Statistical Process Control (SPC) Implementation in Manufacturing Industry to Improve Quality Performance: A Prisma Systematic Literature Review and Meta Analysi

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Abstract. The fundamental need for quality in manufacturing is the production process must be able to generate the product with an acceptable variance from the stated quality index. Statistical process control (SPC) is frequently used to monitor standards, take measurements, and take corrective action. Preferred Reporting Items for Systematics Reviews and Meta-Analyses (PRISMA) methods were used to better inform reviewers and readers about the authors' actions and findings, speed up the review process, and improve the quality of the reporting. Publish or perish, VOS viewer, and Mendeley Desktop were also used to search related articles and analyze the bibliometric. The conclusion notes that integrating other quality approaches has increased the use of SPC in the manufacturing sector. This was applied within other quality improvement programs such as Six Sigma and TQM. Even though SPC is a statistically based technique, challenge, and limitation factors showed that implementing SPC in the manufacturing industry will be successful if other crucial factors like management, education/training, culture, and the availability of human resources are well-prepared. In conclusion, the authors hope that this review will highlight the value of SPC as a potential tool for quality control and enhancement in the manufacturing sector.

1. INTRODUCTION

The majority of the manufacturing industry is a labor-intensive industry whose process area still relies heavily on manual labor. Defects and low productivity are two of the most common issues [1]. The basic issue in a quality-orientated organization is to what level we can satisfy customers' expectations. One of the key techniques used to guarantee a specific standard of quality in a good or service in accordance with consumer expectations is quality control [2].

A product should be produced in a stable process in order to have an acceptable level of variation in the specified quality index relative to their stated specifications [3]. Statistical process control (SPC) is a statistical method that is frequently employed to make sure the process meets the standards. Statistical process control (SPC) is commonly used In Manufacturing process to monitor standards, take measurements, and take corrective action [4].

These SPC research objectives are to monitor and control the process to ensure that it performs at its full potential in order to generate a conforming product and determine the proactive approach to eliminate variations and to minimize non-conforming items products [5].

The SPC can be helpful not only for examining a single sample but also to monitor consistency over time. This is accomplished by using control charts to determine whether the process is considered to be performing appropriately or whether it is out of control [6].

The SPC involves collecting samples and determining if the mean, range, or standard deviation are all included within the confidence interval indicated by limits on a control graph, also termed as a control chart [7].

Control charts represent a control condition when all the points are within the control limit or an out-of-control situation when a point is outside the control limit. The mean chart and range chart clearly show that every point is between upper and lower control limits and oscillates up and down around the centerline without a distinct change trend or chain [8].

The various chart patterns offer tangible diagnostic data on the production system, allowing for system adjustment and achieving the objective of statistical process control [9].

Control charts, which are an important and fundamental component of statistical process control (SPC), can only identify assignable causes which need to be addressed through administrative, operational, and engineering actions. Three parallel lines which are the Central Line (CL), Upper Control Limit (UCL), and Lower Control Limit (LCL) are utilized for generating the control chart [10].

Montgomery categorizes control charts based on the characteristics of the process. A control chart should be designated as a type of variable if sampling can extract values from a continuous scale.

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Comparatively speaking, qualitative variables require a specific kind of attribute control chart. On the other hand, a particular kind of attribute control chart is required for qualitative variables. In addition, these two categories encompass a number of different types of control charts [11]. Although there are many various types of control charts, the X-bar and R-charts for variables with a small sample size are the most popular ones. They can also be based on a large sample size greater than or equal to ten [12].

Even though statistical process control (SPC) is frequently used in other industries, there are very few information and its applicability in the manufacturing industry due to the special characteristics of manufacturing products, and in order to plot a control chart, the data must be normally distributed. It is also essential to guarantee statistical independence (i.e., no correlation) among individual data collected [13].

Up to this point, there has not been a solid, structured review analyzing prior publications and guiding future research on the application of SPC in the manufacturing business. Utilizing a systematic literature review technique, the conclusion of this paper identifies significant implementation areas from the standpoint of operational aspects, including motivations, benefits, limitations, and agenda for future research. The study (meta-analysis) would be utilized to establish the significant importance and to generate a more comprehensive knowledge to understand the current trends related to the SPC in the manufacturing industry.

2. METHODOLOGY

2.1 Procedure

The methods used is systematic literature review (SLR) and meta-analysis with the Preferred Reporting Items for Systematics Reviews and Meta-Analyses (PRISMA). PRISMA methods were used to better inform reviewers and readers about the authors' actions and findings, speed up the review process, and improve the quality of the reporting [14]. The procedure of this systematic review consists of several steps:

1) Background and Purpose
2) Research Question.
3) Searching for literature.
4) Selection Criteria.
5) Practical Screen.
6) Quality Checklist and Procedures.
7) Data Extraction Strategy.
8) Data Synthesis Strategy.

2.2 Search Strategies

Relevant randomized controlled trials that were published electronically in the Google Scholar databases. The search articles were done online by using the search words “statistical process control” using Publish or Perish v8 software.

Table 1. Searching Literature Study

Publish or Perish V8	Source database	Keyword
	Google Scholar	“Statistical Process Control”

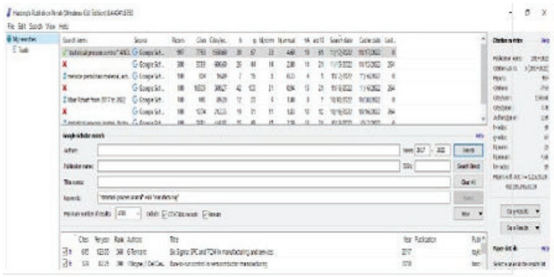

Fig. 1. Sourced by Google Scholar using Publish or Perish v8

2.3 Database Resources

Sources of data and information on literature studies were obtained from Google Scholar through software Publish or Perish v8 collected 997 Literature Studies using Literature Studies from 2017- 2022.

Table 2. Searching Literature Study

No	Process	Remark
1	Identification	The data search is from Google Scholar uses keywords.
2	Screening	This process includes filtering or selecting data (articles or research titles) according to the topic or title and keywords of the research problem.
3	Eligibility	This process is based on data (articles or research journals) with full text (Tittle & Abstract) that meet the inclusion and exclusion criteria.
4	Included	All data (articles or research journals) that meet all the requirements and criteria will be further analyzed.

2.4 Inclusion & Exclusion Criteria

Inclusion criteria: The study has specifically incorporated original journal articles published by respectable publishers, i.e., Emerald, Taylor and Francis, Elsevier, Wiley, and Cambridge, based on developing countries only, using Google scholar with Publish or perish v8. The study has also considered articles published between 2017 and 2022, while papers in the English language were explicitly considered for SLR and meta-analysis. The study has considered the keywords of “Statistical Process Control”, “Control Chart”, “Manufacturing”, “Statistical Quality Control” for search strategy.

Exclusion criteria: The study has excluded e book, theses, and unpublished research, while SLRs and meta-analyses were not taken into analysis. The study also excluded published articles before 2017 and for non-manufacturing sector.

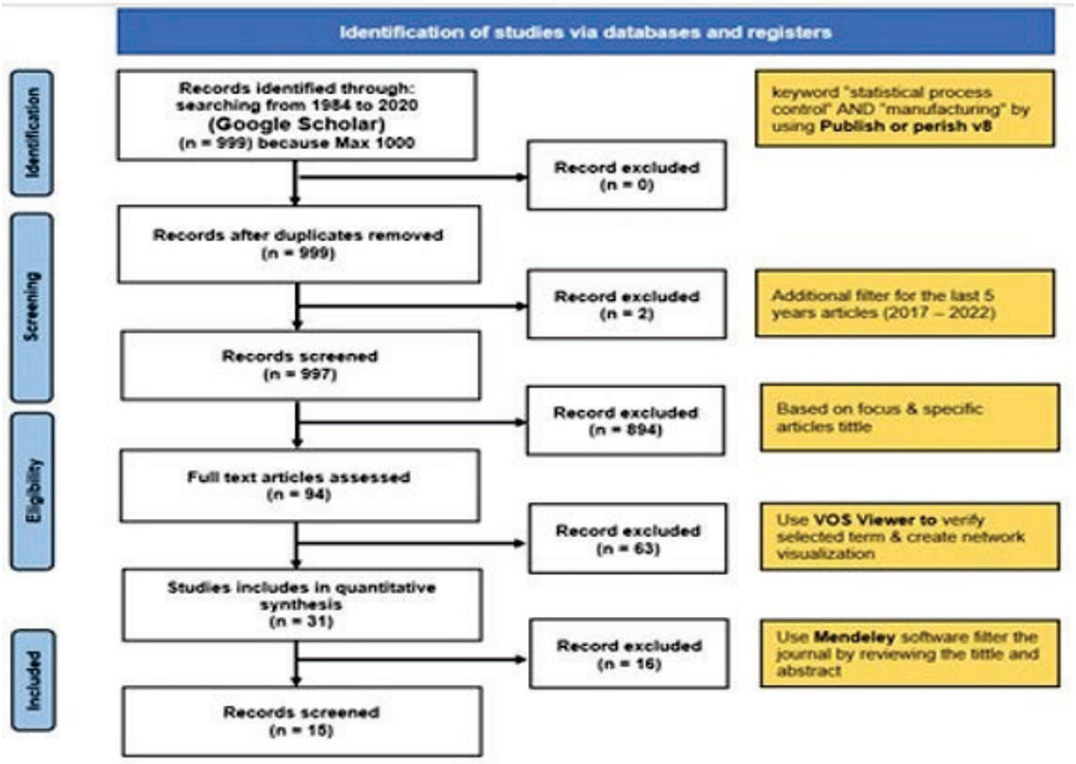

Fig. 2. PRISMA flowchart

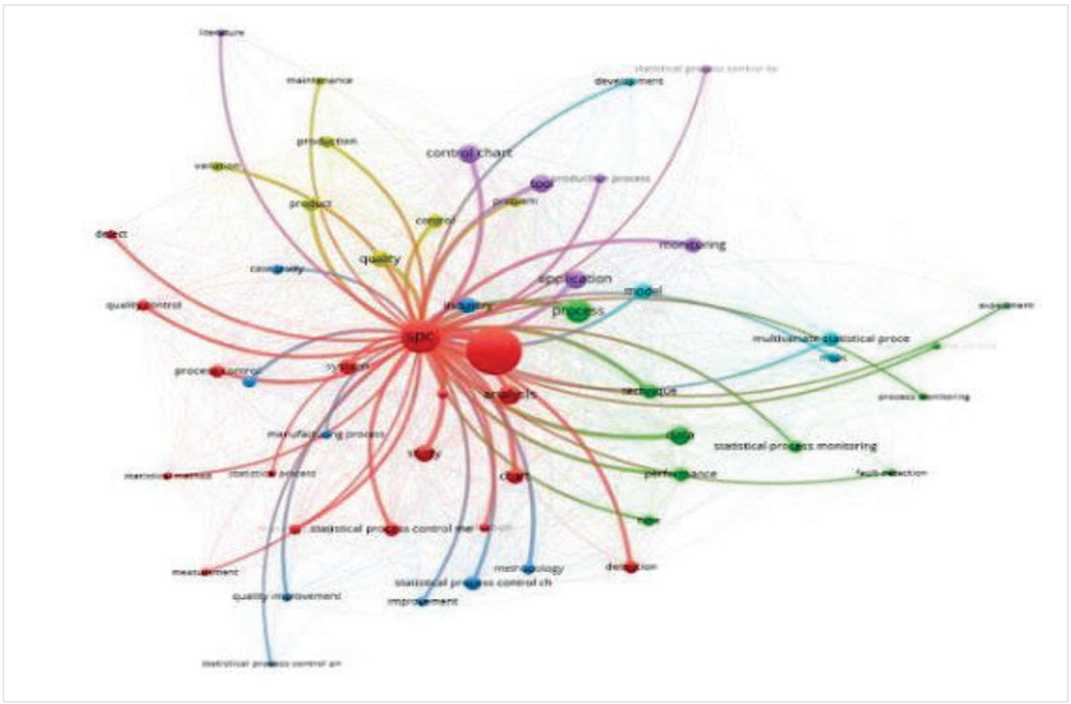

Fig. 3. VOS Viewer Network Visualization

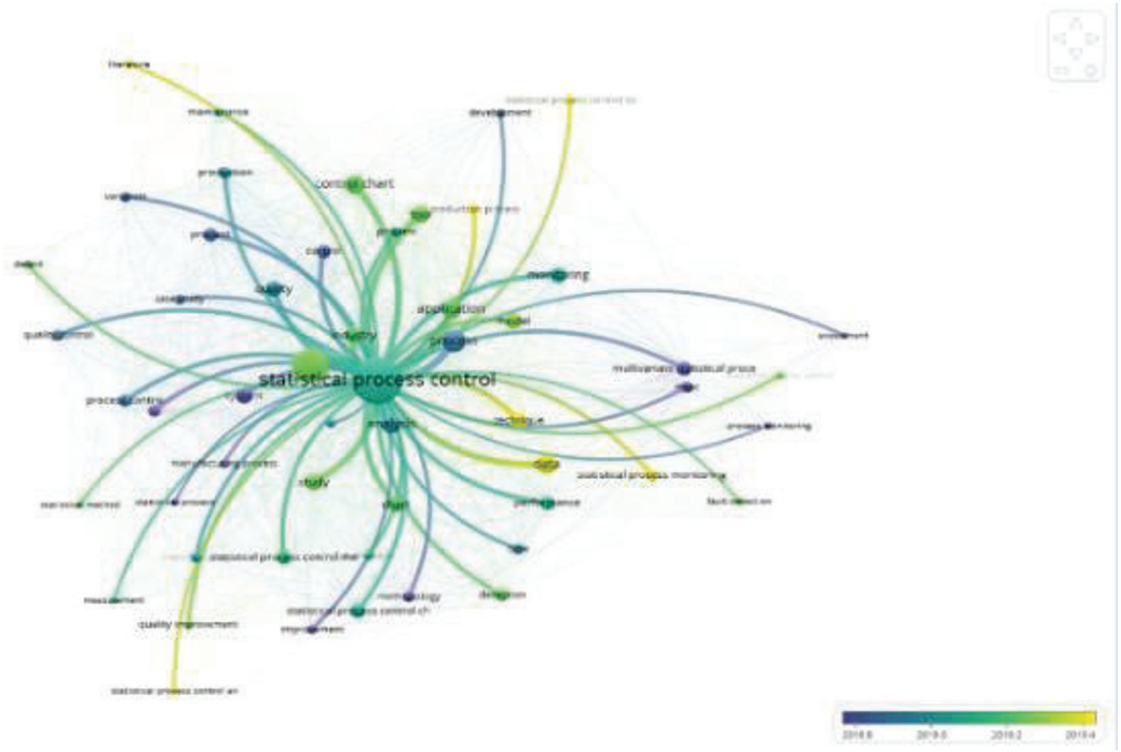

Fig. 4. VOS Viewer Overlay Visualization

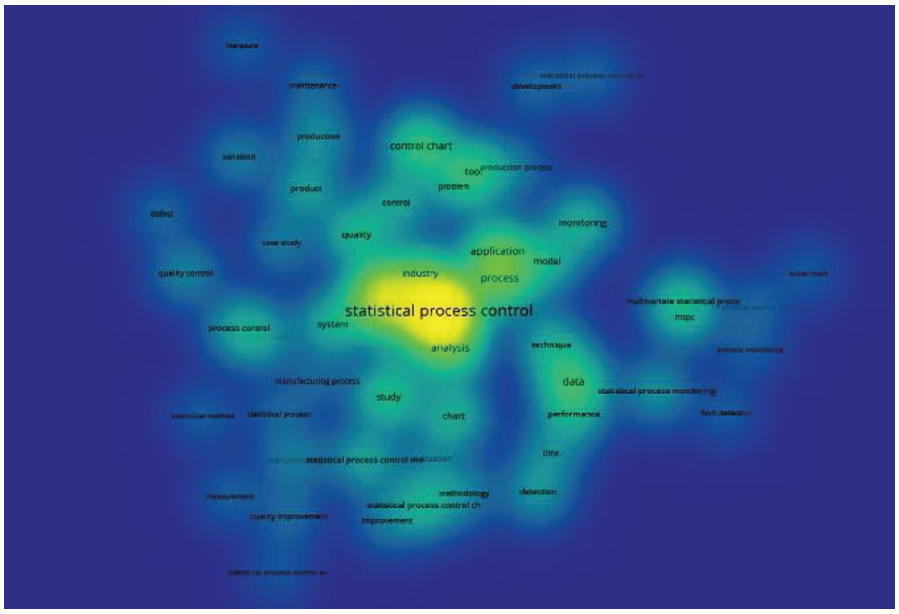

Fig. 5. VOS Viewer Density Visualization

Table 3. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Type of literature study	Article/Journal	Citation, e-book
Timeline	2017-2022	Older
Sector/Area	Manufacturing	Non-Manufacturing

3. RESULT

3.1 PRISMA Diagram

PRISMA diagram illustrates the number of articles reviewed at each level. Provide details on the included research characteristics, the possibility of bias (quality assessment), and the outcomes across various studies. Summarize the major conclusions, including the

robustness of the supportive evidence and the review's limitations [15].

There were two steps carried out at the screening stage, namely by selecting literature studies based on the tittle (n=31) and based on the common methods used (n-15) which were relevant to the discussion of the problem. These steps can be seen in figure 2.

3.2 Analysis of Keywords

Figure 3 provides a Network visualization of the most important keywords. The Statistical Process Control, process control, defect and quality control are the most significant literature concerns, they care are in the same cluster (red area). This shows that there is a close relationship between them.

Figure 4 shows the trend from year to year related to this research.so there were only a few studies in 2019 related with statistical process control.

From Figures 5, it can be seen that the keywords that often appeared were statistical process control, control chart, process, and analysis. From these data, we can search the novelty statistical process control research. For example, research related to the manufacturing process is still little done by other researchers. To that end, researchers can contribute to tackling the SPC implementation by conducting studies on manufacturing industry.

Figure 6 shows that the search articles selecting also was done using Mendeley Desktop Software, utilize Mendeley to find relevant papers based on what we read in the journal title and abstract. The benefit also to verify suitability between the topic and the content of the article.

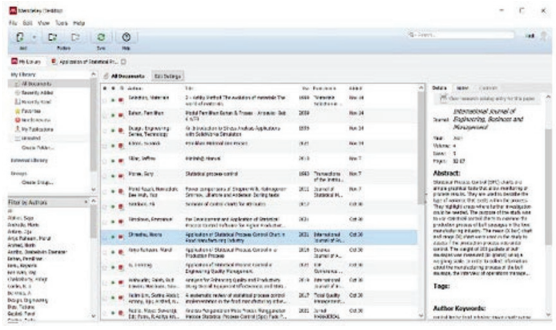

Fig. 6. Mendeley Desktop to assess journal tittle & abstract

4. CONCLUSION

The conclusions are determined by a review and analysis of 15 published articles from 2017 to 2022 regarding SPC implementation in the manufacturing industry. It has been discovered that the utilization of SPC in manufacturing industry is growing with the integration of other quality methods. This implementation was applied within other quality improvement programs such as Six Sigma and TQM. There were two major methods or control chart that commonly used; Xbar- RChart and P chart for defect and defective process control.

Despite the fact that SPC is a statistically based technique, the challenges and limitation factors showed that the manufacturing industry's implementation of SPC will be successful if other crucial factors like management, education/training, culture, and the availability of human resources are well prepared. In conclusion, the authors hope that this review will highlight the significance of SPC in the manufacturing sector as an effective method for quality control and improvement.

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