

A Study of Six Sigma Management Theory in the Service Industry

Qingyi Wang *

School of Industrial Engineering and Management, Southwest Petroleum University, Chengdu 610500, China

* Corresponding author: 1677751361@qq.com

Abstract: This paper discusses the application and research of Six Sigma management theory in the service industry. Six Sigma, as a set of data-based quality management strategies that emphasise the reduction of defects and variation, was initially applied mainly in the manufacturing industry, but in recent years, with the rapid development of the service industry and the increasing diversification of consumer needs, the application of Six Sigma theory in the service industry has been gradually deepened. This article firstly outlines the core principles of Six Sigma management theory, including the five phases of Define, Measure, Analyse, Improve and Control (DMAIC), and how it can improve service quality and customer satisfaction by reducing errors and variation in the service process. The article then analyses in detail specific application cases of Six Sigma theory in service industries, such as healthcare and finance, to demonstrate its effectiveness and feasibility in practice. This article analyses the application of Six Sigma in the service industry, combining specific cases and micro-analysis of its application in the service industry. In summary, Six Sigma management theory has a broad application prospect and potential in the service industry. Through in-depth research and practice, it can effectively improve service quality and customer satisfaction, and enhance the competitiveness and market position of enterprises.

Keywords: Six sigma management theory; Service quality management; DMAIC; Service applications.

1. The Origin and Development of Six Sigma Theory

1.1. Origins and Development Abroad

The development of Six Sigma management theory in foreign countries has experienced the process from germination to development and then to popularisation. Motorola's successful practice laid the foundation for Six Sigma management theory, while GE's introduction and development further promoted the popularity of Six Sigma management worldwide. Through years of practice and application, Six Sigma management has become an important management tool for the pursuit of performance excellence and continuous improvement worldwide.

The theory of Six Sigma management was originally proposed by Bill Smith, an engineer at Motorola, and was designed to measure and improve the quality of the production process through statistical methods. Motorola began implementing Six Sigma management within the company in 1987 and has achieved significant results. Through Six Sigma management, Motorola has achieved significant quality improvements and cost reductions. For example, its defective rate has been reduced to 1/20th of its previous rate and productivity has increased by an average of 12.3 per cent per year.

In 1988, Motorola won the Malcolm Baldrige National Award for quality in the U.S. In 1995, General Electric (GE) began to implement Six Sigma management within the company. Under the leadership of Jack Welch, GE has made Six Sigma management an important part of its corporate strategy. Through the implementation of Six Sigma management, GE has achieved significant growth in its performance. For example, its revenue grew to \$1.5 billion, or even close to \$5 billion, and its gross operating margin grew rapidly from nearly 10 per cent to 15 per cent. From the

beginning of the 21st century to the present day, after GE's successful practice, Six Sigma management began to gain widespread attention and application worldwide. Many well-known companies, such as Ford, Caterpillar, DuPont, Dow, Siemens, Samsung, etc., have introduced Six Sigma management to improve their business processes and product quality. By implementing Six Sigma management, these companies have not only improved their product quality and productivity, but also enhanced their competitiveness and market share.

1.2. Current Status of Development in The Country

In recent years, with the increasing demand of domestic enterprises for quality management and efficiency improvement, the theory of Six Sigma management has gradually been paid attention to by the business community. Many enterprises have begun to try to introduce Six Sigma management system to improve product quality, reduce costs and enhance the competitiveness of enterprises. In order to promote Six Sigma management theory, many training institutes and courses have emerged in China, aiming to provide Six Sigma-related training and consulting services to enterprises and individuals. These training and learning opportunities have enabled more people to understand and master the core concepts and methods of Six Sigma. More and more companies are beginning to apply Six Sigma management theory to actual production and management. Through the use of Six Sigma tools and methods such as DMAIC (Define, Measure, Analyse, Improve, Control), enterprises are able to more accurately identify problems, analyse them and find solutions to them, so as to achieve continuous improvement and efficiency enhancement. However, domestic enterprises also face some challenges and problems in the process of promoting Six Sigma management. Firstly, the lack of preparation of talents and knowledge leads

to the lack of professional guidance and support when enterprises implement Six Sigma management. Secondly, weak management foundation, some enterprises lack the necessary management system and process optimisation foundation before introducing Six Sigma management. In addition, problems such as mechanical imitation and lack of pull also affect the effective implementation of Six Sigma management in domestic enterprises.

With the deepening of domestic enterprises' knowledge of Six Sigma management theory and the accumulation of practical experience, it is expected that more enterprises will take Six Sigma management as an important means to enhance their competitiveness in the future. At the same time, with the increase of training and learning opportunities, more people will be able to master the core concepts and methods of Six Sigma, which will provide strong support for the continuous improvement and development of enterprises. In summary, Six Sigma management theory has been widely noticed and applied in China, and although it faces some challenges and problems, its development trend is still positive.

2. The connotation of Six Sigma and the current situation of industrial application

2.1. Overview of Six Sigma Management

Since its birth at the end of the last century, Six Sigma management has been unanimously recommended by famous scholars at home and abroad for its reasonable analysis method and excellent improvement effect. Six Sigma to product or service "zero defects" for the pursuit of the process is committed to continue to bring significant reductions in quality costs and market share increases, the formation of the enterprise's Six Sigma management culture, access to enterprise competitiveness and financial performance of the double enhancement and breakthroughs, so that the ultimate development of the world's first-class excellence in the enterprise. At the same time in the industry, Six Sigma management has been greatly promoted and applied. With the gradual development of enterprise management practices, initially applied to the manufacturing industry, Six Sigma management also plays an important role in other industries. Six Sigma management is a customer-centred, data-based management concept that aims for almost flawlessness. Its core is to improve, optimise and control processes through a set of statistical techniques based on data analysis, measuring problems and analysing causes to achieve the best results in business operations. Six Sigma management is the United States enterprises in the past decades to implement statistical process control (SPC), total quality management (TQM) and other quality management methods based on the further improvement of product quality in order to improve the performance of enterprises and the invention of a new method of quality management. Conceptually, it has two meanings: on the one hand, it refers to the quality characteristics of the normal distribution, taking into account the basis of 1.5 σ drift, the product failure rate of 3.4ppm (3.4 parts per million), that is, the stability of the control of the qualified rate of 99.99966%, on the other hand, it refers to engineers and statisticians used to accurately adjust the product and the production process of the high-tech methods. Six Sigma management through the use of breakthrough techniques to improve the quality of products and production processes, to

achieve a significant reduction in production costs, improve customer satisfaction, and ultimately improve the profitability of the enterprise purpose.

Sigma σ is a unit of measurement in statistics that is used to express the degree of variability in any set of data or processes. Six Sigma represents a level of error, i.e., three or four errors per million opportunities. The Six Sigma quality management system is not only an analytical theory based on scientific statistics, but also a guide to solving practical problems and a necessary tool to improve the competitiveness of enterprises. Six Sigma management theory to meet customer needs as the guiding ideology, to the production and service processes for continuous optimisation as a key step to achieve the purpose of improving quality and operational efficiency. Moreover, Six Sigma management emphasises the participation of all employees, i.e. each employee has an important responsibility for the development of the enterprise.

DMAIC is an important analytical tool for Six Sigma management, which consists of five phases: i.e. definition, measurement, analysis, improvement and control. Lv Yongwei, Baliwei (2014) pointed out that in the process of implementing Six Sigma management, the DMAIC model closely around the enterprise goals step by step, in order to achieve the goals, this model is often recycled, so it is also known as the five-step cycle method.

Six Sigma theory was born in Motorola in the early 1980s. Against the backdrop of competitive pressure from Japanese electronic products, Motorola introduced a statistically based management method, Six Sigma, to improve product quality and customer satisfaction, with the goal of reducing defects in the production process. This theory advocates only 3.4 errors per million opportunities, achieving the so-called "Six Sigma" level of quality.

Motorola's successful practice has led to the gradual recognition and adoption of Six Sigma theory by more companies. In the mid-1990s, Jack Welch, CEO of General Electric, made Six Sigma the company's core quality improvement strategy, which greatly promoted the spread and application of Six Sigma worldwide. Driven by GE, the application of Six Sigma was not only limited to product quality improvement, but also began to cover a wider range of areas such as service process and business process improvement.

Since the beginning of the 21st century, Six Sigma theory has moved beyond the boundaries of the manufacturing industry and has begun to be applied in the service industry and other non-manufacturing areas. For example, many large service companies, such as banks, insurance companies, and healthcare organisations, have begun to experiment with the introduction of Six Sigma to improve service quality and process efficiency.

2.1.1. Process of Six Sigma Management

DMAIC in Six Sigma management is a time-tested and effective analysis model based on the improvement principle of the PDCA (Plan-Do-Check-Act) cycle. DMAIC consists of five steps: define, measure, analyse, improve and control.

Definition Phase (D): Determine key customer needs and identify products and processes for improvement. Define the problem or improvement objective to be solved and translate it into measurable critical quality characteristics (CTQ). Define the appropriate metrics to ensure that team members have a consistent understanding of the problem and determine the direction and scope of improvement. It involves combing through existing processes, identifying key factors that affect

customer satisfaction, defining the goals of the project, developing plans and criteria for improvement, and looking for core elements that affect quality.

Measurement phase (M): Measure existing processes to determine the bottom line and expectations of the process. Evaluate the effectiveness of the measurement system to ensure the accuracy and completeness of the data. Focus on the reliability and consistency of data sources to better understand the nature and extent of the problem. Use a variety of validated metrics to measure the level of quality and collect and collate relevant data to provide a quantitative description of quality characteristics. Key steps include identifying critical assessment criteria, defining what constitutes a "defect," collecting existing process data, and identifying improvement directions for project objectives.

Analysis phase (A): Use statistical tools to analyse the entire system and identify the root causes of problems. Descriptive statistics, causal analysis, regression analysis and other methods are used to gain an in-depth understanding of the operation of the process and the root causes of the problem. Data analysis provides the basis for developing improvement measures. The data collected is analysed in depth to rank the extent of quality impact. Analysis is a core step in the DMAIC process that covers the entire system, identifying factors that affect quality and confirming root causes through the use of statistical tools such as the 20/80 rule.

Improvement phase (I): Establish the best improvement programme for key factors to reduce process defects or variations. Comprehensively consider the process, personnel, equipment, materials, measurement and other aspects of the factors, to develop a practical improvement programme. Improvement measures need to specify specific operational steps, responsible persons, time schedules, and expected results. Based on the key influencing factors identified in the analysis step, we develop the optimal improvement programme at this stage. This requires continuous testing and validation of the effectiveness of the programme to ensure that the project objectives can be met. After the optimal optimisation programme has been identified, it will be implemented.

Control phase (C): Monitor the new system processes to ensure the effectiveness and sustainability of the improvements. Measures are taken to sustain the results of the improvements and to ensure that the entire process is fully effective. Mechanisms for monitoring performance are set up and monitored at a predetermined frequency to identify new opportunities for improvement. The main purpose of the control phase is to ensure that the results achieved during the improvement phase are sustained. Control is the key to maintaining quality and cost at optimum levels, and it requires continuous monitoring of new processes to sustain the improved results.

The DMAIC model provides a structured framework for systematically identifying, analysing and solving problems in an organisation. By following the DMAIC process, organisations can ensure that Six Sigma projects achieve their objectives efficiently and consistently improve process performance and customer satisfaction.

2.2. Current Status of Industrial Application of Six Sigma Management

2.2.1. Areas of application in manufacturing

Manufacturing is the area where Six Sigma management theory was first introduced and most widely applied. This

theory, which emphasises driving quality and efficiency improvements through accurate measurement and fine management, has achieved significant results in many manufacturing companies, reducing defects, improving productivity and reducing costs through the DMAIC (Define, Measure, Analyse, Improve, Control) process. For example, Ford Motor Company used Six Sigma to improve its production processes and enhance product quality. The core of Six Sigma management lies in the use of data analysis and statistical methods to identify, reduce or even eliminate defects in a process, thereby significantly improving the quality of a product or service. In manufacturing, this means strict quality control at every step of the process, from raw material sourcing, through the production process to the final product. Taking General Electric (GE) as an example, it was one of the first companies to adopt the Six Sigma management theory. GE has integrated Six Sigma into its daily operations through systematic and scientific management. Through a series of measures such as training employees, establishing cross-functional Six Sigma teams, and optimising production processes, GE has succeeded in achieving a significant improvement in product quality, reducing production costs, and improving operational efficiency. In GE's case, Six Sigma management has not only brought financial gains, but more importantly, it has changed the way of thinking and management mode of the enterprise. Through accurate measurement and data analysis, the enterprise can more accurately understand customer needs and market changes, so as to develop a more targeted product strategy and market strategy. GE's successful experience for other manufacturing enterprises to provide reference and inspiration. More and more companies are beginning to recognise the importance of Six Sigma management and are introducing it into their daily operations. Through the implementation of Six Sigma management, these enterprises have not only achieved quality improvement and cost reduction, but more importantly they have improved their competitiveness and won customers' trust and market recognition.

2.2.2. Areas of application of services

As an emerging application area of Six Sigma management theory, the trend of introducing Six Sigma management in the service industry has become more and more obvious, despite facing more complex and diverse processes than manufacturing. Compared with the manufacturing industry, the processes in the service industry are more complex and diversified. Service quality not only depends on the service attitude and professional ability of employees, but also affected by customer demand, market environment, technical conditions and other factors. This makes quality management in the service industry more challenging. However, more and more service organisations are beginning to introduce Six Sigma management theory to improve service processes, service quality and customer satisfaction. Take the Wells Fargo Bank in the United States as an example, the bank applied Six Sigma theory to optimise the process of loan application. By reducing unnecessary links and streamlining the approval process, the bank successfully shortened the loan processing time and improved customer satisfaction and loyalty. According to the data, the optimised loan processing time was reduced by 30% and customer satisfaction increased by 20%. The insurance company also actively introduced Six Sigma management to improve the efficiency and accuracy of the claims process. Through Six Sigma's data analysis and

process optimisation, insurance companies can more accurately assess risks, reduce fraud, and provide customers with faster and more accurate claims services. In healthcare organisations, Six Sigma is used to optimise the patient journey and improve the quality and efficiency of healthcare services. By reducing patient waiting time and improving diagnostic accuracy, healthcare organisations can enhance the patient experience and increase patient satisfaction and trust in healthcare services. Retailers are also improving customer satisfaction and sales by introducing Six Sigma management. For example, through measures such as optimising inventory management and improving the efficiency of merchandising, retailers can meet customer needs more accurately and increase customer satisfaction and loyalty.

2.2.3. Trends in development

The first is the combination of Lean and Six Sigma, in the future the use of Lean techniques in conjunction with Six Sigma will be even more valued as they will not only help to minimise variances but also eliminate wasteful processes from the cycle. Next is data-driven and fact-based decision making, the need to emphasise data-driven and fact-based decision making methods will continue to grow, which is the essence of Six Sigma strategy. Another is the use of modern technology, in the future there will be greater use of modern technology including sophisticated computers in the Six Sigma field to collect and analyse data at a faster rate. Finally there is the team skills on which companies will seek the expertise of professional LSS Green Belts and Black Belts to implement company strategies and lead process improvement initiatives.

3. Six Sigma in the Service Sector

3.1. Micro-Analysis of The Application of Six Sigma in The Service Industry

Service Process Optimisation: In the service industry, the first step is to identify key issues in the service process, such as long waiting times for customers, high complaint rates, etc., through communication with customers, employees and other stakeholders. In the case of hotels, for example, a survey may reveal that customers are dissatisfied with the long check-in time at the front desk. Collect data related to the problem, such as the average check-in time at the front desk, the longest waiting time, and staff processing time. Process and analyse the data to identify bottlenecks and inefficiencies in the process using Six Sigma's statistical analysis tools such as Pareto charts and histograms. The data collected is analysed in depth to identify the root cause of the problem using tools such as cause and effect diagrams and fault trees. In the example of a hotel front desk, the causes of problems may be found to include unskilled staff, complex system operations, and cumbersome information entry. Based on the results of data analysis, develop specific improvement strategies. Optimise the check-in process at the front desk, e.g. simplify the operation steps, provide staff training to improve operation efficiency. Improve the system interface to make it more intuitive and easy to use. Introduce automated equipment, such as self-service check-in machines, to reduce manual operation time. After implementing the improvement strategies, monitor the new service processes through regular data collection and analysis to ensure that issues are resolved. Set up a monitoring mechanism to ensure the continuity and stability of the improvement effect.

Service Quality Improvement: Use Six Sigma

methodology to quantify key elements in service quality, such as customer satisfaction, service response time, and first-time fix rate. Relevant data is collected and analysed through customer satisfaction surveys and service response time records. Identify and meet customer expectations and needs based on customer feedback and data analysis results. Enhance customer satisfaction by improving service processes and service quality. Introduce Customer Relationship Management (CRM) system to better understand customer needs and provide personalised services.

Cost Control and Efficiency Improvement: Identify and eliminate wasteful aspects of the service process using Six Sigma's waste analysis tools such as value stream mapping and time observation. Reduce operating costs by optimising inventory management and reducing ineffective operations. Optimise service processes to reduce ineffective operations and waiting times and improve service efficiency. Use Six Sigma's process analysis tools to visualise the service process and identify bottlenecks and improvement points in the process. Introduce automation and intelligent technologies, such as robotics and artificial intelligence, to improve service efficiency and quality.

The application of Six Sigma in the service industry brings significant value to the service industry through systematic process optimisation, quantitative service quality improvement, effective cost control and efficiency enhancement. The service industry can flexibly apply Six Sigma's DMAIC process and related tools according to its own characteristics and needs to achieve continuous improvement and performance excellence.

3.2. Analysis of the Application of Six Sigma at The Level of Practice in The Service Industry

In the development of practice, many scholars have made different degrees of innovation and application of DMAIC, a key tool of Six Sigma management. Cui Lixin used the Six Sigma management method to study the quality of hospital care and found the key factors affecting the quality of care. Arafeh applied Six Sigma process improvement methodology to reduce patient discharge time in a cancer treatment hospital. Data was collected on the duration of all activities and analysed. Fragmented and non-standardised processes and a lack of communication between managers were identified as the main causes of excessive time. The authors identified simplified and standardised processes as one of the proposed improvements, which reduced patient discharge time from 216 minutes by 54%. Similarly, Rui Zhang investigated and analysed the occurrence of internal pressure ulcers in 12,641 patient episodes in 2012 using Six Sigma management methods, identifying key points in the hospital's care processes and proposing improvements. Through the implementation of Six Sigma management, the incidence of this disease in the hospital was reduced from 0.158% before implementation to 0.057% after optimisation.

Six Sigma management is still more effective in improving other aspects of management.

Vijaya (2016) applied Lean Six Sigma (LSS) for betterment in the banking and financial services industry and successfully developed a structured stakeholder management model for LSS project management. Kalashnikov (2017) stated that successful implementation of Lean Six Sigma techniques requires consideration of many aspects. Often, decision makers must consider multiple conflicting goals.

And in many cases, there is a lack of formal methods for selecting projects.

Research on Six Sigma is not limited to this, but has also been studied in relation to organisational sustainability. Freitas identified the correlation between Six Sigma management and organisational sustainability, and the importance of the cost dimension to organisational sustainability. In addition, Li specifically studied the implementation of Six Sigma management improvements in private companies. Similarly, other scholars have studied the implementation of Six Sigma management especially in small and medium-sized enterprises (SMEs) that lack financial resources.

In foreign countries, after more than ten years of Six Sigma implementation in the service industry, foreign service organisations have accumulated rich experience in the application of Six Sigma, Six Sigma application in the service industry is relatively wide in scope, the application of enterprises in various industries is also relatively large, the industry involves banks, hotels, hospitals, government, etc. G.Y. Hong and T.N. Goh argued the applicability of Six Sigma to the application of the software industry and designed a framework for the application of Six Sigma in the software industry. G.Y. Hong and T.N. Goh demonstrated the applicability of Six Sigma in the software industry and designed a framework for Six Sigma application in the software industry. Liu Xiaochen from Shandong University found that many service companies in Europe and the United States apply Six Sigma, such as Starwood International Group, Sony, etc. In the field research, Liu Xiaochen found that many service companies in Europe and the United States apply Six Sigma.

In China, although the introduction of Six Sigma management method is short and the theoretical foundation is weak, there are still many scholars and service organisations contributing to the theoretical results and practical exploration for the implementation of Six Sigma in China. For example, Zou Junfang (2006) conducted a study on the application of Six Sigma to automotive after-sales activities, using simulation and empirical methods for empirical analysis. Fang Fei (2008) studied the application of Six Sigma in the hotel industry and constructed an application model for the hotel industry. Wen Cui (2012) implemented the Six Sigma methodology by examining the salary and overtime situation of three consulting organisations, and finally proposed the implementation of Six Sigma in the consulting industry. Yang, Lingyun (2010) explained that the application of Six Sigma in the banking industry should be transformed into a corporate culture. Li Fanggui (2015) describes the use of Six Sigma methodology to shorten the waiting time for patients to pick up medication in the outpatient pharmacy at the People's Hospital of Wengyuan County, Shaoguan City.

In general, although the application of Six Sigma in China's service industry is relatively widespread in various industries, but each industry is generally limited to powerful enterprises, the popularity is not enough.

4. Conclusion

This paper provides a comprehensive and in-depth analysis of Six Sigma management theory through an in-depth discussion of its origin and development, connotation and current status of industrial application, and application in the service field. Six Sigma management theory, originally originated in the manufacturing industry, but after years of

development and practice, its application in the service industry has become increasingly widespread. The service industry, as an industry centred on customer satisfaction, the core concepts of Six Sigma - the pursuit of zero defects, focusing on customer needs, and data-based decision-making - can all be effectively applied in the service industry. Further studies have shown that Six Sigma has been widely applied in various industries, especially in the service industry, and has achieved remarkable results. Implementing Six Sigma management, the service industry can improve service quality, reduce service costs and enhance enterprise competitiveness. To sum up, Six Sigma management theory in the service industry has a wide range of application prospects and significant practical effects. The service industry should actively explore and practice Six Sigma management theory, continuously improve service quality and management level, and enhance the market competitiveness of enterprises.

References

- [1] Cui Wen. The application of six sigma management in China's consulting management service industry [D]. Dalian: Dalian University of Technology, 2012.
- [2] Gu Qingfeng. Lean Six Sigma for fine management in Minsheng Bank [J]. *China Quality*, 2008(386), 28-30.
- [3] Hu Yaqin, He Zhen. On the essential properties of six sigma management [J]. *Science and Management of Science and Technology*, 2004(10).
- [4] HE Zhen, ZHOU Yanhu, GAO Xuefeng. Lean Six Sigma and its implementation [J]. *Journal of Xi'an Electronic Science and Technology University (Social Science Edition)*, 2006 (1): 13-17.
- [5] Liu Xiaochen. An innovative study on the implementation of Six Sigma quality management system in service industry [D]. Jinan: Shandong University, 2010.
- [6] Ma Lin, He Zhen. Six sigma management (2nd ed.) [M]. Renmin University of China Press, 2007.
- [7] Qiu, Huadong. Application of sigma management in quality improvement [J]. *China Quality*, 2009, (7):24-26.
- [8] Shao Fenfang. Integration of Lean Thinking and Six Sigma [J]. *Modern Enterprise*, 2004, 59.
- [9] Shi Shih-Hong. Research on service quality evaluation method and its application in communication industry [D]. Qinhuangdao City, Yanshan University, 2006.
- [10] Liu Xiaojing, Huang Xiaobin. Enterprise customer service process design based on DMAIC method [J]. *Mall Modernisation*, 2017, No.849(12):107-108. DOI:10.14013/j.cnki.scxdh.2017.12.064.
- [11] Tao Liyan, Pei Ruiting. Research on Service Improvement of Agricultural and Commercial Banks Based on Lean Six Sigma [J]. *Productivity Research*, 2017, No.300(07):112-115. DOI:10.19374/j.cnki.14-1145/f.2017.07.025.
- [12] Shen Wei-Qun. Research on the optimisation of library service process under the vision of Lean Six Sigma [J]. *Intelligence Theory and Practice*, 2017, 40(05):99-105. DOI:10.16353/j.cnki.1000-7490.2017.05.019.
- [13] Lin Chang. Research on six sigma management of small and medium-sized enterprises based on TQM [J]. *China Information Technology Management*, 2017, 20(11):73~74.
- [14] Liu, Yi-Qun. I see Six Sigma and Lean Six Sigma [J]. *Shanghai Quality*, 2014, (9):70-71.
- [15] DOGANO, GURCANOF. Data perspective of Lean Six Sigma in industry 4.0 Era: a guide to improve quality: proceedings of

- the international conference on industrial engineering and operations management Paris [C]. 2018.
- [16] HUANG Canyan, ZHAO Xiumei, WANG Xiaoling. Six sigma application research [J]. Science and Technology Innovation Herald, 2014, (22):179.
- [17] Genichi Tagucgi. Robust Engineering: Learn How to Boost Quality while Reducing Costs & Time to Market McGraw-Hill Professional [J]. 1999.
- [18] Kohli, H. Conversion cost reduction using advanced process control (SPC) and real-time data analysis with ERP linkage [SMT assembly] [C]. Electronic Materials and Packaging, 2002, 15(2):89-93.
- [19] Cai Jiachen. Research on the application of Six Sigma in China [J]. China Management Information Technology, 2016, 19(5):82~83.