considered as the backbone of Indian economy.

Present era shows the importance of maintenance in business strategy that impact directly or indirectly on manufacturing performance and implements continuous improvement of SMEs. This section presents a collection of the various available strategies of maintenance system used in literature. Principles of maintenance have been broadly accepted by many researchers. Many authors and practitioners across the world have studied and remarked on maintenance definitions.

Very confined literature is available on different existing maintenance strategies and their importance on SMEs. Paper initially collected the total literature on maintenance of SMEs but also indicates a clear pictorial view on different available maintenance strategies used in SMEs. These strategies based on various emerging trends of enterprises and conclude a clear outlines of the guidance for maintenance up gradation. Paper also provides various case studies and available references on maintenance techniques and models. The researchers and professionals who are working on maintenance optimization also describe appropriate references to manage the maintenance strategies. In SMEs, definition of maintenance could be explained by several authors differently, many of them (researchers) also mention the limitations of maintenance system of SMEs. The objective of this study is to analyzing the effects of different existing maintenance strategies / models and practices of SMEs on pragmatic way. Study based in terms of quality and innovative practices and their consequences on performance of SMEs. Additionally, Aim of research scholars to comprehend the impact of quality initiatives and innovations on the universal sustainability as a whole.

Dekker and Scarf (1998) explains development in industrialization and computerization increases which resulted in reduction in quantity of workers, whereas invested capital in manufacturing equipment has increased during last few decades. Jain (2013) shown meaning of maintenance which means keeping equipment autonomously by production operators in good condition- i.e. repair, grease, clean and spent necessary time on it. Jain, M., K., et al (2016) presents the intention is to improve product quality, profitability which automatically improve the brand name in the market lastly satisfy customer.

A. Methodology

In recent times most effective and economic technique to perform research by using the database and internet. Although, we observe very much propagation of particulars – effectively and non-effectively, certified and non- certified, credible and incredible and above all useful and useless. Hence, Google Scholar is used to initiate a search for qualitative research literature. Initially “maintenance” “SMEs,” “maintenance Framework,” and “literature review on maintenance” have been used as the searching keywords. Few papers downloaded initially but shortly it became clear that majority of research papers, not in all, connected with different types of SMEs and related with about maintenance issues completely not connected to maintenance practices of SMEs. After that, keyword “maintenance of SMEs” was used and downloads 157 research papers.

These research papers were studied to realize the different research problems examine by research scholars on maintenance of SMEs. Many research papers was initially noticed, even though presented literature review on maintenance systems of SMEs, also described maintenance implementation case studies on it.

The various researchers introduced different approaches of maintenance in various SMEs and few of them also presented the maintenance frameworks (conceptual, implementation, strategic, operational, etc.). Some maintenance implementation frameworks were also examined. Research has shown that there is no standard maintenance implementation framework and key point of this is the shortage of devoted maintenance implementation methodologies, tools or techniques. All the informed tools used in maintenance are separate fully developed tools like TQM, TPM, 5S, Six-sigma, JIT, kaizen, LM, etc. So, decision was made to review research papers for maintenance optimization tools and techniques.

As long as reviewed the available research papers it was observation to be made that many quality cross-references were missing and a small query exposed that in different research papers are utilizing the word “maintenance in organization” in place of “maintenance in enterprises.”

As a result, these two key-words were again used for getting more research papers for review. This resulted in 33 papers with term maintenance in enterprises and 30 papers with maintenance implementation in SMEs. Some more papers, found related with literature by referral of references were reviewed due to their significant role in the expansion of maintenance.

Twelve research papers from these are about maintenance principles, six research papers about maintenance management, four about lean + six sigma , 13 about maintenance in SMEs, three about maintenance framework, three about continuous improvement, and rest 11 about maintenance tools and techniques. It is important to point out that number of research papers also discussed various problems but every research paper classified into the best appropriate group depends upon title of research paper, its abstract or frame of research paper.

B. Review of Different Methodologies

Author presented a consolidated table of different maintenance strategies incorporate in the available literature. Purpose of this table to showing the variation in the principles, objectives, and scope of maintenance changed over this period of time. Author also considered the table used to collect all the available strategies of different maintenance practices. These all are based on various Methodologies present in literature. Aggregate 157 research papers had been analyzed out of which 63 methodologies compared from over 38 international journals and seven conferences, three workshops over the period of 1999-2020.

In this research and development, literature review of research papers, research papers of various concepts, descriptive research papers, experimental research papers and analytical research papers including different case studies, various surveys, best practices were included. There are many limitations to this research methodology. Research papers availability was one of the important limitations for authors. Principal portion of databases of this papers were from Taylor & Francis, Emerald, IEEE, Springer, Elsevier Emerald, Science Direct, and ASME, etc. Additionally, other search was also implemented related to books, conferences and other research outlets. Authors wish to make clear that all the papers reviewed may not have these two keywords and all the papers having these two words may have not been reviewed. Many papers were reviewed from cross-references because these contained the required information.

Table 3.1 for Different available strategies of SMEs:

S N	Author	Year	Types of Methodology	Country	Journal	Aim of Maintenance practices (Methodology Based)
1	Cagliano, R., et al.	2001	Descriptive	Italy	Integrated manufacturing System	Effectiveness and good performance of SMEs, lower complexity, facilitate communication etc
2	Waeyenbergh ,G., et al.	2002	Empirical	Belgium	International journal of production economics	People, materials, money, overall maintenance, plant availability, product quality, safety
3	Shah, R., et al.	2003	Exploratory Cross section	India	Journal of operations management	Planning and scheduling strategies, safety improvements, total quality management programs
4	Pierre, J., S., et al.	2004	Empirical	Canada	International journal of productivity &performance management	Improves productivity, efficiency, growth and returns.

5	Seow, C., et al.	2006	Conceptual	UK	International conference management of innovation and Technology (IEEE)	Extending life of machinery, a lack of preventive maintenance lead to expensive breakdown of capital equipment.
6	Demirbag, M., et al.	2006	Empirical	UK Turkey	Journal of manufacturing technology management	Intensifying global competition, increasing demand for better quality by customers, provide high quality products
7	Singh, L.,P., et al	2006	Empirical	India	PICMET 2006 proceedings, Istanbul, turkey	Empirical study of impact of quality management practices like Just-in-Time, 5S's tools, suggestion schemes, workers participation.
8	Deros et al.	2006	Descriptive	Malaysia	Benchmarking: An international journal	Review process, awareness, key issues visit, data collection, best practices, monitoring result, standardization, implementing, planning
9	Alsyouf, I., et al.	2007	Descriptive	Sweden	International journal production economics	Failure, passing of time, condition, maintenance action (inspection, repair, or replacement)
10	Singh,R., K, et al.	2008	Descriptive	India	International journal of services and operations management	Understanding the concept of competitiveness, corrective measures, challenges and strategy development
11	Baglee, D., et al.	2008	Empirical	UK	IFAC Workshop on intelligent manufacturing systems	High productivity and quality, maintenance strategy. Increase equipment effectiveness, maximize gains.
12	Singh,L.,P., et al	2009	Empirical	India	IUP journal of operations management	Technology management, quality management programs, causes of poor quality and quality control techniques used.
13	Fumagalli, L., et al.	2009	Descriptive	Rusia	Proceedings of the 13th IFAC symposium on information control problems in manufacturing	Improvement of maintenance management, quality of products
14	Barton, R., et al.	2009	Empirical	India	Journal of manufacturing technology management	Reduce processing time, cycle time, set up time, inventory defects and scrap, overall equipment effectiveness, qualitative benefits , improved employee morale, job satisfaction
15	Knowles, M., et al.	2010	Descriptive	UK	Control and cybernetics	Easy to use ,solve complex maintenance problem
16	Fassoula, E.,D.,	2010	Exploratory Cross section	UK	Total quality management and business excellence	Reduction of internal cost, effective management continuous performance improvement, quality, safety
17	Singh, R., K., et al.	2010	Exploratory Cross section	India	Management research review	Improving management talent, level of equipment, cost, quality, product range technology
18	Pophaley, M.,et al.	2010	Descriptive	India	Journal of industrial engineering and management	Avoid failure, improve maintenance developed to visualize, analyze and optimize complex maintenance problems.
19	Kris,D., et al.	2011	Comparative	Belgium	Norwegian university of science and technology	Manufacturing operation management systems, improve results of the inquiry.
20	Singh, R.,K.,	2011	Descriptive	India	Asian journal on quality	Management commitment, employees training, improve coordination customer feedback and supplier, quality data process management, product/service design, quality

21	Hall, O.P, et, al.	2011	Empirical	California	Journal of accounting and finance	Cost savings, market response, efficiency, challenges managerial and associated with an activity-based costing (ABC) model
22	Fraser, K., et al.	2011	Empirical	South Australia	International journal global energy issues	Review maintenance literature by analyzing the country, author, method, sector and industry
23	Hussain,I., et al.	2012	Comparative	Pakistan	African journal of business management	Cooperation among public institutions and private enterprises networks and at the same time providing public services.
24	Hashim, S., et al.	2012	Descriptive	Malaysia	International journal of engineering research and development	Innovation, compete in global market, improve the quality of a product or service , world class performance
25	Alexis,O., et al.	2012	Descriptive	Vigo	International conference on industrial engineering and industrial management	Maintenance planning, execution, evaluation, measurement, analysis and modification and continuous improvement.
26	Panizzolo, R., et al.	2012	Empirical	Italy	Taylor and Francis	Identify and eliminate root causes of waste, summarize the company profile, managerial approach on different factors.
27	Jamian, R., et.al.	2012	Descriptive	Malaysia	Asia pacific journal of operational management	5S, continuous improvement of industrial workplace environment, high quality, low cost and rapid delivery of products
28	Yi,S.,H, et al.	2012	Empirical	S. Korea	Journal of management and strategy	Innovation and increased productivity with the workers, communication and cooperation between labour and management.
29	Emami,R., et al.	2012	Empirical	Malaysia	International journal of innovative ideas	Retaining employees, job satisfaction, physical and emotional health of employees. Job satisfaction and employee turnover.
30	Mathur, A., et al.	2012	Empirical	India	Production planning and control	Improving productivity, continuously researched, refined, adapted, upgraded and modernized the development of new models of business results of information revolution.
31	Wakjira, B.,M., et al.	2012	Empirical	USA	Global journal of researches in engineering industrial engineering	Increase in labor productivity, controlled maintenance, reduction in maintenance costs, production stoppages and downtimes.
32	Nowduri,S.,	2012	Descriptive	Pennsylvania	World journal of management	Low to middle per capita income, relation between global population, and world's economy
33	Kulkarni, A., et al.,	2013	Descriptive	India	International journal of engineering research and development	Productivity, circulation, costs, delivery, supply, quality, achieve zero defects, safety, less violations, morale for verify TPM.
34	Attri, R., et al.	2013	Empirical	India	International journal of production research	Permits self-analysis, evaluation, comparison, mathematical modeling and conversion of qualitative factors to quantitative values
35	Robson,K.,et al.	2013	Comparative	U.K	International journal of business and management	Adoption of machine failure, improvement activity, change in skills, cultures over time, improve techniques to follow different practice like TPM, PM, TQM, LM
36	Macchi, M., et al.	2014	Descriptive	Milano	International federation for information processing	Integration of maintenance with production functions within mechanical plants.

37	Jain,A., et al.	2014	Descriptive	India	International journal of lean six sigma	Changing environment, improvement concept , zero breakdown, 5S, total employee involvement, zero defect concept, zero accident
38	Jain,A.,et, al.	2014	Empirical	India	International journal of mechanical and production engineering research and development	TPM implementation, enhance availability, performance, quality rate, OEE, productivity, quality, reduce maintenance cost, breakdown, losses
39	Akindipe, I.,S.,	2014	Exploratory Longitudinal	Nigeria	Entrepreneurship journal of management and innovation	Effective and efficient functioning of the inventory management, total performance of organization.
40	Pattanawasan porn, P.	2014	Comparative	Thailand	International journal of industrial engineering	Plans, implements, controls forward, reverse flow, storage of goods, services, point of consumption customers' requirements.
41	Hadjiski, M., et al.	2014	Descriptive	Bulgaria	International symposium on business modeling and software design	Developed and tested many methodologies tools, techniques and strategies, TPM, RCM
42	Hu, Q., et al.	2015	Descriptive	UK	Journal of manufacturing technology management	Transparent system, scientific, reproducible procedure for the literature search and analysis, how to analyze the literature.
43	Gupta., G., et al.	2015	Empirical	India	Proceedings of the 2015 IEEE	Successfully identify the critical components in complex repairable and non-repairable systems, failure and repair calculation, improve reliability and availability of system.
44	Parikh, et al.	2015	Descriptive	India	International journal of innovative research in advanced engineering	Optimizing equipment effectiveness, eliminating breakdowns, TPM has revolutionized maintenance
45	Majumdar, J.,P.	2016	Descriptive	India	International journal of applied research	Improving customer satisfaction, improved business performance, TQM, capitalizes involvement, workforce, suppliers, meet customer expectations
46	Yadav, V., et., al.	2016	Empirical	India	International conference on emerging trends in mechanical engineering	Investigate, evaluate, measure key areas, user-inventory, supplier, maintenance, management, plant layout, friendly, process and handling.
47	Gerba, Y., T., et al.	2016	Descriptive	India	International journal of applied research	Performance, success and growth of SMES, such as survival, profit; return on investment, reputation sales growth, no of employee happiness, and so on
48	Bruno, G., et al.	2016	Descriptive	Italy	Journal of intelligent manufacturing	Define a model, capture manufacturing knowledge, real data available in manufacturing SME ,defined a procedure
49	Gupta, H.,	2016	Empirical	India	Global business review	Various types of innovation tools, product, process and organization, data collected, launch a new product faster than competitors
50	Netto., R., J., k., et al.	2016	Empirical	Brazil	Engineering systems and networks	Performance measures, obtained equipment to monitor, define moment to preventive maintenance, analyzing the variation
51	Majava, J., et al.	2017	Descriptive	Finland	Management and production engineering review	Developing production, enabling continuous improvement, improves value; minimize all non-

						value adding activities from production process
52	Wan, L., et al.	2017	Descriptive	Shanghai	Journal of quality in maintenance engineering	Improve manufacturing, quality, reliability improved, reduce down time, rejections
53	Baglee, D., et al.	2017	Descriptive	Finland	30th International congress & exhibition on condition monitoring and diagnostic engineering management	Opportunity exist, improvements to competitiveness, profitability, TPM, RCM and CBM approaches to allow management to develop and implementation.
54	Knol, W,H., et al.	2018	Exploratory Cross section	Netherlands	International journal of production research	Increase operational performance, practices, SMEs could improve their lean practices for learning focus, improvement training and support congruence.
56	Pai, M.,P., et al.	2018	Empirical	India	International conference of materials science and engineering	TPM implemented, questionnaire method used, planning, scheduling for future use in maintenance planning activity.
57	Joshi, K.,M., et al.	2018	Descriptive	India	International journal of advanced research in engineering & technology	Quality initiatives, complexity of TPM increases, many inherent limitations so that SMEs can work full potential.
58	Sezer, E., et al.	2018	Empirical	Mexico	IEEE International conference on engineering, technology and innovation	Improve production, maintenance activities; assure high quality standards, to reduce cost and downtimes, to gain significant insights about production processes ITs/OTs.
59	Mohanti., J.,	2019	Descriptive	India	International journal of research and scientific innovation	Local skills, resources ,sell product locally, involve lower investment in machines, part time employment such as handlooms, sericulture, bidi-making, embroidery, knitting, coir, wood carving ,handicrafts, Khadi
60	Caldera., H. T., S.,. et al,	2019	Exploratory Cross section	Australia	Journal of cleaner production	Research findings, identified enablers comprise, stakeholder engagement, integrated strategy, continuous improvement, barriers comprise: lack of financial resources, lack of knowledge, time, risks in practice.
61	Dias., M., C., et al.	2019	Exploratory Cross section	Brazil	International journal of research in engineering and sciences	Solve practical applications of real problems, exploratory objective, survey method, from questionnaire, applied to a sample.
62	Pagare, A., K., et al.	2020	Descriptive	India	international conference on innovative advancement in engineering and technolog	Correct details in the correct schedule, improvement in instrument lifecycle, in plant care, less accidental chances optimal backup , other possibilities and their benefits.
63	Sidhu., S., S., et al.	2020	Descriptive	India	International conference on intelligent communicate computational research	Emphasizes the need for SMEs, enhance availability, quality of product, performance, OEE, productivity and reduction of breakdowns.

According to table, author categorized the various research methodologies given by several academicians into six classes – Based on concepts, Based on explanations, Based on comparison, Based on experiments, Based on survey, and Based on data collection survey . Dangayach and Deshmukh, (2001) and Bhamu and Sangwan (2014): these research methodologies given below:

Based on basic concept of maintenance: **Conceptual**

Based on various explanations of maintenance: **Descriptive (For performance based issues)**

Based on comparative analysis among various maintenance practices: **Comparative**

Based on experiments (data study): **Empirical**

Based on through survey, at one point of time: **Exploratory cross-sectional**
Based on data collection survey on two or more point simultaneously: **Exploratory longitudinal**
Allocation of different Methodologies used by several researchers is shown.

Different Methodologies	Total no of Research papers	% Contribution
Conceptual	2	3%
Descriptive	28	44%
Comparatively	2	3%
Empirical	23	37%
Exploratory Cross sectional	3	5%
Exploratory longitudinal	5	8%

To maintain the same, there are different optimization tools adopted by different researchers with different time. 94 research papers (57 International and 37 National) were studied and reviewed by the Author on the basis of various optimization tools or techniques at past 20 years of time span i.e. from 1999 to 2019. In this study uses data collected from a research of 135 organizations included manufacturing (101) and services (34) both in India.

Table 3.2 of Maintenance tools used: (Comparisons)

S. No	Name of Author	Year	Remarks/suggestion/ improvement/ positive pts	Maintenance tools used	Country
1	Bamber, C., J., et al.	1999	Increased production efficiency, availability, reliability	TPM, Maintenance	U.K
2	Yusof, S.,M., et al.	2000	Quality initiatives, quality assurance system	TQM	U.K
3	Cagliano, R., et al.	2001	Improvements in skills, achieve highest level of performance	ANNOVA, WCM	Italy
4	Waeyenbergh, G., et al.	2002	Maintenance plan development for framework	TPM,RCM,BCM	Belgium
5	Shah, R., et al.	2003	Continuous improvement, quality products sustainability of process	LM	USA
6	Pierre, J., S., et al.	2004	Performance Improved, Knowledge increases	Benchmarking TQM	Canada
7	Kumar, M. et al.	2006	Reduction in overall costing of Smes	LEAN SIGMA Framework	U.K
8	Seow, C., Liu, J.	2006	Extending life equipments improving product quality	Six Sigma, TPM	U.K
9	Demirbag, M., et al	2006	Better performance on Revenue, net profit, returns, investment	TQM	Turkey
10	Singh,L.,P., et al.	2006	Assets utilization, cost reduction, inventory management, quality aspect	JIT, 5S	India
11	Deros et al.	2006	Achieving benchmarking of system	Benchmarking, TQM	Malaysia
12	Alsyouf, I., et al.	2006	Increased profitability, improve quality, improved efficiency,	Maintenance, productivity	Sweden
13	Rao, N.,J., et al.	2007	Optimum performance, time saving	LM	India

14	Ahuja, I. P. S. et al.	2008	Customer satisfaction, product optimization increase production rates, better quality product	TPM	India
15	Singh, R.,K., et al.	2008	Wide range products, competitiveness, customer satisfaction, enhancement	Strategy development	India
16	Baglee, D., et al.	2008	maintenance procedures, Improve knowledge, tool	TPM, RCM	U.K
17	Singh, L.,P., et al.	2009	Cost of reworking, cost of customer complaints, customer satisfaction	Tool of quality management	India
18	Fumagalli, L., et al.	2009	Enhance maintenance activity , improve quality, productivity	CBM	Russia
19	Dowlatshahi, S., Taham, F.	2009	Reduction in Waste, technology acquisition, quality control	JIT	USA
20	Barton, R., et al.	2009	High product quality, cost, continuous improvement	LM, Six sigma	U.K
21	Dai, W.	2009	Advance computing capability, increase productivity	RCM, preventive maintenance	Australia
22	Ma´rquez, A.,C., et al.	2009	Improve maintenance effectiveness & efficiency	FMECA, RCM	Spain
23	Baglee, D., Knowles, M.	2010	Reduce cost of repairing, understand MMP	Condition based management	Sunderland
24	Rose, A. M. N., et al.,	2010	Successful implementation of Lean in Smes	LM	Malaysia
25	Singh, J.,Singh, H.,	2010	Improve quality, reduce cost, productivity	TPM	India
26	Fassoula, E.,D., et., al.	2010	Systematic improvement in Smes	IMS	U.K
27	Singh, R., K., et al.	2010	Develop human resource improve product quality	Competitive Strategy, SMEs	India
28	Pophaley, M., Vyas R.,K.	2010	Strategic management , innovative maintenance practices,	MMP,TPM,RCM	India
29	Tesar, S., et al.	2010	Strategy redefines, competitive advantages	TPM	Prague
30	Kaur,M.	2010	Performance, quality increases	LM,TQM	India
31	Simoes, J., M., et al.	2011	Systematic, dynamic performance approach	JIT, TQM,TPM	Portugal
32	Sharma, A. et al.	2011	Maintenance optimization , equipment availability, spare parts management	RC, TPM	India
33	Kris,D., et al	2011	Production process optimization, time gain	CIM,ERP	Belgium
34	Singh, R., K.	2011	ISM methodology, Improve performance n customer satisfaction	ISM	India
35	Hall, O.,P., Mcpeak, C.,J.,	2011	Increasing productivity, cost reduce, improved pricing	ABC	California
36	Hussain, I., et al.	2011	Growth performance, effectiveness of Smes	Performance measurement	Pakistan

37	Fraser, K., et al.	2011	Improve knowledge of various maintenance model	TPM,RCM, CBM	Australia
38	Hashim, S. et al.,	2012	Improve manufacturing performance, increase effective use equipment, automobile Industry	TPM, LM	Malaysia
39	Alexis,O., et al.	2012	Improving reliability, maintenance management,	MM	Venezuela
40	Panizzolo, R., et al.	2012	Creating performance culture, encourage participation	LM	Italy
41	Jamian, J., et al.	2012	Operational and environmental performances increase in Smes	5 S	Malaysia
42	Ho-Seong, Yi	2012	Min technological unemployment, adoption of new technologies	Technology management	South Korea
43	Emami, R., et al.	2012	Job satisfaction, learning culture, turnover intention	Information system , KG	Malaysia
44	Shah., B.	2012	Support implementation, solve problem n challenges of Smes	TPM, CSF	U.K
45	Winter, C., P., et al.,	2012	Quantify the customer service level, provide the necessary processes	SME, FMEA, RCM	Germany
46	Mathur, A., et al.,	2012	Improved productivity, cost reduction	KPI n tools	India
47	Wakjira, M., W., et al.	2012	Improve production, OEE, eliminates breakdown	OEE, TPM	USA
48	Nowduri, S.	2012	Overall improvement , beyond regions	Sustainability entrepreneurship	India
49	Huang, B., et al.	2013	Deficiency of self-innovation, cost based	SMEs, cloud manufacturing	China
50	Kulkarni, A., et al.,	2013	Link b/w employee and TPM cost reduction, high morale	TPM, TQM kaizen	India
51	Attri, R., et al.	2013	Permits self-analysis, evaluation and comparison of organizations	KPI n tools	India
52	Doshi, J. Desai, D.,	2013	Quality improvement, risk reduce, durability, customer satisfaction	Continuously quality improve	India
53	Bhamu, et al.	2013	Lean manufacturing, descriptive analysis	LM	India
54	Sharma, R., K., et al.	2013	Reduce rework, quality, improvement in availability	TPM, Six sigma	India
55	Robson, K., et al.	2013	Reduce excessive level of machine failure, new methods development	maintenance approaches	U.K
56	Macchi, M., et al.,	2014	SMES maintenance improvement, increase capability	TQM,LM	Italy
57 a	Jain, A. et al.	2014	Increase quality, customer satisfaction	TPM	India
57	Jain, A. et al.	2014	Increase quality, customer satisfaction	TPM	India
58	Akindipe,O.,S.	2014	ROI, strongly influence optimum use of resources	IM, inventory management	Nigeria
59	Radziwon, A, et al.	2014	Increase the equipment effectiveness, increasing profits based	SMEs, Flexible Manufacturing	Denmark

60	Jie J.,C.,R., et al.	2014	Increase productivity, increase capacity, customer satisfaction	Six sigma , Lean manufacturing	Malaysia
61	Pattanawasanporn,P.,et al.	2014	Increases employment efficiency, increase skills, decrease defects and delays	TQM	Thailand
62	Bayarçelik., E., B., et al.	2014	Determining innovation factors, smes environment strategy	SMES, financial factor	Turkey
63	Hadjiski, M., et al.	2014	Increase equipment effectiveness, increase ROI	Predictive maintenance	Bulgaria
64	Büyüközkan, G. et al.,	2015	Performance, improve business, bayesian	LM	Turkey
65	Mishra, R.,P.,et al.,	2015	Overall efficiency, quality, performance, cost, better service, reduce	WCM, TPM	India
66	Hu, Q., et al.	2015	Standardized understanding and approach in Lean Smes	LM	U.K
67	Gupta., G., et al.	2015	Reliability analysis and identification of critical component	Reliability, availability	India
68	Parikh, et al.	2015	Zero defects. achieving zero breakdowns	TPM,OEE	India
69	Majumdar, J.,P.	2016	Quality, reliability, sampling	TQM	India
70	Jain, M., K., et al.,	2016	Continuously increasing standards of customer satisfaction is endless	Definition SMEs	India
71	Yadav,V ., Jain, R.,	2016	Increasing efficiency, productivity, lay out improvement	TPM	India
72	Moeuf., A., et al.	2016	Improve reliability, higher performance of product	TQM	Paris
73	Gerba, Y., T., et al.	2016	Reduce transaction costs, learn new skills to workers	External environment	India
74	Thanki, S., et al.	2016	Integration of lean with green environment, implementation feasibility	LM	India
75	Bruno, G., et al.	2016	Increase productivity, reduce ideal time, system updating time	LM	Italy
76	Gupta, H.	2016	Improve service quality, improve organization performance	TQS,TPM	India
77	Netto., R., J., k., et al.	2016	Improve equipment effectiveness	OEE, CBM	Brazil
78	Majumdar, J.,P	2016	Quality, reliability, sampling	TQM	India
79	Majava, J., et al.	2017	Increase productivity, product quality	LM	Finland
80	Wan, L., et al.	2017	Improve employee morale and job satisfaction	TPM	Shanghai
81	AlManei, M., et al.	2017	Reducing waste, improving operating efficiency	LM	U.K
82	Baglee, D., et al.	2017	Performance improved, knowledge increases	CBM,RCM,AMS	Sunderland

83	Knol, W.,H., et al.	2018	Improve performance, training, quality	LM	Nether--lands
84	Pai, M., P., et al.	2018	Improve productivity, safety, employee morale	TPM	India
85	Joshi, K.,M., Bhatt, D.,V.	2018	Creates improvement in safety and sanitation condition & motivation	TPM	India
86	Sezer, E., et al.	2018	Predictive maintenance strategies, digitalization, cost reduction	CBM, PMS	Mexico
87	Mohanti., J.	2018	Economic growth, improve performance of Smes	SMEs, SSI	India
88	Annual report	2018	Growth performance, effectiveness of Smes, different types	SMEs	India
89	Caldera., H. T., S.,. et al,	2019	Integration of lean with green environment, save money, implementation feasibility,	Lean green enablers	Australia
90	Dias., M., C., et al.	2019	Maintenance difficulties, improve quality of maintenance system	QMS, CSF	Brazil
91	Gupta., A., et al.	2019	TPM, implementation, achieve higher growth	TPM, SME	India
92	Pagare, A., K., et al.	2020	Improve production rate, cost saving, remove failures of machines	Predictive maintenance	India
93	Sidhu., S., S., et al.	2020	Execution of best practices, improve product quality, higher returns	Maintenance practices, quality reliability	India

IV. ANALYTICAL DESCRIPTION OF TABLE DATA: FROM **TABLE 3.1** AND **TABLE 3.2**

After analyzing review of literature, few discussions, comments and outcomes consider in present section.

1) From the results of table it indicates that around 35% of research papers are based on empirical in nature discussed the basic concepts or explanation of maintenance processes containing performance evaluation difficulties. Approximately 50% of research papers deal with the descriptive methodologies.

2) From the result of the table author also concluded the maximum number of optimization tools used for maintenance of SMEs. Author categorized the combinations of all tools according to their development (year) wise.

3) Result shown table 3.2 that entire 94 available maintenance tools divide into five groups by author for comparison i.e.

a) Maintenance / Preventive maintenance

b) Total productive maintenance / 5 S

c) Total quality maintenance / Benchmarking

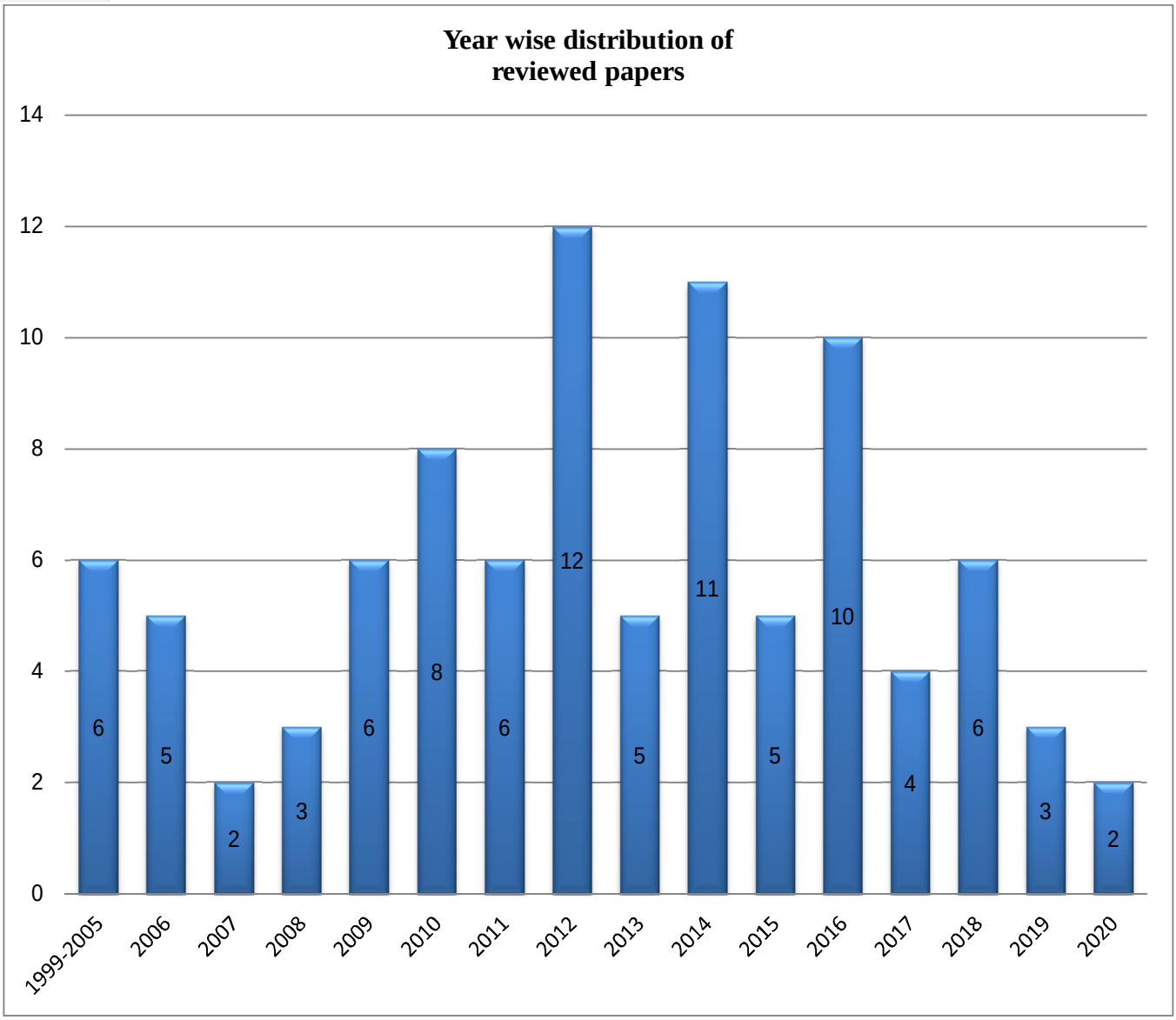
d) Lean manufacturing / Six Sigma

e) World class maintenance / RCM/ Others

4) Classification of research papers over a period of time

Diagram represents distribution of all 94 articles from 1999 to April 2020. U

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue IV Apr 2022- Available at www.ijraset.com



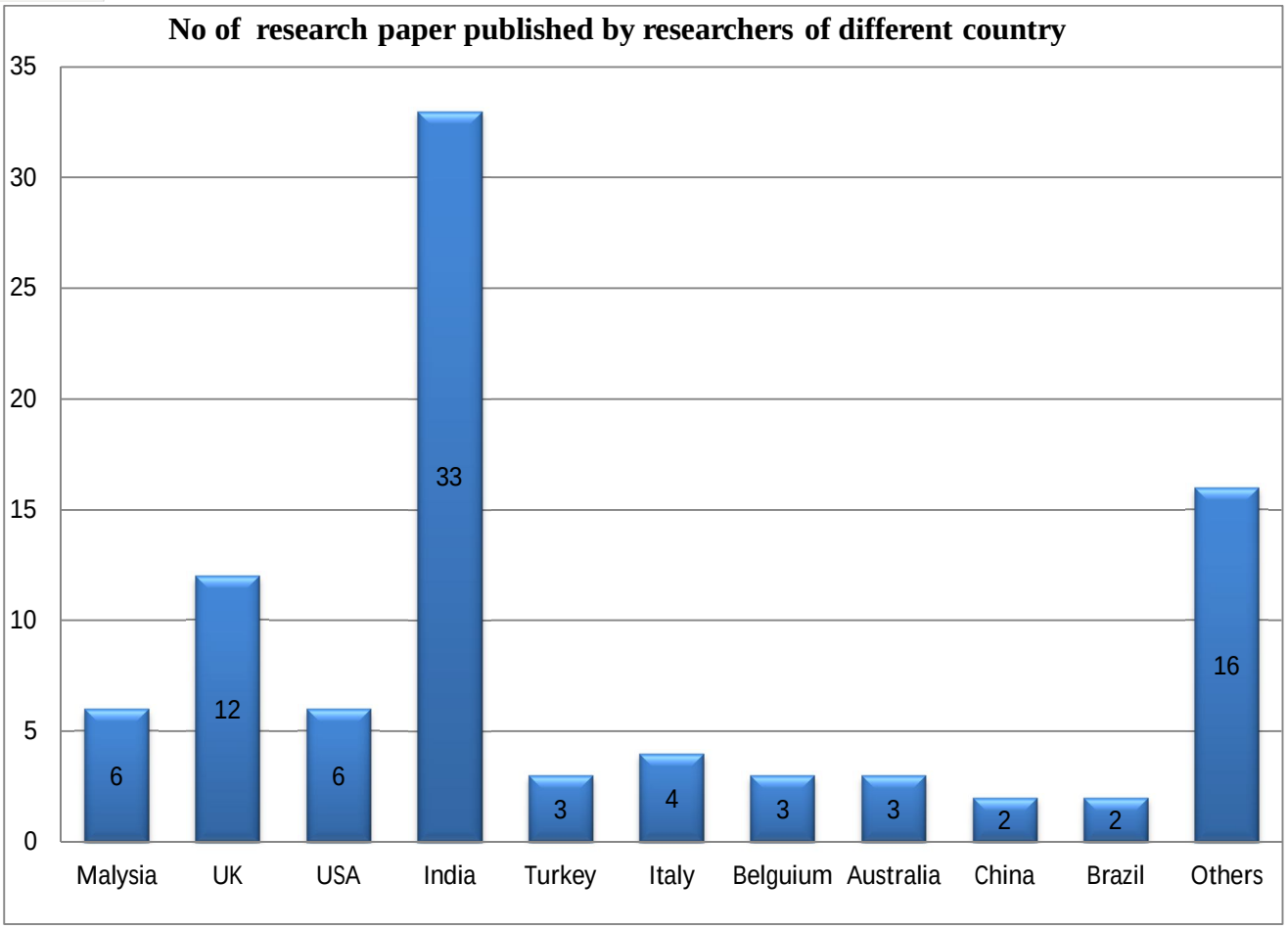
Conclusion can be taken from the data table that the study of various maintenance practices has been collected from the starting of the twenty first century assumed that conduct research takes few more years to published and composed. Market recession was one of the reasons during this time. This force of recession derives the various enterprises and research scholars to come forward with solutions to minimize the cost of production. Maintenance optimization tools and their implementation procedures were broadly considering for cost cutting through waste reduction.

5) Distribution of research papers over regional basis

As shown the figure below, around 37 percent of the papers are published by authors from India. USA, UK and Malaysian authors publish 13, 7 and 7 percent respectively. Maximum number of research papers is based on the experimental study of Indian industry. There are various authors from many nations.

This demographically presentation of authors indicates that various maintenance practices in SMEs is applicable on whole word either from developed counties to developing countries. Unexpectedly Author observes the involvement of Japanese is less. One of the reasons for this is that the Japanese prefer the term Toyota production.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue IV Apr 2022- Available at www.ijraset.com



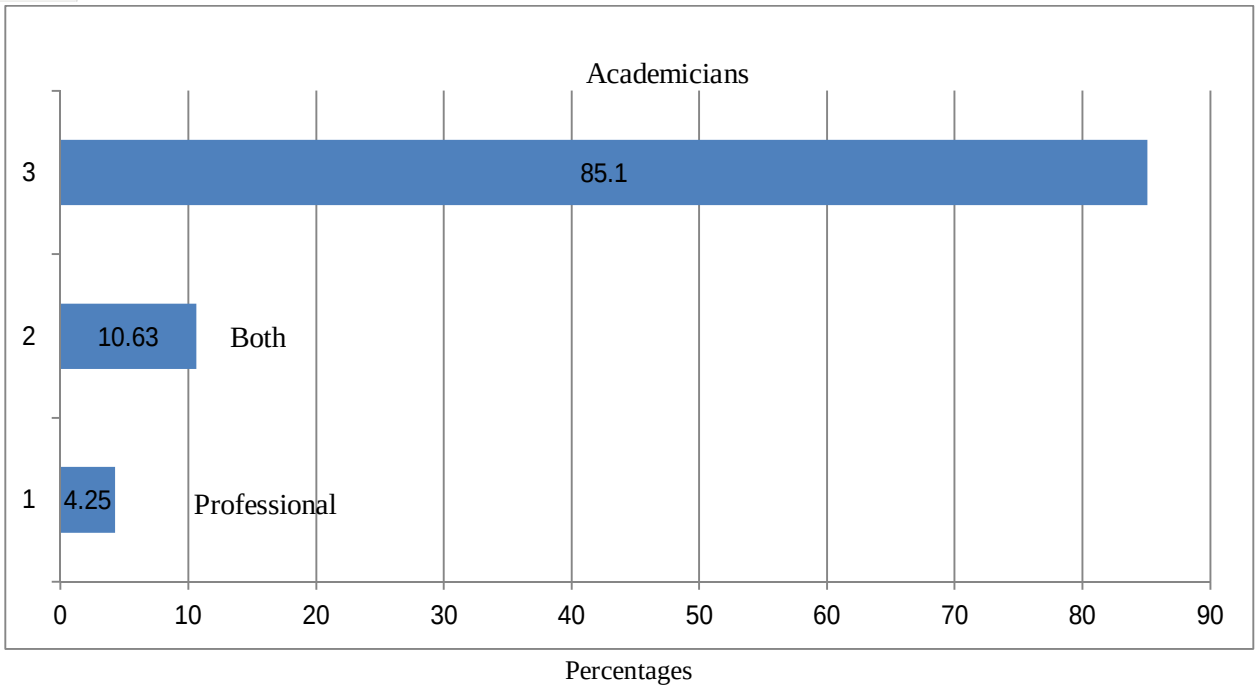
Others included: Canada, Russia, Spain, Portugal, Venezuela, South Korea, Germany, Nigeria, Thailand, Paris, Finland, Sweden, Prague, Denmark, and Netherlands.

In this section author presents the review of 94 scholarly articles during 1999-2020 from various international journals and conferences determining the research participation. Nearly twenty seven articles (approximately 29 per cent of total considered articles) were published in the following 10 different journals:

a) Journal of Quality in Maintenance Engineering (05).
b) International Journal of Production Economics (03).
c) Productivity Planning and Control (04).
d) International Journal of Productivity & Quality Management (02).
e) International Journal of Engineering Research and Development (02).
f) International Journal of Production Research (03).
g) Journal of Cleaner Production (02).
h) Journal of Quality in Maintenance Engineering (02).
i) International Conference on Industrial Engineering and Management (03).
j) Small Business Economics (02).

Most of the research in Maintenance practices is developed by academic writers using enterprise details. In total 94 writer's considerations, approximate 80 writers (which is 85.10 %) are actually related with academics and only 4 writers (4.25 %) are professionals. In total, 10 writers (10.63 %) are both writers as well as professionals.

Below figure shows the percentage distribution of research papers



From analyzing the available data, Paper concluded that most of the coverage related with topic of Maintenance Practices in SMEs. This study performed between the periods of 1999-2020 was given by *The Journal of Quality in Maintenance Engineering,* and *Production Planning and Control.* 142 research papers published on maintenance management reviewed and methodically classified by Garg and Deshmukh (2006). Bhamu and Sangwan (2014) have also reviewed 209 published research papers related with maintenance. All the collected papers for this study related to maintenance implementation in SMEs have been classified year wise, as shown.

Maintenance could also be implemented in different sectors of industries as maintenance of SMEs, manufacturing industries, process industries, services industries etc. SMEs maintenance consist all types of SMEs. Manufacturing sector consist automobile industries, various steel plants, different types of tyre plants etc. Process sector consist textiles, food process, beverage, petroleum and oil industries. Service sector consist to produces services, maintenance, repairs, training, or consulting.

V. RECENT MAINTENANCE IMPLEMENTATION BARRIERS OF SMES

In present scenario SMEs are customer base industries which facing the various challenges due to cut throat competition. These challenges are in terms of reliability, quality, durability, cost, shape and size of the products, policies, employee, regulations etc. These challenges are also called barriers of SMEs. Author categorized various types of probable barriers which effects maintenance implementations in SMEs.

Prospective Gaps and Barriers	Symbols	Barriers Measures	References
Management side	GB1	Absence of implementation of commitments by top authorities	Mishra, R.P. et al. (2008), Ahuja, I.P.S. et al. (2008), Ma´rquez, A.C. et al. (2009), Bamber, C.J et al. (1999), Singh, R.K. et al. (2008), Attri, R. et al.(2013), Majumdar, J.,P. (2016), Panizzolo, R., et al. (2012)
	GB2	Lack of awareness of approaches and ideology by mid-level managers	Alexis,O., et al. (2012), Bamber, C.J et al. (1999) and Kulkarni, A., et al. (2013)
	GB3	Pay too much attention on production outputs as compare to inlet quality	Hall, O.,P. et al. (2011), Baglee, D., et al. (2008), Dai, W.(2009), Pattanawasanporn, P. et al (2014)

Organizational side	GB4	Lack of resources (men, materials, capital, time-period, etc.)	Singh, R.K. et al. (2008), Ahuja, I.P.S. et al. (2008), Bamber, C.J et al. (1999)
	GB5	Absence of maintenance objectives of manufacturing site workers	Attri, R. et al.(2013), Ahuja, I.P.S. et al. (2008), Mishra, R.P. et al. (2015), Panizzolo, R., et al. (2012)
	GB6	Large turnover issues	Bamber, C.J et al. (1999), Dai, W. (2009)
Working culture	GB7	Frequent change in working environment	Attri, R. et al.(2013), Baglee, D. et al.(2010), Hashim, S. et al.(2012)
	GB8	Hurdle exists between various operational units	Singh, R.K. et al. (2008), Bamber, C.J et al. (1999) and Rose, A. M. N. et al.(2010)
	GB9	Unwillingness with frequent changes in working environment	Singh, R.K. et al. (2008), Ahuja, I.P.S. et al. (2008), Ma´rquez, A.C. et al. (2009), Bamber, C.J et al. (1999), Attri, R. et al.(2013)
Workers side	GB10	Absence of commitments of workforce	Ahuja, I.P.S. et al. (2008), Kulkarni, A., et al. (2013), Gupta., A., et al. (2019)
	GB11	Limitation with working sources	Singh, R., K., et al. (2010), Baglee, D., et al. (2008), Macchi, M., et al. (2014)
	GB12	Absence of work togetherness in same working units	Kris,D., et al (2011) , Bamber, C.J et al. (1999)
Monetary	GB13	Economic restrictions	Baglee, D. et al.(2010), Ahuja, I.P.S. et al. (2008)
	GB14	Higher workers expenses	Hashim, S. et al.(2012),
	GB15	Absence of better award schemes	Bamber, C.J et al. (1999), Ahuja, I.P.S. et al. (2008), Pattanawasanporn, P. et al (2014)
Prospective Gaps and Barriers	Symbols	Barriers Measures	References
Strategical side	GB16	Lack of provision of policies	Ahuja, I.P.S. et al. (2008), Macchi, M., et al. (2014), Pattanawasanporn, P. et al (2014)
	GB17	Maintenance implementation and strategy issues	Mishra et al. (2008), Bamber, C.J et al. (1999), and Hashim, S. et al.(2012)
	GB18	Insufficient utilization of workers and team	Singh, R., K., et al. (2010), Thanki, S., et al. (2016)
Functional side	GB19	Deficiency to understand and information about maintenance	Ahuja, I.P.S. et al. (2008), Baglee, D., et al. (2008), Dai, W.(2009)
	GB20	Underestimate the assignment	Attri, R. et al.(2013), Majumdar, J.,P. (2016),
	GB21	Shortage of progress time intervals	Bamber, C.J et al. (1999), .
Technological	GB22	Lack of monitoring tools	Hall, O.,P. et al. (2011)
	GB23	Lacking of Computer Aided Process Planning (CAPP)	Ahuja, I.P.S. et al. (2008), Jain, A. et al. (2014)
	GB24	Absence of quality measurement and performance measurement systems	Hussain, I. et al. (2012), Alexis,O., et al. (2012)
Instrument side	GB25	Deficiency in maintenance management system	Panizzolo, R., et al. (2012)
	GB26	Absence in autonomous maintenance	Bamber, C.J et al. (1999), Rose, A. M. N. et al.(2010), Macchi, M., et al. (2014)

	GB27	Deficiency in instruments handling	Hashim, S. et al.(2012), Jain, A. et al. (2014)
Consumer side	GB28	Profit based setup of Smes not consumer oriented	Bhamu, et al. (2006)
	GB29	Variable philosophy for manufacturing / production process	Hashim, S. et al.(2012)
	GB30	Deficiency in customer management policies	Thanki, S., et al. (2016)
Information-based	GB31	Communication gap from top- level management side	Ahuja, I.P.S. et al. (2008), Majumdar, J.,P. (2016),
	GB32	Absence in coordination level between various production units	Panizzolo, R., et al. (2012)
	GB33	Lack of synchronization between manufacturing and support	Ahuja, I.P.S. et al. (2008),
Governmental	GB34	Absence in government regulations of Smes	Thanki, S., et al. (2016)
	GB35	Larger quantities of bank capital credit	Jain, A. et al. (2014), Attri, R. et al.(2013),
	GB36	Lacking of implementations in governments health and safety provisions for Smes	Thanki, S., et al. (2016)
Prospective Gaps and Barriers	Symbols	Barriers Measures	References
Infrastructural	GB37	Deficiency of skilled workers	Ahuja, I.P.S. et al. (2008)
	GB38	Absence of maintenance measuring tools during implement	Majumdar, J.,P. (2016), Pattanawasanporn, P. et al (2014)
	GB39	Absence in workforce management department	Panizzolo, R., et al. (2012)
Education and Training	GB40	Absence of skilled coordinator	Majumdar, J.,P. (2016)
	GB41	Deficiency in implementation and knowledge issue	Singh, R., K. (2011)
	GB42	Absence in training and educating policies	Ahuja, I.P.S. et al. (2008), Mishra, R.P. et al. (2008), Bamber, C.J et al. (1999), Panizzolo, R., et al. (2012), Macchi, M., et al. (2014)
Psychological	GB43	Absence in long-term dedication of workers with management policies	Sharma, R. K. et al. (2013) Majumdar, J.,P. (2016),
	GB44	Examination of other activities excluding works	Ahuja, I.P.S. et al. (2008), Bamber, C.J et al. (1999)
	GB45	Absence of leadership agreement	Pattanawasanporn, P. et al (2014)

A. Recent Maintenance Implementation Enablers of SMEs

The taxonomy of drivers and enablers introduces as a probable technique to facilitate continuous manufacturing practice in SMEs. Some of them are presented, drawn from the thematic analysis: integrated strategies, continuous improvement, stakeholder involvement and streamlined processes.

Below table categorized the all possible combinations of enablers which show the essentiality of maintenance implementation in SMEs.

Prospective Enablers	Symbols	Enablers Measures	References
Management side	EB1	Full involvement of higher authorities with workers and all units of SMEs in maintenance activities	Caldera., H. T. S. et al (2019), Ahuja, I.P.S. et al. (2008), Alexis, O. et al. (2012), Mishra, R.P. et al. (2008), Coad, A. et al. (2011), Gupta, A. et al. (2019)
	EB2	Involvement in exercise and Learning programs	Bamber, C.J et al. (1999), Singh, R.K. et al. (2008), Attri, R. et al.(2013), Hashim, S. et al.(2012)
	EB3	Promotion of quality standards and planning of maintenance practices	Mishra, R. P. et al. (2008)
Prospective Enablers	Symbols	Enablers Measures	References
Organizational side	EB4	Arrange enough quantity of resources (men, materials, capital, time-period, etc.)	Bamber, C.J et al. (1999), Ahuja, I.P.S. et al. (2008), Cagliano, R. et al. (2001)
	EB5	Properly defined maintenance objectives, uses 5'S	Ahuja, I.P.S. et al. (2008), Attri, R. et al. (2013)
	EB6	Efficient implementing and uses maintenance frameworks	Waeyenbergh,G., et al. (2002), Bamber, C.J et al. (1999),
Working culture	EB7	To maintain healthy and smooth working environment	Rajesh Attri, Rajesh (2013), Shah,R.,et al. (2003)
	EB8	Effectively implementing TPM and Lean manufacturing	Bamber, C.J et al. (1999), Waeyenbergh,G., et al. (2002)
	EB9	To improve the willingness of employees with changing work environment culture	Pierre, J., S., et al. (2004), Bamber et al. (1999), Lawrence (1999), Ahuja, I.P.S. et al. (2008), Rao, N.,J., et al. (2007)
Workers side	EB10	Determination in commitment of employees	Singh,L.,P., et al. (2006), Ahuja, I.P.S. et al. (2008), Kulkarni, A., et al. (2013)
	EB11	To facilitates qualitative and quantitative resources to workers	Sharma, R. K.et al.(2013), Cagliano, R. et al. (2001)
	EB12	To improve team working culture among different units	Bamber, C.J et al. (1999), Panizzolo, R., et al. (2012)
Monetary	EB13	Increase investment in R & D and concern requirement of Sme	Ahuja, I.P.S. et al. (2008), Baglee, D. et al. (2008)
	EB14	Financial support and better salary ranges	Wan, L., et al. (2017)
	EB15	Improve better wages, incentives overtimes and award schemes	Ahuja, I.P.S. et al. (2008), Bamber, C.J et al. (1999),
	EB16	Implementing TPM, Six sigma,	Hashim, S. et al.(2012), Tesar, S., et al. (2010)

Strategical side		Lean manufacturing, 5'S etc	
	EB17	Utilize OEE, predictive and preventive maintenance in Smes	Bamber, C.J et al. (1999), Mishra, R.P. et al. (2008), Wakjira, M., W. et al. (2012)
	EB18	Proper work allocation, work rotation , increase team work	Jamian, R., et al. (2012)
Functional side	EB19	Accept different maintenance policies, RCM used	Winter, C., P., et al. (2012), Ahuja, I.P.S. et al. (2008)
	EB20	Performance based knowledge management, products reliability	Baglee,D., et al. (2017), Pierre, J. S. (2004)
	EB21	Utilizes KAIZEN, lean tools use	Bamber, C.J et al. (1999), Kulkarni, A., et al. (2013)
Technological	EB22	Implementation of computerized total production monitoring	Yusof, S.M. et al. (2000)
	EB23	(CAPP) Computer aided process planning , CAD/ CAM uses	Ahuja, I.P.S. et al. (2008), Ho-Seong, Yi (2012)
	EB24	Accept TQM for maintain the quality measurement	Macchi, M., et al. (2014), Kulkarni, A., et al. (2013)
Prospective Enablers	Symbols	Enablers Measures	References
Instrument side	EB25	Implementing computer based maintenance manage system	Ma´rquez, A.,C., et al. (2009)
	EB26	Concentrate on autonomous maintenance system	Fumagalli, L., et al.(2009), Bamber, C.J et al. (1999)
	EB27	Implementing preventive and breakdown maintenance	Dai, W. (2009),
Consumer side	EB28	Focus on estimating the customer requirements	Ahuja, I.P.S. et al. (2008), Singh, L.P. et al. (2009)
	EB29	Wide range of acceptance in philosophy for production	Kris. D. et al. (2011)
	EB30	Implementing the customer requirement based policies	Winter. C. P. et al. (2011), Jain, M., K., et al. (2016)
Information-based	EB31	To improve the effectiveness of communication with top- level management	Ahuja, I.P.S. et al. (2008), Panizzolo, R., et al. (2012), Wakjira, M.W. et al. (2012)
	EB32	Implementing effective level of information system between various production units	Robson, K. et al. (2013), Waeyenbergh. G. et al. (2002)
	EB33	Real time tracking system for manufacturing and support	Ahuja, I.P.S. et al. (2008), Shah, R. et al. (2003)
Governmental	EB34	Accepting various government based policy for tax rebate and subsidy	Mohanti., J., J. (2018), Annual report (2018)
	EB35	Implementing different schemes of government for Smes	Jain, A. et al. (2014), Mohanti., J., J. (2018)
	EB36	Implementing health and safety provisions for all employees	Pai, M. P.et al. (2018), Joshi, K.M. et al. (2018)
	EB37	Improve efficiency and skills of employees	Pattanawasanporn, P.et al. (2014) , Ahuja, I.P.S. et al. (2008)

Infrastructural	EB38	Implementing various tools for measurement of maintenance	Baglee, D. et al. (2008), Attri, R. et al. (2013)
	EB39	Utilizes maintenance framework for improving performance of all the departments	Kulkarni, A., et al. (2013)
Education and Training	EB40	Appointed skilled coordinators for education and training	Cagliano, R., et al. (2001), Knol, W.H. et al. (2018)
	EB41	Arrange expert talks, seminars, conferences and workshops for improving skills of workers	Pattanawasanporn, P.et al. (2014) , Gerba, Y., T., et al. (2016),
	EB42	To implementing and regulate the best training and education policies for organization	Pierre, J., S., et al. (2004), Ahuja, I.P.S. et al. (2008), Mishra R.P. et al. (2008), Bamber, C.J et al. (1999), Waeyenbergh,G., et al. (2002), Bamber, C.J et al. (1999)
Prospective Enablers	Symbols	Enablers Measures	References
Psychological	EB43	Implementing long-term term workers retention policies for Smes	Singh, R., K., et al. (2010)
	EB44	Psychological and emotional treatment to workers regarding other activities also	Bamber, C.J et al. (1999), Ahuja, I.P.S. et al. (2008), Fumagalli, L., et al. (2009)
	EB45	To provide responsibility and ownership for workers	Caldera., H. T. S. et al. (2019)

VI. CONCLUSION

The Author endeavors to evaluate the effect of various possible barriers in the maintenance implementation in SMEs. Paper also considers possible taxonomy of SMEs enablers. The purpose is to improve the overall performance of SMEs.

At present, in a worldwide development the large-scale enterprises focusing on its essential skills proceedings on production, delivery of services and subcontracting SMEs for many times. This characteristic is because SMEs are the backbone of the large-scale enterprises. Consequently, this is the correct time for SMEs for implementing the aggressive maintenance policy of competitiveness.

At the beginning of the first section of the research, literature review considered. This section is about the detailed description of maintenance, definition, need, purpose, types, analysis with different available methodologies of SMEs. This section ended with various barriers and enablers of SMEs for effective implementation of maintenance in it. Development of Maintenance Framework for SMEs has been considered in next section of research by author.

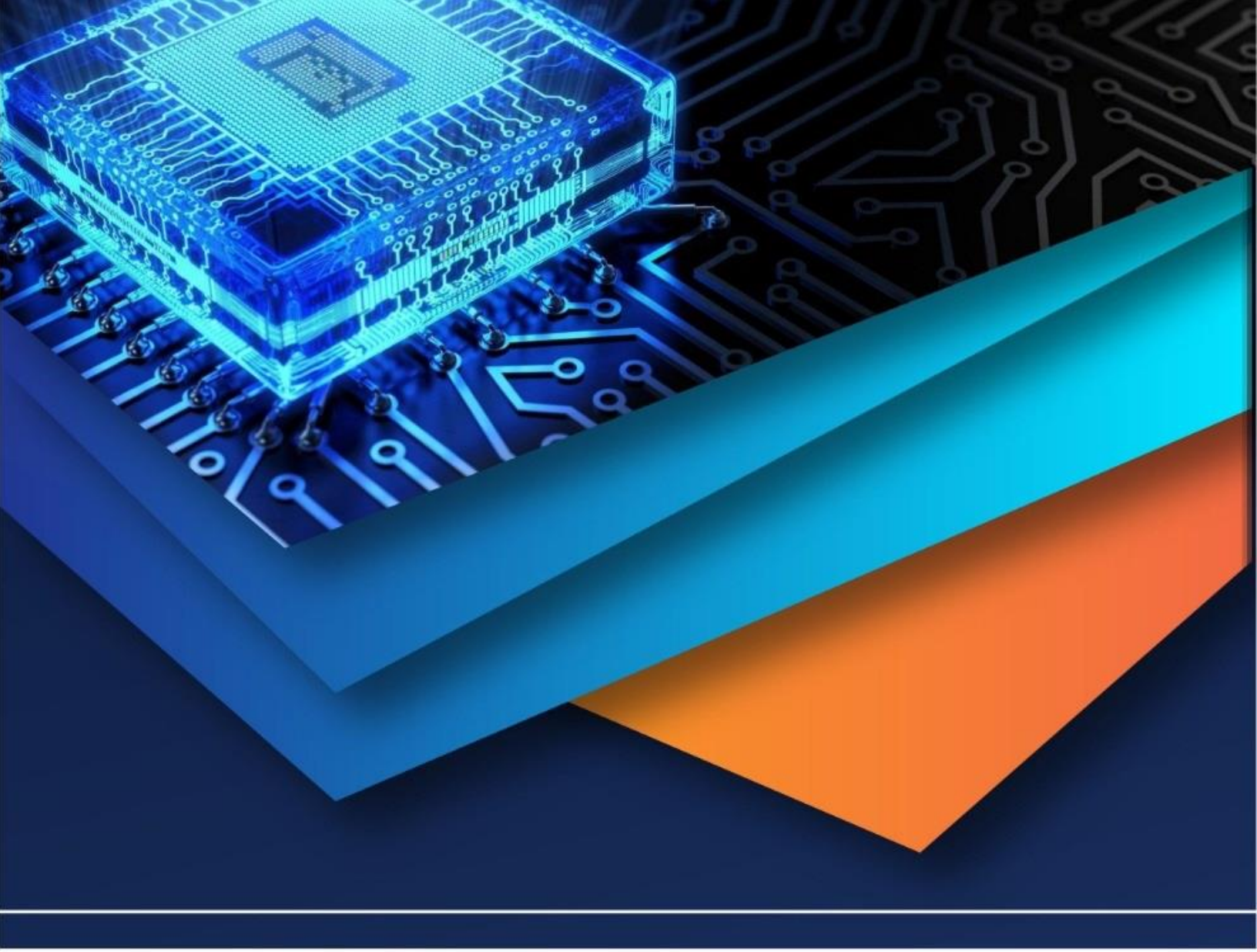
REFERANCES

[1] Aggarwal, H., Gupta, H. and Sengupta, J. (2017) ‘‘Conditions of Unorganized Manufacturing Industries with Special Reference to MSMEs: A Field Study in Uttar Pradesh’’, Global Business Review, pp. 1597–1612.
[2] Ahuja, I. P. S. and Khamba, J. S. (2008) ‘‘Total productive maintenance: Literature review and directions’’, International Journal of Quality and Reliability Management, pp. 709–756.
[3] Aljumaili, M. (2015) ‘‘Journal of Quality in Maintenance Engineering Article’’, Journal of Quality in Maintenance Engineering, pp. 358–374.
[4] Almanei, M., Salonitis, K. and Xu, Y. (2017) ‘‘Lean Implementation Frameworks: The Challenges for SMEs’’, Procedia CIRP. The Author(s), pp. 750–755.
[5] Alsyouf, I. (2007) ‘‘The role of maintenance in improving companies’’ productivity and profitability’’, International Journal of Production Economics, pp. 70–78.
[6] Attri, R., Grover, S. and Dev, N. (2014) ‘‘A graph theoretic approach to evaluate the intensity of barriers in the implementation of total productive maintenance (TPM)’’, International Journal of Production Research, pp. 3032–3051.
[7] Baba, D., Mohd Yusof, S. and Azhari, S. (2006) ‘‘A benchmarking implementation framework for automotive manufacturing SMEs’’, Benchmarking: An International Journal, pp. 396–430.
[8] Badli Shah, M. Y. (2012) ‘‘Total productive maintenance: A study of Malaysian automotive SMEs’’, Lecture Notes in Engineering and Computer Science, pp. 1460–1464.

[9] Baglee, D., Gorostegui, U., Jantunen , E., Sharma, P., Campos, J. (2017) ''How can SMEs adopt a new method to advanced maintenance strategies? A Case study approach'', Research paper, pp. 1-9.
[10] Baglee, D. and Knowles, M. (2010) ''Maintenance strategy development within SMEs: The development of an integrated approach'', Control and Cybernetics IFAC, pp. 275–303.
[11] Bamber, C. J., Sharp, J. M. and Hides, M. T. (1999) ''Factors affecting successful implementation of total productive maintenance: A UK manufacturing case study perspective'', Journal of Quality in Maintenance Engineering, pp. 162–181.
[12] Bayarçelik, E. B., Taşel, F. and Apak, S. (2014) ''A Research on Determining Innovation Factors for SMEs'', Procedia - Social and Behavioral Sciences, pp. 202–211.
[13] Bhamu, J. and Sangwan, K. S. (2014) ''Lean manufacturing: Literature review and research issues'', International Journal of Operations and Production Management, pp. 876–940.
[14] Bruno, G., Taurino, T. and Villa, A. (2018) ''An approach to support SMEs in manufacturing knowledge organization'', Journal of Intelligent Manufacturing. Springer US, pp. 1379–1392.
[15] Büyüközkan, G., Kayakutlu, G. and Karakadilar, I. S.(2015) ''Assessment of lean manufacturing effect on business performance using Bayesian Belief Networks'', Expert Systems with Applications, pp. 6539–6551.
[16] Cagliano, R., Blackmon, K. and Voss, C. (2001) ''Small firms under MICROSCOPE: International differences in production/operations management practices and performance'', Integrated Manufacturing Systems, pp. 469–482.
[17] Caldera, H. T. S. Desha, C. and Dawes, L. (2019)''Evaluating the enablers and barriers for successful implementation of sustainable business practice in lean SMEs'', Journal of Cleaner Production Elsevier Ltd, pp. 575–590.
[18] Chan, J. (2014) ''Implementing the Lean Six Sigma Framework in a Small Medium Enterprise (SME) – A Case Study in a Printing Company'', Proceedings of the 2014 International Conference on Industrial Engineering and Operations Management, pp. 387–396.
[19] Coad, A. and Tamvada, J. P. (2012) '' Firm growth and barriers to growth among small firms in India'', Small Business Economics, pp. 383–400.
[20] Dai, W. (2014) '' The Impact of Emerging Technologies on Small and Medium Enterprises (SMEs)'', Journal of Law and Governance, pp. 53–60.
[21] Dangayach, G. S. and Deshmukh, S. G. (2001) '' Manufacturing strategy Literature review and some issues'', International Journal of Operations and Production Management, pp. 884–932.
[22] Demirbag, M., Tatoglu, E., Tekinkus , M., and Zaim, S.,(2006) ''An analysis of the relationship between TQM implementation and organizational performance: Evidence from Turkish SMEs'', Journal of Manufacturing Technology Management, pp. 829–847.
[23] Doshi, J. A. and Desai, D. A. (2014) ''Review of continuous quality improvement methodology - enablers, exertion, benefits for SMEs'', International Journal of Quality and Innovation, pp. 245-255.
[24] Dowlatshahi, S. and Taham, F. (2009) ''The development of a conceptual framework for Just-In-Time implementation in SMEs'', Production Planning and Control, pp. 611–621.
[25] Emami, R., Moradi, E., Idrus, D., and Almutairi, D., O.(2012) ''Investigating the Relationship between Organizational Learning Culture , Job Satisfaction and Turnover Intention in it SMEs'', International Journal of Innovative Ideas, pp. 8–23.
[26] Fassoula, E. D. and Rogerson, J. H. (2003) ''Management tools for SMEs'', Total Quality Management and Business Excellence, pp. 1143–1158.
[27] Fraser, K., Hvolby, H. H. and Watanabe, C. (2011) ''A review of the three most popular maintenance systems: How well is the energy sector represented?'', International Journal of Global Energy Issues, pp. 287–309.
[28] Fumagalli, L., Macchi, M. and Rapaccini, M. (2009) ''Computerized maintenance management systems in SMEs: A survey in Italy and some remarks for the implementation of Condition Based Maintenance'', IFAC Proceedings Volumes (IFAC-Papers Online) IFAC, pp. 1615–1619.
[29] Garg, A. and Deshmukh, S. G. (2006) ''Maintenance management: Literature review and directions'', Journal of Quality in Maintenance Engineering, pp. 205–238.
[30] Gerba, Y. T. and Viswanadham, P. (2016) ''Performance Measurement of Small Scale Enterprises: Review of Theoretical and Empirical Literature'', International Journal of Applied Research, pp. 531–535.
[31] Gupta, A. (2019) ''An Analysis of Barriers and Enablers for Effective Implementation of Total Productive Maintenance (TPM) in Small and Medium Enterprises (SMEs) in India : Literature Review'', International Journal of Modern Engineering & Management Research, pp. 41-61.
[32] Gupta, G., Mishra, R. P. and Jain, P. (2016) ''Reliability analysis and identification of critical components using Markov model'', IEEE International Conference on Industrial Engineering and Engineering Management, pp. 777–781.
[33] Hadjiski, M. B., Doukovska, L. A., Kojnov, S. L., Monov, V. V., and Nikov , V. G., (2014) ''Significance of the predictive maintenance strategies for smes'', BMSD 2014 - Proceedings of the 4th International Symposium on Business Modeling and Software Design, pp. 276–281.
[34] Hall, O. P. and McPeak, C. J. (2011) ''Are SMEs ready for ABC?'', Journal of Accounting & Finance, pp. 11–22.
[35] Hashim, S., Habidin, N. F., Conding, J., Ain, N., Jwaya, S. L., Zubir, A. F. M., (2012) ''Total Productive Maintenance and Innovation Performance in Malaysian Automotive Industry'', International Journal of Engineering Research and Development, pp. 2278–2267.
[36] Hu, Q., Mason, R., Williams, S. J., and Found, P. (2015) ''Lean implementation within SMEs: A literature review'', Journal of Manufacturing Technology Management, pp. 980–1012.
[37] Huang, B., Li, C., Yin, Chao.and Zhao, X., (2013) ''Cloud manufacturing service platform for small- and medium-sized enterprises'', International Journal of Advanced Manufacturing Technology, pp. 1261–1272.
[38] Hussain (2012) ''SMEs development and failure avoidance in developing countries through public private partnership'', African Journal of Business Management, pp. 1581–1589.
[39] Jain, A., Bhatti, R. and Singh, H. (2014) ''Total Productive Maintenance (TPM): A Proposed Model for Indian SMEs'', International Journal of Mechanical and Production Engineering Research and Development (IJMPERD), pp. 1–22.
[40] Jain, A., Bhatti, R. and Singh, H. (2014) ''Total productive maintenance (TPM) implementation practice: a literature review and directions'', International Journal of Lean Six Sigma, pp. 293–323.
[41] Jain, M. K. C. and Gandhi, S. K. P. (2016) ''Defining Indian SMEs: A Critical Analysis'', International Journal of Arts, Humanities and Management Studies, pp. 12-25.

[42] Jamian Rahim, Ab Rahman Mohd Nizam, M.D Baba and Nik Ismail, N. Z. (2012) ''A Conceptual Model Towards Sustainable Management System Based Upon 5S Practice For Manufacturing SMEs'', Asia Pacific Journal of Operations Management, pp. 19-31.
[43] Joshi, K. M. (2018) "A Modified TPM Framework for Indian SMEs", International Journal of Advanced Research in Engineering and Technology (IJARET) Volume 9, Issue 6, pp. 1–14.
[44] Knol, W. H., Slomp, J., Schouteten , R.L.J. and Lauche , K. (2018) ''Implementing lean practices in manufacturing SMEs: testing critical success factors using Necessary Condition Analysis'', International Journal of Production Research Taylor & Francis, pp. 3955–3973.
[45] Kour, M. (2016) "SMEs and their significance in India'', International Journal Multidisciplinary and Academic Research (SSIJMAR), pp. 1–8.
[46] Kr Singh, R. (2011) ''Analyzing the interaction of factors for success of total quality management in SMEs'', Asian Journal on Quality, pp. 6–19.
[47] Kris, D., Thierry, D. and Johannes, C. (2011) "A Method to Support SMEs to Optimize their Manufacturing Operations'', MITIP 2011, Norwegian University of Science and Technology, Trondheim, Norway, pp. 1-10.
[48] Kulkarni, A. and Dabade, M. (2013) ''Investigation of Human Aspect in Total Productive Maintenance (TPM): Literature Review'', International Journal of Engineering Research and Development, pp. 2278–67.
[49] Kumar Sharma, R. and Gopal Sharma, R. (2014)''Integrating six sigma culture and TPM framework to improve manufacturing performance in SMEs'', Quality and Reliability Engineering International, pp. 745–765.
[50] Kumar, M., Antony, J., Singh, R. K., Tiwari, M. K., and Perry, D.(2006) ''Implementing the lean sigma framework in an Indian SME: A case study'', Production Planning and Control, pp. 407–423.
[51] Macchi, M., Pozzetti, A. and Fumagalli, L. (2014) ''Exploring the Integration of Maintenance with Production Management in SMEs'', IFIP Advances in Information and Communication Technology, pp. 507–514.
[52] Majava, J. and Ojanperä, T. (2017) ''Lean Production Development in SMEs: A Case Study'', Management and Production Engineering Review, pp. 41–48.
[53] Majumdar, J. P. and Manohar, B. M. (2016) ''Why Indian manufacturing SMEs are still reluctant in adopting total quality management'', International Journal of Productivity and Quality Management, pp. 16–35.
[54] Márquez, A. C. et al. (2009) ''The maintenance management framework: A practical view to maintenance management'', Journal of Quality in Maintenance Engineering, pp. 167–178. Mathur, A., Mittal, M. L. and Dangayach, G. S. (2012) ''Improving productivity in Indian SMEs'', Production Planning and Control, pp. 754–768.
[55] Mishra, R. P. et al. (2015)''Development of a framework for implementation of world-class maintenance systems using interpretive structural modeling approach'', Procedia CIRP Elsevier B.V., pp. 424–429.
[56] Nowduri, S. (2012) ''Framework for Sustainability Entrepreneurship for Small and Medium Enterprises (SMEs) in an Emerging Economy'', World Journal of Management, pp. 51–66. Ortiz, A., Carlos, R. M. and Henry, I. (2012)''Maintenance management model for industrial Smes'', 6th International Conference on Industrial Engineering and Industrial Management, pp. 276–283.
[57] Pagare, A. and Kumar, N. (2020)''Improve Production Rate using Substitute Machine with Predictive Maintenance Plan'', SSRN Electronic Journal, pp. 1–4.
[58] Panizzolo, R., Garengo, P., Sharma, M. K., Gore, A., (2012) ''Lean manufacturing in developing countries: Evidence from Indian SMEs'', Production Planning and Control, pp. 769–788.
[59] Pattanawasanporn, P. (2014) ''Logistics and Supply Chain Management approach to SMEs in Noodle Factory Industry - Lean and Six Sigma Tool'', Proceedings of the 2014 International Conference on Industrial Engineering and Operations Management January 7 – 9, 2014, pp. 3105–3118.
[60] Pillania, R. K. (2008)''Creation and categorization of knowledge in automotive components SMEs in India'', Management Decision, pp. 1452–1464.
[61] Pophaley, M. and Vyas, R. K. (2010) ''Plant maintenance management practices in automobile industries: a retrospective and literature review'', Journal of Industrial Engineering and Management pp. 512-541.
[62] Pai, M. P., Ramachandra, C. G., Srinivas, T. R., and Raghavendra, M. J., (2018) ''A Study on Usage of Total Productive Maintenance (TPM) in Selected SMEs'', IOP Conference Series: Materials Science and Engineering, pp. 1-8.
[63] Radziwon, A., Bilberg, A., Bogers, M., and Madsen, E. S., (2014) ''The smart factory: Exploring adaptive and flexible manufacturing solutions'', Procedia Engineering Elsevier B.V, pp. 1184–1190.
[64] Robson, K., MacIntyre, J. and Trimble, R. (2013) ''Towards a Simpler Selection Process for Maintenance Strategies'', International Journal of Business and Management, pp. 105–114.
[65] Rose, A. M. N., Deros, B. Md. and Rahman, M. N. Ab (2010) ''Development of framework for lean manufacturing implementation in SMEs'', The 11th Asia Pacific Industrial Engineering and Management Systems Conference The 14th Asia Pacific Regional Meeting of International Foundation for Production Research, pp. 1–5.
[66] Seow, C. and Jiying, L. (2006) ''Innovation in maintenance strategy through six sigma: Insights of a Malaysian SME'', ICMIT 2006 Proceedings - 2006 IEEE International Conference on Management of Innovation and Technology, pp. 793–797.
[67] Sezer, E., Romero, D., Guedea, F., Macchi, M., and Emmanouilidis , C., (2018) ''An Industry 4.0-Enabled Low Cost Predictive Maintenance Approach for SMEs'', 2018 IEEE International Conference on Engineering, Technology and Innovation, ICE/ITMC 2018 – Proceedings, IEEE, pp. 1–8.
[68] Shah, R. and Ward, P. T. (2003) ''Lean manufacturing: Context, practice bundles, and performance'', Journal of Operations Management, pp. 129–149.
[69] Sharma, A., Yadava, G. S. and Deshmukh, S. G. (2011)''A literature review and future perspectives on maintenance optimization'', Journal of Quality in Maintenance Engineering, pp. 5–25.
[70] Sidhu, S. S., Singh, K. and Ahuja, I. S. (2020) ''Role of Maintenance Practices in Indian SMEs: A Literature Review'', SSRN Electronic Journal, pp. 1-10 .
[71] Sigh, R. K., Garg, S. K. and Deshmukh, S. G. (2008) ''Challeges and strategies for competitiveness of SMEs: A case study in the Indian context'', International Journal of Services and Operations Management, pp. 181–200.
[72] Simões, J. M., Gomes, C. F. and Yasin, M. M. (2011) ''A literature review of maintenance performance measurement: A conceptual framework and directions for future research'', Journal of Quality in Maintenance Engineering, pp. 116–137.
[73] Singh, J. and Singh, H. (2010)''Assessment of Continuous improvement approach in SMEs of Northern India'', International Journal of Productivity and Quality Management, pp. 252–268. Singh, L. P., Bhardwaj, A. and Sachdeva, A. (2006) ''Quality management practices vs. performance of SMEs: An empirical study of Indian industries'', Portland International Conference on Management of Engineering and Technology, pp. 2393–2399.

[74] Singh, R. K., Garg, S. K. and Deshmukh, S. G. (2010) ''The competitiveness of SMEs in a globalized economy: Observations from China and India'', Management Research Review, pp. 54–65.
[75] St-Pierre, J. and Raymond, L. (2004) "Short-term effects of benchmarking on the manufacturing practices and performance of SMEs", International Journal of Productivity and Performance Management, pp. 681–699.
[76] Tesa, Š., Havlí, Z. and O, V. (2010) ''ICT industry and resources based analysis of maintenance SME in the Central'', Agris on-line Papers in Economics and Informatics, pp. 107–114.
[77] Thanki, S., Govindan, K. and Thakkar, J. (2016) ''An investigation on lean-green implementation practices in Indian SMEs using analytical hierarchy process (AHP) approach'', Journal of Cleaner Production Elsevier Ltd, pp. 284–298.
[78] Thomas, A., Barton, R. and Chuke-Okafor, C. (2009)"Applying lean six sigma in a small engineering company - A model for change", Journal of Manufacturing Technology Management, pp. 113–129.
[79] Van Der Lei, T., Herder, P. and Wijnia, Y. (2012) ''Asset management: The state of the art in Europe from a life cycle perspective'', Asset Management: The State of the Art in Europe from a Life Cycle Perspective, pp. 1–172.
[80] Waeyenbergh, G. and Pintelon, L. (2002)''A framework for maintenance concept development'', International Journal of Production Economics, pp. 299–313.
[81] Yadav, V. (2016)''Lean Manufacturing within Indian SMEs'', International Conference on Emerging Trends in Mechanical Engineering, pp. 1-5.
[82] Yusof, S. M. and Aspinwall, E. (2000)"Conceptual framework for TQM implementation for SMEs'', TQM Magazine, pp. 31–36.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY