Implementation of statistical process control for quality control cycle in the various industry in Indonesia: Literature review

(*Implementasi peta kendali statistik untuk gugus kendali mutu pada kasus industri di Indonesia: Kajian literatur*)

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Abstrak. Tinjauan pustaka sistematis adalah metode yang ketat untuk menilai dan menggabungkan hasil penelitian dibandingkan dengan tinjauan pustaka biasa, yang terdiri dari bibliografi, tinjauan sistematis literatur yang ada mengenai pertanyaan penelitian spesifik tentang topik yang diminati. Statistical Process Control (SPC) adalah teknik mapan dalam konteks yang baru-baru ini digunakan dalam pengaturan produksi. Perangkat Produksi tidak seperti manufaktur yang membutuhkan lebih banyak sumber daya manusia dan mesin, sehingga menghasilkan satu kali produksi suatu item. Oleh karena itu penting untuk menilai apa SPC bekerja dalam konteks perangkat lunak. Dengan demikian, pertimbangan ini memotivasi kami untuk mendefinisikan dan melakukan tinjauan evaluasi untuk menilai apakah SPC digunakan secara efektif dan benar-benar untuk Quality Control Cycle (QCC) di berbagai industri di Indonesia. Menurut proses tinjauan literatur sistematis, protokol yang ditetapkan direvisi dan disempurnakan oleh penulis. Jurnal kumpulan jurnal ini telah digunakan di berbagai industri di Indonesia. Kami melaporkan pertimbangan dan hasil awal kami dalam tinjauan sistematis pada SPC dan menemukan 30 jurnal yang dikumpulkan sebagai referensi bagi pembaca dalam membuat jurnal penelitian terkait dengan SPC. Produk dan kesan pertama kami baik. Koleksi jurnal ini juga dapat memudahkan peneliti untuk mendapatkan referensi jurnal yang diinginkan.

Kata kunci: proses kendali statistik, gugus kendali mutu, peta kendali, industri.

Abstract. *A systematic literature review is a rigorous method of assessing and combining research results compared to the usual literature review, which consists of annotated bibliographies, a systematic review of the existing literature regarding specific research questions on a topic of interest. Statistical Process Control (SPC) is a well-established technique in a context that has recently been used in software production. Software production is not like manufacturing because it requires more human resources and machines, resulting in an item's one-time production. It is therefore essential to assess what SPC works in a software context. Thus, this consideration has motivated us to define and conduct an evaluation review to assess whether SPC is used effectively and genuinely Quality Control Cycle (QCC) in Indonesia's various industries. According to a systematic literature review process, an established protocol was revised and refined by the authors. This journal collection of journals has been used in various industries in Indonesia. We report our preliminary considerations and results in a systematic review on the SPC and find 30 journals collected as references for readers in making research journals related to SPC. Our products and first impressions are favorable. This journal collection can also make it easier for researchers to get the desired journal references.*

Keywords: statistical process control, quality control cycle, control chart, industry.

1 Introduction

Based on a collection of articles on the implementation of SPC in the QCC process that the author collected all came from the Indonesian state, so this systematic literature review focuses on articles in Indonesia. Total Quality Management (TQM) is effortless. Each part of an organization has customers, whether within or without. The need to identify what the customer requirements are and then set about meeting them forms the core of a total quality approach. This requires three hard management necessities: a sound management system, tools such as SPC, and teamwork (Oakland, 2003). Quality control is the oldest quality concept. It refers to the detection and elimination of components or final products that are not up to standard. It is an after-the-event process concerned with detecting and rejecting defective items. These are complementary in many ways, and they share the exact requirement for an uncompromising commitment to quality (Sallis, 2014). Conventionally, quality is guaranteed through a thorough inspection of the finished product.

On the other hand, SPC uses statistical tools to observe process performance for detection (Amdani & Trisnawati, 2021). Business competition in household needs is very tight, so companies need to make many improvements in various aspects to increase productivity through efficiency and effectiveness by controlling product defects. So a quality control method is required, and Statistical Process Control is selected in the form of control p-chart, X and R chart, Pareto diagram, cause and effect diagram, process capability analysis (Gatot, 2021). The method used in solving the problem is SPC. This method uses several tools such as Ishikawa Diagram, Check Sheet, Scatter Diagram, Pareto Chart, Control Chart. Also, data processing is needed to determine the process's capability by calculating the process's Cp value (Rottie, 2019). SPC is the statistical science technique in observing and improving the production process to produce quality products (Septiana, 2019). The companies cannot avoid defects in the production process, but the number of defects can be reduced by controlling the quality (Hidayat, 2019). In measuring how much the level of product damage that a company can accept by determining the tolerance limit for the resulting product damage, you can use Statistic Processing Control (Desianti, 2019). The quality control method that uses statistical tools is the SPC method. The production process's quality is controlled from production when the production process takes place until the finished product (Norawati & Zulher, 2019). Quality control analysis is done using statistical called seven tools consisting of check sheet, p control chart, Pareto diagram, and cause and effect diagram to answer those problems (Dharmayanti & Rahayu, 2018).

The purpose of this study was to assess what SPC works in a software context. Thus, these considerations motivated us to define and conduct an evaluation review to assess whether SPC is being used effectively and truly QCC in various industries in Indonesia. According to the systematic literature review process, the established protocol was revised and refined by the authors. This journal collection of journals has been used in various industries in Indonesia.

2 Theoretical Review

Quality control tools are used to assist the QCC process. Statistical quality control using SPC has 7 (seven) main statistical tools that can be used as a tool for quality control, among others; check sheets, histograms, control charts, Pareto diagrams, process diagrams, scatter diagrams, and cause and effect/fishbone diagrams (Oakland, 2003). Based on (https://www.winspc.com/, 2021), the following is an explanation of SPC tools:

Check Sheet
A check sheet is a simple document used to collect data in real-time and at the location where the data appears. Usually, these documents consist of blank forms designed to "record" or store the desired information quickly, easily, and efficiently. The data collected can be in the form of qualitative and quantitative data. Check sheets that contain quantitative data are sometimes

referred to as tally sheets. If your job is related to quality control, you already know that check sheets are one of the seven essential quality control tools.

Histogram

Now you can put the data from the check sheets into a histogram. A histogram is a snapshot of the variation of a product or the results of a process. It often forms the bell-shaped curve, which is characteristic of a regular cycle. The histogram helps you analyze what is going on in the process and helps show a process's capability, whether the data is falling inside the bell-shaped curve and within specifications. A histogram displays a frequency distribution of the occurrence of the various measurements. The variable being measured is along the horizontal x-axis and is grouped into several ranges of sizes. The frequency of occurrence of each measurement is charted along the vertical y-axis.

Control Charts & Other Charts

Whether making mom's recipe for spaghetti sauce or admitting patients to an emergency room, the outcome of a process is never the same every time. Fluctuation or variability is an inevitable component of all systems and is expected, arising naturally from the effects of miscellaneous chance events. However, variation outside a stable pattern may indicate that the process is not acting consistently. Events that fall beyond the expected variability of events forming a not random pattern suggest that the process is out of control. Variable charts are based on variable data that can be measured on a continuous scale. For example, weight, volume, temperature, or length of stay. These can be measured to as many decimal places as necessary. Individual, average, and range charts are used for variable data. Attribute charts are based on data that can be grouped and counted as present or not. Attribute charts are also called count charts, and attribute data is also known as discrete data. Attribute data is measured only with whole numbers. For example, control charts are c-chart, u-chart, np-chart, and p-chart.

Pareto Diagram

The Pareto chart can be used to display categories of problems graphically so they can be appropriately prioritized. The Pareto chart is named for a 19th-century Italian economist who postulated that a small minority (20%) of the people owned a significant proportion (80%) of the land's wealth. There are often many aspects of a process or system that can be improved, such as the number of defective products, time allocation, or cost savings. Each part usually contains many more minor problems, making it difficult to determine how to approach it. A Pareto chart or diagram indicates which issue to tackle first by showing the proportion of the real problem that each of the more minor matters comprises. This is based on the Pareto principle: 20% of the sources cause 80% of the problem. A Count Pareto chart is a vertical bar graph displaying rank in descending order of importance for the categories of issues, defects, or opportunities. Generally, you gain more by working on the problem identified by the tallest bar than trying to deal with the smaller bars. However, you should ask yourself what item on the chart has the most significant impact on your business's goals because sometimes the most frequent problem, as shown by the Pareto chart, is not always the most important. SPC is a tool to be used by people with experience and common sense as their guide.

Flow Charts (Process Diagram)

After a process has been identified for improvement and given high priority, it should then be broken down into specific steps and put on paper in a flowchart. This procedure alone can uncover some of the reasons a process is not working correctly. Other problems and hidden traps are often discovered when working through this process. Flowcharting also breaks the process down into its many sub-processes. Analyzing each of these separately minimizes the number of factors that contribute to variation in the process.

Scatter Diagram

The Scatter diagram, or plot, is another problem analysis tool. Scatter plots are also called correlation charts. A Scatter plot is used to uncover possible cause-and-effect relationships. It is constructed by plotting two variables against one another on a pair of axes. A Scatter plot cannot prove that one variable causes another, but it does show how a team of variables is related and

the strength of that relationship. Statistical tests quantify the degree of correlation between the variables.

Cause-and-Effect/Fishbone Diagrams

One analysis tool is the Cause-and-Effect (or Fishbone) diagram. These are also called Ishikawa diagrams because Kaoru Ishikawa developed them in 1943. They are called fishbone diagrams since they resemble one with a long spine and various connecting branches. The fishbone chart organizes and displays the relationships between different causes for the effect that is being examined. This chart helps manage the brainstorming process. The major categories of reasons are put on significant branches connecting to the backbone, and various sub-clauses are attached to the branches. A tree-like structure results, showing the many facets of the problem. Using this chart is to solve the problem at the head and then fill in the major branches. People, procedures, equipment, and materials are commonly identified causes. This tool can be used in focused brainstorming sessions to determine possible reasons for the target problem. The brainstorming team should be diverse and have experience in the problem area. A lot of good information can be discovered and displayed using this tool.

3 Method

A systematic literature review started with the collection of papers as a data base for studies related to SPC totaling 35 articles/references with keywords used in Google Scholar, Elsavier, Research Gate and others, namely statistical process control, quality control cycle, control chart, and industry. The five steps conclude the identification of all the literature obtained. The last stage is publishing in national journals. More details can be seen in Figure 1.

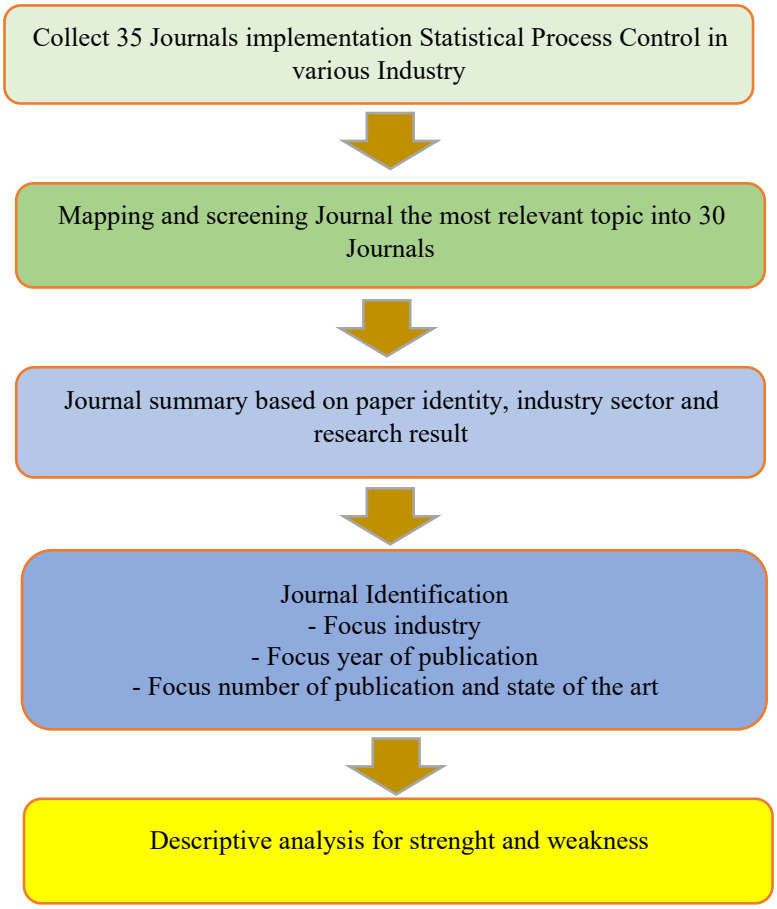

Figure 1 Study framework.

Based on Figure 1, In the first step, the researcher collected 35 journals related to the SPC method. They were selected into 30 journals because five other journals were not associated with the research theme, namely two journals about the literature review and three more journals related to SPC outside Indonesia. The researcher decided five journals were not included in this study. Andthen mapping and screening Journal the most relevant topic into 30 Journals in to table. Next step is journal summary based on paper identity, industry sector and research result. Make the journal Identification, based on focus industry, focus year of publication and focus number of publication and state of the art. After that make the descriptive analysis for strenght and weakness.

4 Result and Discussion

Journal Summary

The selected journals or articles will be analyzed, and the analysis was carried out based on the researcher and year, research object, and research results. The author summarizes them in Table 1.

Table 1 Existing Literature review of Statistical Process Control in Various Industries

No	Paper Identity	Industry Sector	Result
1	(Amdani & Trisnawati, 2021)	Garment	From the causal diagram (fishbone), it is found that the factors of machine material, humans (employees), environment, and methods are the causes of the decline in the quality of the Koko shirt product
2	(Gatot, 2021)	Plastic box	The most dominant number of defects is due to hole products by 55%. On the lid of the Box Plastics, the most prevalent number of defects is expected to non-standard colors of 47.82%
3	(Rottie, 2019)	Food	Factors that cause defective products are human factors and tofu processing methods
4	(Wiranti, 2019)	Plastic	The most dominant type of defect was the Bottle Dent defect, amounting to 18,000 with a percentage of 62%
5	(Septiana, 2019)	Furniture	After sorting the defects based on the number of defects, namely C, D, A, B, then the percentage of the number of defects is calculated and the number of defects is accumulated, the results of the cumulative number of the four types of defects are 47%
6	(Hidayat, 2019)	Textile	The main factors that cause the defects are human, machine, raw material, and work environment
7	(Desianti, 2019)	Coffee Powder	Quality control is carried out on raw materials, production processes, and finished products. The most common types of defects were 10,041 pcs of dirty plastic packaging, 534 pcs of coarse coffee powder, and 2,155 pcs of unsuitable grams
8	(Norawati & Zulher, 2019)	sweet bread	The most dominant type of product damage is due to incompatible size. Based on the simple diagram, the main factors that cause damage is labor, machine, raw materials, and environmental factors. Keywords
9	(Dharmayanti & Rahayu, 2018)	Metal	The main factors causing the defect are the engine factor that has not been hot, the method factor, and the inaccuracy of labor
10	(Trenggonowati & Arafiany, 2018)	Steel	Data defects in 2015 are still uncontrolled, and it can be seen from the eight points that are out of control, based on the cause and effect diagram of the factors causing the dimensional defects
11	(Indrawati & Isnaini Dwi Ningsih, 2018)	Air Conditioner	The Environmental Laboratory of the Faculty of Biology, Jenderal Soedirman University, namely the average value of each parameter, namely TDS = (4.85 mg / L), pH = 6.53, DHL = 0.00117 (ms), temperature = 23.3C, Turbidity = 0.4265 (NTU)
12	(Faiq et al., 2018)	Fruits	That there are still defects in production is shown in the control chart that there are points that are out of control.

Table 1 Continue

No	Paper Identity	Industry Sector	Result
13	(Rosyidah, 2018)	Water Treatment	X-chart and R-chart, it can be analyzed that all the measurement data is within control limits, which indicates that the information is in conditions in statistical control
14	(Supriyadi, 2018)	Ceramic	The production process is within control limits, but there is a significant irregular movement of points. With the capability of the Plating layer thickness measurement process being low, the value is only 70% of the target to be achieved
15	(Bastuti et al., 2018)	Footwear	The results of calculations using the p control chart diagram show that three points are out of control, namely in April, July, and December
16	(Pamungkas et al., 2018)	Salt	Judging from the control chart, there are no data on salt samples out of control limits. Whether it's for NaCl levels and salt particle size
17	(Yudianto et al., 2018)	Paper	That the number of defects in bobbin cigarette paper products is still under control, which means that the number of defects that occur can still be controlled
18	(Meri et al., 2017)	Bottled Water	The X and R-charts contain some data that are out of control, namely the pH test of 7.2%, 13.89% turbidity, and 6.67% TDS, which means that the production process is still unstable
19	(Rahmah & Pawitan, 2017)	Milk	The histogram shows the total disability of R1 as much as 366,280 liters in November 2014, and the Pareto diagram analysis shows that the disability of R1 is 82.62%
20	(Solihudin & Kusumah, 2017)	Ceramic	Machine cut-off type C-325-3A, hole/hole processed by two tools, namely drill Ø9.0mm and SA Ø10.3mm, Changing LS2 settings to size 50 ~ 60mm
21	(Wicaksana, 2017)	Cement Bagging	The defect level in the leaky bags was broken bags with a total of 14,568 pcs and a leaky bag with a total of 5,110 pcs
22	(Rahmah & Pawitan, 2017)	Milk	The control p-chart in product quality control can identify that the product quality is within the control limits that should be
23	(Rachman, 2017)	Garment	The level of damage to clothing in the Finishing section in the January 2017 period is out of control between the upper control limit (UCL) and the lower control limit (LCL), as well as damage beyond the control limit
24	(Devani & Wahyuni, 2017)	Paper	There are 20 days out of 55 days of observation that are out of control, so it can be said that the product is out of control
25	(Wildan Noor & Fauziyah, 2016)	Palm Oil	Based on Pareto diagram analysis, the most dominant damage occurs because of the high levels of moist (39%)
26	(Gunawan & Tannady, 2016)	Garment	20 data are outside the specified control limits, which means that the whole process has not been controlled
27	(Ratnadi & Suprianto, 2016)	Spinning Textile	There is a point outside the control limit, namely in the 22nd period, which is due to special reasons. This indicates that the production process still needs further improvement
28	(Adin Elman Syarif & Ayik Pusakaningwati, 2016)	Fertilizer	From the control chart above, it can be seen that the defective products produced are within control limits, and the number of faulty products has decreased significantly
29	(Fajar Ningrum, 2015)	Printing and Packaging	Total production of elbow cartons during April 2016 amounted to 76,151 pcs with several defects of 4,402 pcs or 1.77%, with the most dominant type of damage being the wrong size of 46.1%, imperfect shapes of 30.3%, and rough cuts of 23.6%
30	(Kosasih et al., 2015)	Heavy Equipment	From the control chart, it can be seen that the bucket production process from May 2013 to September 2013 was entirely within the control limits, both lower control limits

Journal Identification

The identification of literature will be identified from various perspectives. The perspective includes the industry's focus, the year of publication, the number of publishers, and state of the art about SPC tools. SPC implementation is very popularly used in the manufacturing industry. More precisely, in the plastic and garment industry. Figure 2 informed that SPC is more widely implemented in industrial plastic (10%) and garment (10%). This is in line with the growing trend of both industries. In plastic manufacturing companies and garment industries. One of the daily management tools that have been proven effective in managing and controlling processes is the application of Statistical Process Control (SPC), a process control method using statistical data and techniques to maintain process stability to meet customer requirements. For more details, see Figure 2.

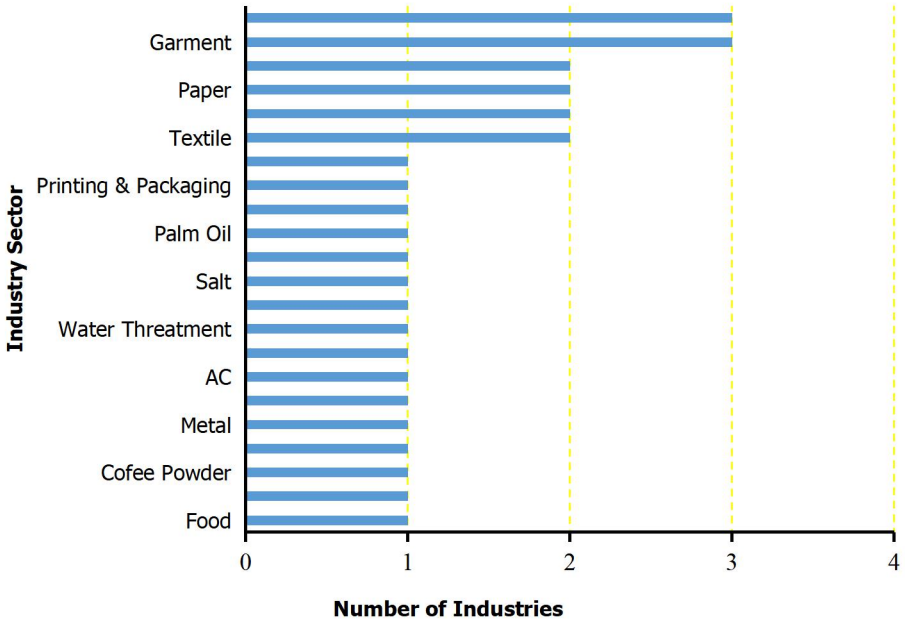

Figure 2 The focus of the industry.

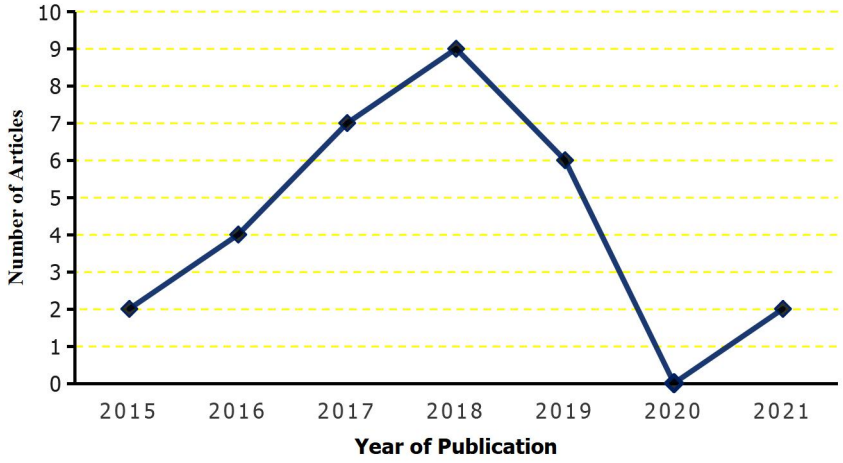

Figure 3 The focus of Year of Publication.

Figure 3 shows that 2018 is the year of publication most frequently searched during the 2015-2021 period of nine articles (Figure 4). This is evident in identifying the journal. For several years, almost every year, many journals have entered national publications.

Table 2 shows that many publications are the purpose of the paper published in Indonesia in the 2015-2021 period. This is proof that in Indonesia, there are many publications. The author suggests that researchers use publicate in Indonesia to require a trial or promotion in education. SPC tools that are often and most widely used in the Indonesian industry are control charts, fishbone diagrams, and Pareto diagrams. For more details, see Table 2.

Table 2 State of the Art Publisher and use of the SPC tools

No	Paper Identity	Publisher	Statistical Process Control Tools						
			Check Sheet	Histogram	Control Chart	Pareto Diagram	Process Diagram	Scatter Diagram	Fishbone Diagram
1	(Amdani & Trisnawati, 2021)	IKRA-ITH	√		√	√			√
2	(Gatot, 2021)	SENAS TITAN			√	√			√
3	(Rottie, 2019)	Realtech			√				√
4	(Wiranti, 2019)	InTent		√	√				√
5	(Septiana, 2019)	Media Teknologi			√	√			√
6	(Hidayat, 2019)	Management Review	√		√	√			√
7	(Desianti, 2019)	Pendidikan Ekonomi Undiksha			√	√			√
8	(Norawati & Zulher, 2019)	Menara Ekonomi	√	√	√				√
9	(Dharmayanti & Rahayu, 2018)	Manajemen Industri dan Logistik	√		√	√			√
10	(Trenggonowati & Arafiany, 2018)	Industrial Service			√	√			√
11	(Indrawati & Isnaini Dwi Ningsih, 2018)	Integrated Lab Jurnal	√		√				
12	(Faiq et al., 2018)	Jurnal Riset Manajemen	√	√	√	√			
13	(Rosyidah, 2018)	Integrasi			√				
14	(Supriyadi, 2018)	JIT MI	√		√	√			√
15	(Bastuti et al., 2018)	Teknologi	√		√	√			
16	(Pamungkas et al., 2018)	Optimalisasi	√		√	√			√
17	(Yudianto et al., 2018)	Buletin Utama Teknik	√	√	√	√			√
18	(Meri et al., 2017)	Teknologi			√				√
19	(Rahmah & Pawitan, 2017)	Accounting and Business Studies	√	√	√	√			√
20	(Solihudin & Kusumah, 2017)	Seminar Nasional Inovasi dan Aplikasi Teknologi			√	√			√
21	(Wicaksana, 2017)	Jurnal Teknik Mesin	√		√	√			√

Table 2 Continue

No	Paper Identity	Publisher	Statistical Process Control Tools						
			Check Sheet	Histogram	Control Chart	Pareto Diagram	Process Diagram	Scatter Diagram	Fishbone Diagram
22	(Rahmah & Pawitan, 2017)	Accounting and Business Studies	√	√	√	√			√
23	(Rachman, 2017)	Informatika			√	√			√
24	(Devani & Wahyuni, 2017)	JITI		√	√	√		√	√
25	(Wildan Noor & Fauziyah, 2016)	Manajemen Fakultas Ekonomi UMY			√	√			√
26	(Gunawan & Tannady, 2016)	Teknik Industri	√		√	√			
27	(Ratnadi & Suprianto, 2016)	INDEPT	√		√	√		√	√
28	(Adin Elman Syarif & Ayik Pusakaningwati, 2016)	Yudharta	√	√	√	√			
29	(Fajar Ningrum, 2015)	Riset Bisnis dan Manajemen	√		√	√			√
30	(Kosasih et al., 2015)	Ilmiah Teknik Industri UT			√	√			√
	Number of tools used in industry		17	8	30	24	0	2	24

Strength Analysis

In this literature study, the authors found the strength of all the journals that had been analyzed. Power is based on three perspectives, namely journal writing, industry, and science. Journal explained in a clear and complete ranging from the abstract, introduction, review literature, methodology, results & discussion and conclusions. The advantage for the perpetrator of business to apply the Statistical Process Control method to get the slim, SPC is measuring and controlling quality by monitoring the manufacturing process. Quality data is collected in product or process measurements or readings from various machines or instrumentation. The information is collected and used to evaluate, monitor, and control a process. SPC is an effective method to drive continuous improvement. However, providing new references for the subsequent researchers in problem-solving related to implementation with the lean six sigma approach.

Weakness Analysis

In addition to the literature study's strengths, the author also found several weaknesses based on journal writing, industry, and science. The format of writing journals is not organized, so that makes the writer difficulty in identifying literature. The approach of Statistical Process Control requires a time that is very long in the implementation. Need stages which systematic to get a result that is best and necessary monitoring it regularly. There are many new tools in the modern like this so that researchers have many options in solving problems. As a result, the Statistical Process Control approach is neglected.

5 Gap in Literature Review on SPC and Future Research Agenda

The authors have identified the following gaps in the current literature on Statistical Process Control. This gap has been grouped and prioritized as follows. Lack of differentiation between leadership style required from Senior/Executive management and Middle management in organizations. Leadership is a critical factor in the success of SPC. Its impact will be the subject of future research to determine which leadership characteristics are most conducive to the successful deployment of SPC. The Lack of differentiation among industry sectors such as manufacture and services. A different leadership style may be required in various industry sectors and across organizations of quite different sizes. Lack of results, the most variation of each paper's goals make products have much variation that depends on six Sigma will be used on industry condition. The SPC method uses more control charts while the DMAIC method, also at the measuring stage, often uses control chart tools, DPMO, and Sigma level. So Future research will conduct a literature review of Lean Six Sigma collects data to attain its goal. Collected data should be analyzed to create an optimum and proper decision. However, Industry 4.0 technologies change to gather an enormous amount of information. Therefore, traditional data analysis techniques do not seem sufficient because they require more prolonged and valuable data. It is possible to profit from advanced techniques suitable for extensive data, like big data analytics and process mining, and traditional methods to create effective decisions, shown in Figure 5. In future research, Collaboration of 3 components, Six Sigma, Lean manufacturing, and industry 4.0, can provide a guide that makes easier, faster, more reliable, and satisfied decisions with data to improve processes. For more details, see Figure 4.

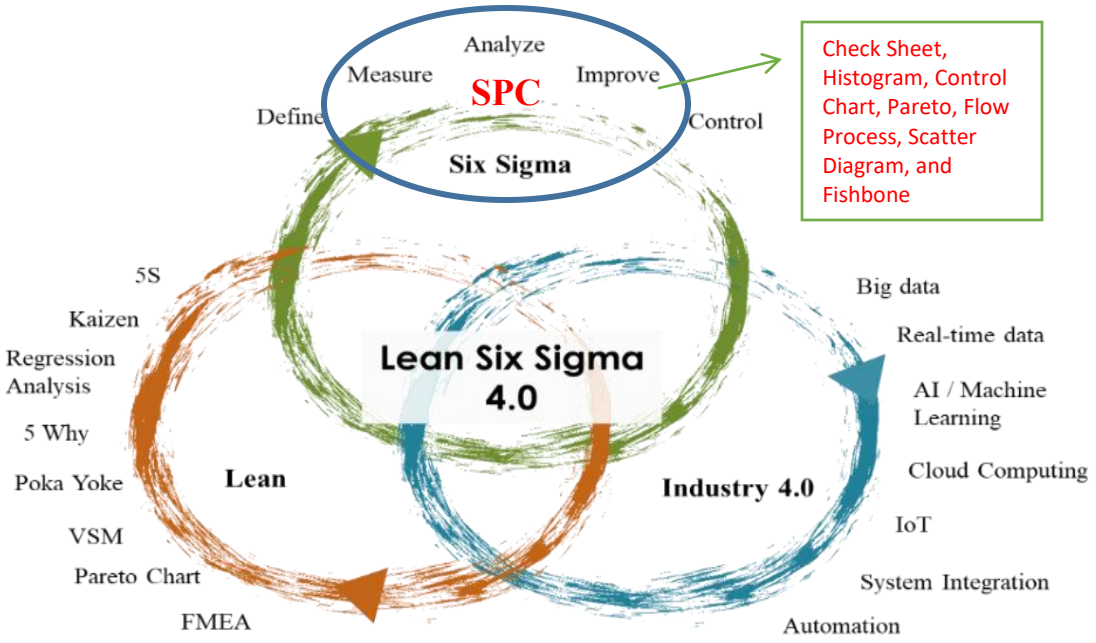

Figure 4 Future Research Framework.

6 Conclusion

After conducting a review of the studies from 30 selected journals, this research can be concluded: (a) It was found that the SPC method was more widely applied in the plastic (10%) and garment (10%) industries. This is in line with the growth trend of the two sectors. In plastic manufacturing companies and the garment industry. The SPC method is also familiar in various

kinds of industries in Indonesia, this method is widely used in continuous improvement, (b) Based on the publication year taken during the period 2015-2021, 2018 was the year that saw nine articles published, and this is evident in the identification of journals. For several years, many journals have entered national publications, (c) The SPC tool that is often and most commonly used in the Indonesian industry is a control chart. All studies use it because every repair requires monitoring of defects either before restoration or after repair. Meanwhile, SPC tools such as fishbone diagrams and Pareto diagrams, almost all industries also use them because these two tools are interrelated and easy to apply, and (d) In addition to the SPC method, which is often used by many industries, there is another more comprehensive method, namely the method of applying DMAIC, Lean manufacturing and others.

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