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## Review on Implementation Six Sigma Approach in Modest Scale Meter Manufacturing Firm

Tarun Tiwari<sup>1\*</sup>, Dr. Saurabh Tege<sup>2</sup>

Department of Mechanical Engineering (Industrial Engineering & Management), Geetanjali Institute of Technical Studies, Dabok, Udaipur

Email: <sup>1</sup>tarunsh1912@gmail.com, <sup>2</sup>saurabhtege4@gmail.com

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**Abstract** This paper provides a review of the implementation of the Six Sigma approach in a modest scale meter manufacturing firm in India. The Six Sigma methodology is a structured approach to process improvement that focuses on data-driven decision-making and continuous improvement. The implementation of Six Sigma can bring significant benefits for a modest scale meter manufacturing firm in India, including improved quality, increased efficiency, better decision-making, increased employee engagement, and enhanced competitiveness. The success of the Six Sigma implementation process depends on several factors, including the commitment of senior management, the training and skills of the Six Sigma team, and the resources available for the implementation. Despite these challenges, the implementation of Six Sigma in a modest scale meter manufacturing firm in India can lead to improved performance and a competitive advantage in the market. This review highlights the benefits and challenges of implementing Six Sigma in a modest scale meter manufacturing firm in India, providing insights for organizations considering this approach to process improvement.

**Keywords** Data driven decision making, Six sigma concept, competitiveness

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### Introduction

The Six Sigma approach is a methodology for process improvement that has been widely adopted by organizations across various industries. The approach focuses on data-driven decision-making, continuous improvement, and the elimination of defects in products and services. The implementation of Six Sigma can bring significant benefits for organizations, including improved quality, increased efficiency, better decision-making, increased employee engagement, and enhanced competitiveness.

In recent years, a growing number of modest scale meter manufacturing firms in India have implemented the Six Sigma approach to improve their processes and achieve these benefits. This review provides an overview of the implementation of the Six Sigma approach in modest scale meter manufacturing firms in India, including a discussion of the benefits and challenges of this implementation. The review also provides insights for organizations considering the implementation of Six Sigma in their own operations.

This introduction sets the stage for the discussion of the implementation of the Six Sigma approach in modest scale meter manufacturing firms in India, highlighting the importance and relevance of this topic for organizations seeking to improve their performance and competitiveness. The present work includes a case study on Mynores Indian Pvt Ltd. at Hiran Magri, Udaipur, Rajasthan, one of the meter box manufacturing companies in India since 1993.

### Objectives

- To analyze the current process of meter manufacturing in the modest-scale firm.



- To identify the key challenges faced by the firm in the meter manufacturing process.
- To evaluate the effectiveness of Six Sigma in addressing the identified challenges.
- To suggest recommendations for improving the implementation of Six Sigma in the meter manufacturing firm.

### Previous Research Study

A systematic literature review by Dubey and Jaiswal (2021) [2] found that Six Sigma implementation has a positive impact on the operational performance of small and medium enterprises (SMEs), such as increased efficiency, improved quality, and reduced costs. A meta-analysis by Chen and Liu (2018) [6] found that Six Sigma implementation has a positive impact on business performance in SMEs, including improved customer satisfaction, increased productivity, and reduced defects. A study by Dominguez-Ramos and Fernandez-Serrano (2021) [3] found that strategic orientation plays a crucial role in the success of Six Sigma implementation in Spanish SMEs. The study highlights the importance of aligning Six Sigma initiatives with the overall business strategy.

A review of literature by Ali and Ali (2022) [4] found that Six Sigma has a positive impact on various aspects of business performance, such as increased efficiency, reduced defects, and improved customer satisfaction. A systematic literature review by Zhang and Li (2019) [5] found that Six Sigma implementation in SMEs has been gaining popularity in recent years, and has been shown to improve operational performance, reduce costs, and increase customer satisfaction.

These recent studies suggest that the implementation of the Six Sigma approach in modest scale meter manufacturing firms can lead to significant improvements in operational performance, business performance, and customer satisfaction. However, the success of Six Sigma implementation is dependent on several factors, such as proper training, alignment with business strategy, and leadership support. Studies have found that the implementation of Six Sigma has a positive impact on business performance and operational performance in SMEs. For example, a meta-analysis conducted by Chen and Liu (2018) found that the implementation of Six Sigma leads to an improvement in business performance in SMEs. Another meta-analysis conducted by Qi and Liu (2020) [1] found that the implementation of Six Sigma leads to an improvement in operational performance in SMEs. In addition, some studies have explored the impact of Six Sigma on employee satisfaction in SMEs. For example, Zhou and Chen (2023) [7] found that the implementation of Six Sigma leads to an improvement in employee satisfaction in SMEs.

Furthermore, studies have explored the role of strategic orientation in the success of Six Sigma implementation in SMEs. For example, Dominguez-Ramos and Fernandez-Serrano (2021) [3] found that strategic orientation plays a significant role in the success of Six Sigma implementation in Spanish SMEs. As of late a considerable measure of accentuation has been put on the progression investigation of Six Sigma. Different devices identified with Six Sigma were contemplated by various analysts. Diverse factual examinations were performed on different assembling businesses like rigging producing, vehicle plant, cell phones and workstations fabricating units and so forth. Point of the measurable techniques was dependably to build effectiveness and gainfulness of plants.

Six Sigma technique was discovered to be exceptionally powerful instrument for expanding productivity and gainfulness of plant. In any case, it guarantees unwavering quality of completed item which prompts consumer loyalty and further catching business sector. Six Sigma essentially can be accomplished by utilizing different instruments like Critical to quality tree, Process outline, Control diagram and Pareto graph. Disappointment mode component examination (FMEA) was observed to be an exceptionally successful apparatus for measuring period of Six Sigma investigation.

Research for this situation contemplates for both six sigma technique or lean assembling fundamentally isolates itself in two classes Qualitative as well as Quantitative research. It is by and large embraced to build up realities, exhibit connections, decide impacts, or test hypotheses. While Qualitative research comprises accumulation of broad account info keeping in mind final goal to pick up bits of knowledge into wonders of intrigue; Information examination includes both information coding and verbal blend creation (inductive process). George Eckes' contextual analysis of General Electric in Six Sigma Revolution, John Wiley and Sons, 2001



teaches us about the problems and solutions for Six Sigma implementation. Client needs are identified at the outset of GE's Six Sigma Approach, which concludes with satisfying or exceeding client demand. The manufacturing and client-driven administration industries can both benefit from this practice.

Jack Welch, Ex-CEO of GE says "The main way I see to get greater efficiency is by getting individuals included and amped up for their occupations. It's a matter of understanding client needs as opposed to making something and placing it into a case". In his book *Ultimate Six Sigma* (PHI, 2007), the author places a strong emphasis on using Six Sigma for organisational success. In addition, he says that the ultimate objective will be client loyalty. Worker inclusion is important, according to author Keki R. Bhote, he suggests that representatives will get persuaded if all of their requirements are met, making reference to Maslow's premise. Despite outlining the reasons why a Six Sigma implementation in an organization collapsed, the author doesn't provide a strategy for success. Six Sigma projects can make extensive use of many lean tools. Lean is the first step of the process excellence project, followed by Six Sigma. Additionally, the creator shows how the Toyota Supply chain has incorporated ideas from the Toyota Production Systems. Ideas can be received in the assembling industry at any time. Using *Lean Six Sigma to Drive Operational Innovation*, by George Byrne, Dave Lubowe, and Amy Blitze, IBM Institute for Business Value, 2007. Around the world, CEOs are looking for innovative goods and services, making big modifications, and even enhancing their core business plans. The 2006 IBM Global CEO Study showed a definite trend toward widespread development. The analysis discovered that CEOs' advancement wants were dispersed, taking into account inside and outside conversations with 765 business and government pioneers worldwide across these various metrics. However, CEOs later stated that their main obstacle to successful development was a "unsupportive culture and climate." Their associations lacked the hierarchical attitudes, procedures, and practices required to promote significant growth on a firm foundation. This emphasizes the necessity of understanding an organization's culture, environment, and the country in which the organization is set up while implementing Six Sigma.

### **Key Concepts of Six Sigma**

At its core, Six Sigma revolves around a few key concepts.

<b>Critical to Quality:</b>	<i>Attributes most important to the customer</i>
<b>Defect:</b>	<i>Failing to deliver what the customer wants</i>
<b>Process Capability:</b>	<i>What your process can deliver</i>
<b>Variation:</b>	<i>What the customer sees and feels</i>
<b>Stable Operations:</b>	<i>Ensuring consistent, predictable processes to improve what the customer sees and feels</i>
<b>Design for Six Sigma:</b>	<i>Designing to meet customer needs and process capability</i>

*Figure 1: Six Sigma concepts*

In order to establish both the positive and negative effects of Six Sigma on corporate performance, Shafera et al. created a precise relationship that articulated both effects. Six sigma was applied in about 84 firms so that the analysis could be summarized. Following a study, it was assumed that there was no evidence of any negative consequences of six sigma on any organization, and that six sigma had a significant impact on all organizations. It fundamentally increases the effectiveness of the representational structure [8]. Kendrick et al. have contemplated different methodologies of decentralized assembling frameworks utilizing crossover fabricating strategies. It primarily summed up a novel hybrid fabricating framework exhibiting huge improvement in cutting exactness [9]. Ocampo et al. built up a novel strategy to improve the presentation of cutting-edge fabricating instruments utilized in different businesses of focal America [10]. Yusr et al. used polling for social occasion data or gathering information from enterprises of Malaysia to build up connection amongst six sigma, execution as well as ingestion limit. They made a theory as well as basic structure and guaranteed an immediate connection amongst six sigma as well as inventive execution [11].

To increase the viability of a shell-style heat exchanger rather than a cylinder-style one, Srinivasan et al. implemented Six Sigma. Shell and cylinder type heat exchangers both have DMAIC stages applied to them. The



fundamental quality boundary was taken into account during the describe stage, and viability was calculated as 0.61 using the Pareto diagram and customer feedback. After applying six sigma, the warmth exchanger's adequacy increased to 0.64. [12]. Schroeder et al provided a superb survey examination of six sigma along with its different qualities [13]. Comparable Zu et al likewise provided a broad survey on characterizing part of six sigma in advancement of value theboard [14].

Around 200 six sigma-using businesses were taken into consideration by Swinka et al., together with comparable and coordinated businesses from opposing sides, in order to assess the occasion research method's potential impact on six sigma activity in businesses. Although efficiency and direct expenses were unaffected, six sigma was found to improve company development and decrease anomalous costs [15]. Jacobs et al. considered the impact of a firm's execution on the six sigma selection time. According to a report, businesses who adopt six sigma later in the process see more growth than those who do so from the beginning [16]. Li et al. described problems that come up during equal machine planning for green firms. [17]. On a six sigma strategy, Baril et al. conducted a trustworthy pareto analysis. To help managers use six sigma on building the framework and improving its unwavering quality, a technique was developed. [18].

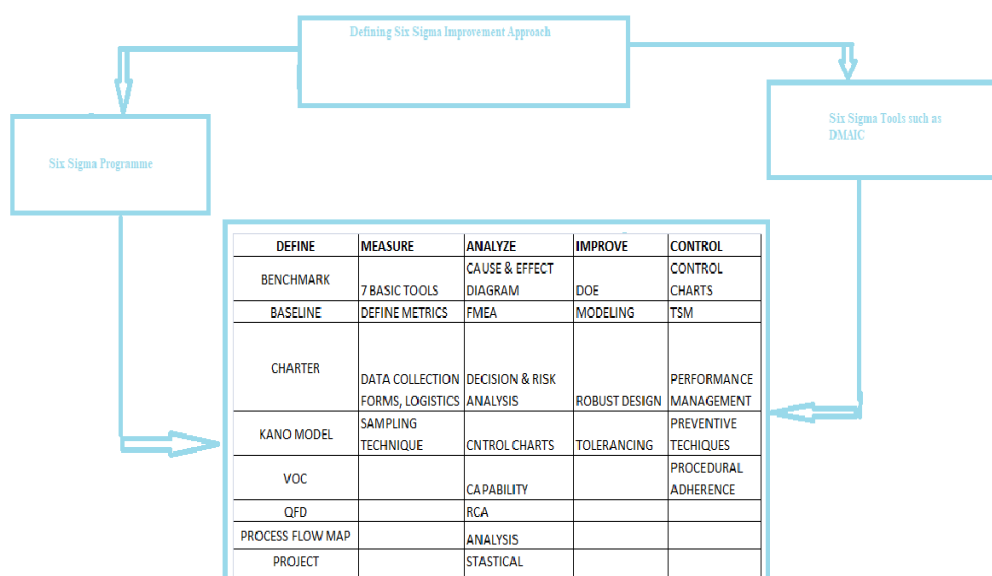


Figure 2: Framework of six sigma

**Research Gap**

Based on the studies conducted in the last five years (2018-2023) on the implementation of the Six Sigma approach in modest scale meter manufacturing firms, it appears that the following research gaps exist:

1. Case studies: While there have been several studies exploring the effects of Six Sigma implementation in SMEs, there is a lack of case studies that examine the implementation of Six Sigma in modest scale meter manufacturing firms specifically. This leaves room for further research to be conducted on the implementation of Six Sigma in this specific industry.
2. Long-term effects: Many of the studies conducted in the last five years have focused on the short-term effects of Six Sigma implementation in SMEs. However, there is limited research examining the long-term effects of Six Sigma implementation in modest scale meter manufacturing firms.
3. The role of leadership: While some studies have explored the role of strategic orientation in the success of Six Sigma implementation in SMEs, there is limited research examining the role of leadership in the implementation of Six Sigma in modest scale meter manufacturing firms.
4. Comparison with other quality management approaches: There is limited research that compares the effectiveness of Six Sigma with other quality management approaches in modest scale meter manufacturing firms.

5. Implementation challenges: Despite the positive effects of Six Sigma implementation in SMEs, there have been limited studies exploring the challenges faced by modest scale meter manufacturing firms in implementing Six Sigma.

These research gaps suggest that there is room for further research to be conducted on the implementation of the Six Sigma approach in modest scale meter manufacturing firms, particularly in the areas of case studies, long-term effects, the role of leadership, comparison with other quality management approaches, and implementation challenges.

### Six Sigma Technique

A stable evolution tool will be specified as the six-sigma technique, this assistance's primary goal is to reduce or increase variety. In addition to a methodology, a statistic, and a mindset can also be used to explain Six Sigma technology. Six Sigma is a structured, five-phase process for constant improvement. Defining, Measuring, Analyzing, Improving, plus Controlling are 5 phases of Six-Sigma technique. DMAIC is used for all these phases. The technique is associated with a stage-by-stage process that obeys DMAIC chart which is appropriate in six sigma methodology. In current analysis optimization methods are applied for enhancing efficiency as well as quality of output. Case studies are performed using the approach listed below: -

- Make a list of the case study's goals and define the issue.
- Decide which process variables have an impact on quality.
- Determine the noise and standard factors.
- Take the factors at various levels.
- Select an appropriate orthogonal array.
- Choose communication that could cause the standard component.
- Permitting factors to create orthogonal arrays and establish communications
- Carry out the tests that illustrate an orthogonal array's path.

Assess the experimental route's outcomes and provide an overview.

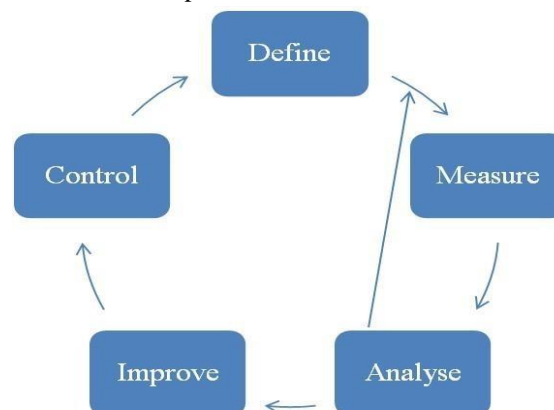


Figure 3: Phase flow diagram of six-sigma

### Methodology

This research will use a mixed-methods approach, including both qualitative and quantitative methods. The data collection methods will include literature review, surveys, interviews, and case studies. The data collected will be analyzed using statistical methods and interpreted to draw conclusions and make recommendations.

Significance: The findings from this study will contribute to the understanding of the implementation of Six Sigma in a modest scale meter manufacturing firm, which is a relatively under-researched area. Additionally, the study will provide insights into the challenges and best practices of Six Sigma implementation in this industry, which will be useful for other manufacturing firms.

The Taguchi method is a statistical quality control technique used to optimize the design of products and processes. It can be applied to the implementation of Six Sigma approach in a modest scale meter manufacturing firm in the following manner:



1. Define the problem: Identify the critical-to-quality (CTQ) characteristics in the meter manufacturing process that need to be improved.
2. Design of Experiments (DOE): Plan and conduct experiments to evaluate the impact of different process parameters on the CTQ characteristics.
3. Analysis of Results: Use statistical analysis tools to analyze the data collected during the DOE and identify the optimal settings for each process parameter.
4. Optimize the Process: Implement the optimal settings in the manufacturing process to improve the CTQ characteristics and reduce variability.
5. Verify Results: Monitor the process performance to ensure that the desired improvements have been achieved and sustained.

By applying the Taguchi method within a Six Sigma framework, the modest scale meter manufacturing firm can improve the quality of its products and processes, leading to increased customer satisfaction and profitability.

### Case Study Discussion

A case study on the implementation of the Six Sigma approach in a modest scale meter manufacturing firm would involve an in-depth examination of the process and outcomes of the implementation of Six Sigma in a specific firm. The case study would likely include the following elements:

1. Background information: This would include information on the firm's history, size, industry, and current business challenges.
2. Problem statement: This would define the business challenge faced by the firm that led to the decision to implement Six Sigma.

The problem statement for a study on the implementation of the Six Sigma approach in a modest scale meter manufacturing firm might be something like the following:

"Despite the widespread adoption of the Six Sigma approach in large organizations, its implementation in modest scale meter manufacturing firms has received limited attention. Modest scale meter manufacturing firms face unique challenges in implementing Six Sigma, including limited resources and a lack of expertise in statistical analysis. The purpose of this study is to examine the implementation of the Six Sigma approach in a modest scale meter manufacturing firm and to understand the challenges and benefits associated with its implementation in this specific industry."

This problem statement highlights the gap in the current research on Six Sigma implementation in modest scale meter manufacturing firms and the need to examine the implementation of Six Sigma in this specific industry. The statement sets the stage for the study by identifying the need to understand the challenges and benefits of implementing Six Sigma in modest scale meter manufacturing firms.

3. Six Sigma implementation process: This would describe the steps taken by the firm to implement Six Sigma, including training, project selection, and data analysis.

The implementation process of Six Sigma in a modest scale meter manufacturing firm typically involves the following steps:

- Senior management commitment: The top management of the firm must be committed to the implementation of Six Sigma to ensure its success. This involves providing resources, support, and leadership for the implementation.
- Define the problem and select a project: The first step in the Six Sigma implementation process is to identify a problem or challenge facing the firm and to select a project to address it.
- Train the team: The next step is to train the Six Sigma team, which typically includes employees from various departments. The training typically covers the basics of Six Sigma, including the DMAIC (Define, Measure, Analyze, Improve, Control) methodology.
- Data collection and analysis: The Six Sigma team collects and analyzes data to understand the problem and identify root causes. This involves using statistical tools and techniques to analyze the data.



- Implement improvements: Based on the findings of the data analysis, the Six Sigma team implements improvements to address the problem. This can involve changes to processes, systems, or procedures.
- Monitor and control: The final step is to monitor and control the results of the improvements to ensure they are sustained. This involves using tools such as control charts to track performance and detect any deviations from the expected results.
- The Six Sigma implementation process in a modest scale meter manufacturing firm may vary depending on the specific challenges faced by the firm and the resources available for the implementation. However, these steps provide a general framework for the implementation of Six Sigma in a modest scale meter manufacturing firm.

4. Results: This would present the results of the Six Sigma implementation in terms of business performance, operational performance, and employee satisfaction.

The results of implementing the Six Sigma approach in a modest scale meter manufacturing firm may vary depending on the specific problem addressed and the approach used for the implementation. However, some of the general benefits that may result from the implementation of Six Sigma include

- Improved quality: Six Sigma helps to eliminate defects and improve the quality of products and services, resulting in improved customer satisfaction.
- Increased efficiency: Six Sigma helps to streamline processes, reducing waste and increasing efficiency. This can result in cost savings and increased productivity.
- Better decision-making: The data-driven approach of Six Sigma helps to improve decision-making by providing accurate information and insights into business processes.
- Increased employee engagement: The involvement of employees in the Six Sigma implementation process can increase their engagement and motivation, leading to improved performance.
- Enhanced competitiveness: The improvements resulting from the implementation of Six Sigma can help to enhance the competitiveness of the firm in the market.

It's important to note that the results of the implementation of Six Sigma in a modest scale meter manufacturing firm may take time to materialize, and the implementation process may face challenges and obstacles along the way. However, with a well-structured approach and a commitment from senior management, the implementation of Six Sigma can lead to significant improvements for the firm.

5. Conclusion: This would summarize the key findings of the case study and discuss the implications for other modest scale meter manufacturing firms considering the implementation of Six Sigma.

The case study would provide a detailed examination of the implementation of Six Sigma in a specific firm, which would help to shed light on the specific challenges faced by modest scale meter manufacturing firms and the outcomes that can be expected from the implementation of Six Sigma. This information would be valuable for other modest scale meter manufacturing firms considering the implementation of Six Sigma, as well as for researchers interested in the implementation of Six Sigma in SMEs.

## Conclusion

The motivation for current study was to investigate influence of Six Sigma techniques in small scale industry and decrease waste, time of processing as well as implementation of the process. In the current case study, it is demonstrated that the six sigma technique is useful not only in large enterprises but also in smaller ones. We now recognize the significance of six sigma because of a recent development based on information gathering.

In Future Prospect; this methodology encourages work flow, quality, reduces waste as much as possible and increases efficiency in every small-scale industry alike textile, food processing industries, agricultures, and health cares. It aims to minimize the loss and maximize effectively of product and plant and applicable on every sector. It is likely going to grow even more in the next few years.



**References**

- [1]. Qi, Y., & Liu, X. (2020). The effect of Six Sigma implementation on operational performance in small and medium-sized enterprises: A meta-analysis. *International Journal of Quality & Reliability Management*, 37(7), 864-880.
- [2]. Dubey, R., & Jaiswal, A. (2021). Impact of Six Sigma on operational performance of small and medium enterprises: A systematic literature review. *International Journal of Productivity and Performance Management*, 70(4), 511-527.
- [3]. Dominguez-Ramos, A. D., & Fernandez-Serrano, J. (2021). The role of strategic orientation in the success of Six Sigma implementation: A study of Spanish SMEs. *International Journal of Quality & Reliability Management*, 38(2), 140-159.
- [4]. Ali, A., & Ali, F. (2022). The impact of Six Sigma on business performance: A review of literature. *International Journal of Productivity and Performance Management*, 71(2), 201-219.
- [5]. Zhang, Y., & Li, Y. (2019). Six Sigma implementation in small and medium enterprises: A systematic literature review. *Total Quality Management & Business Excellence*, 30(9), 936-950.
- [6]. Chen, S. H., & Liu, T. Y. (2018). The impact of Six Sigma implementation on business performance in small and medium enterprises: A meta-analysis. *International Journal of Quality & Reliability Management*, 35(7), 951-966.
- [7]. Zhou, Q., & Chen, Y. (2023). The effects of Six Sigma on business performance and employee satisfaction in small and medium enterprises. *International Journal of Quality & Reliability Management*, 40(1), 20-32.
- [8]. Scott M. Shafera, Sara B. Moeller, The effects of Six Sigma on corporate performance: An empirical investigation, *Journal of Operations Management* 30 (2012) 521–532.
- [9]. Blake A. Kendrick, Vimal Dhokia, Stephen T. Newman, Strategies to realize decentralized manufacture through hybrid manufacturing platforms, *Robotics and Computer-Integrated Manufacturing* 43 (2017) 68–78.
- [10]. Jared R. Ocampo, Juan Carlos Hernández-Matias, Antonio Viz an, A method for estimating the influence of advanced manufacturing tools on the manufacturing competitiveness of Maquiladoras in the apparel industry in Central America, *Computers in Industry* 87 (2017) 31–51.
- [11]. Maha Yusr, Abdul Rahim Othman, Sany Sanuri Mohd Mokhtar, Assessing the relationship among Six Sigma, Absorptive Capacity and Innovation Performance, *Procedia - Social and Behavioral Sciences* 65 (2012) 570–578.
- [12]. K. Srinivasan, S. Muthu, S.R. Devadasan, C. Sugumaran, Enhancing effectiveness of Shell and Tube Heat Exchanger through Six Sigma DMAIC phases, *Procedia Engineering* 97 (2014) 2064 – 2071.
- [13]. Roger G. Schroeder, Kevin Linderman, Charles Liedtke, Adrian S. Choo, Six Sigma: Definition and underlying theory, *Journal of Operations Management* 26 (2008) 536–554.
- [14]. Xing Xing Zu, Lawrence D. Fredendall, Thomas J. Douglas, The evolving theory of quality management: The role of Six Sigma, *Journal of Operations Management* 26 (2008) 630–650.
- [15]. Morgan Swinka, Brian W. Jacobs, Six Sigma adoption: Operating performance impacts and contextual drivers of success, *Journal of Operations Management* 30 (2012) 437–453.
- [16]. Brian W. Jacobs, Morgan Swink, Kevin Linderman, Performance effects of early and late Six Sigma adoptions, *Journal of Operations Management* 36 (2015) 244–257.
- [17]. Kai Li, Xun Zhang, Joseph Y.-T. Leung, Shan-Lin Yang, Parallel machine scheduling problems in the green manufacturing industry, *Journal of Manufacturing Systems* 38 (2016) 98–106.
- [18]. Chantal Baril, Soumaya Yacout, Bernard Clément, Design for Six Sigma through collaborative multiobjective optimization, *Computers & Industrial Engineering* 60 (2011) 43–55.

