

BENEFITS AND CHALLENGES OF DMAIC METHODOLOGY IMPLEMENTATION IN SERVICE COMPANIES: AN EXPLORATORY STUDY

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Ivan Evander Subagyo

Dewi Saraswati

Teddy Trilaksono

Muhammad Setiawan Kusmulyono

Department of Business, School of Business and Economics,
Universitas Prasetiya Mulya

Abstract: The DMAIC (Define, Measurement Analyze, Improve, Control) methodology of Six Sigma has been widely recognized as a breakthrough process improvement strategy for application among human resources that offers an impressive reduction in defects or errors in many business processes. Even though Six Sigma's DMAIC was predominantly applied in the manufacturing industry, recent studies have revealed that it has been implemented effectively in the service industry as well. This article aims to explore the benefits and the fundamental challenges of DMAIC implementation as a student's course project in five Indonesian service companies. An exploratory study was conducted to provide a clear understanding of DMAIC method implementation in service companies. A similar challenge, the lack of openness of the company, was found across cases. Several enhancements in company performance were identified, including improved customer satisfaction, reduction in delivery errors, and shorter waiting time. This research also highlighted the usage of some non-statistical tools and techniques that effectively contribute to each phase of the DMAIC method. Lastly, all five companies reported that these improvement projects offer positive benefits, including increased revenue and cost reduction.

Keywords: DMAIC, case study, company performance, service companies



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Six Sigma is becoming increasingly popular among organizations from various industries as a set of tools to generate improvement, as demonstrated by the number of large organizations that have taken on the challenge of applying the DMAIC (De-

fine, Measurement Analyze, Improve, Control) methodology (Antony et al., 2016; Smêtkowska and Mrugalska, 2018). Initially known as a method for reducing variation, the application of DMAIC in practice can be considered a universal mechanism for problem-solving and process improvement (McAdam and Lafferty, 2004).

Six Sigma itself has been widely taught at schools around the world to help future employers

Corresponding Author:

Ivan Evander Subagyo, Department of Business, School of Business and Economics, Universitas Prasetiya Mulya, DOI: <http://dx.doi.org/10.21776/ub.jam.2020.018.04.19>

build a workforce with the necessary skill sets and to make the graduating students more marketable. However, to master Six Sigma, business leaders must extend beyond just studying the involved concepts and principles and apply them to the existing business process. Kanigolla et al. (2013), found that applied projects assigned in the Six Sigma course aided students in better apprehend the course concepts.

This study aims to explore the implementation of DMAIC methodology within a student's course semester project in service companies. Insight about the benefits and the challenges of implementing the methodology will be gained. Moreover, we will also identify frequently used tools and techniques within DMAIC implementation. This study analyzes 5 companies.

Six Sigma is considered a well-ordered method for improving the business process as well as developing new products and services (Evans and Lindsay, 2014; Linderman et al., 2003). Traditionally under the Six Sigma approach, a methodology called DMAIC (Define, Measure, Analyze, Improve, and Control) can be applied to particular problems so the Six Sigma level of performance can be attained (Breyfogle, 2003). In accordance with Siha and Saad (2008), there are five phases in DMAIC: (1) define and value the problem, (2) evaluate current performance and determine desired service level, (3) analyze causes of problems to discover the root cause, (4) improve the process, and (5) control the enhanced process to ensure the sustainability of the improvement. Every stage is originally developed through statistical and qualitative tools to attain the designated goal for the respective stage (Deeb et al., 2018).

Furthermore, although DMAIC methodology was originally used in manufacturing processes, it has also been widely applied within many service industries, especially financial and healthcare institutions (Siha and Saad, 2008). In the context of the service industry, DMAIC methodology can be utilized to manage customers' dissatisfaction within the business process as certain issues are identified, variables affecting process are quantified, sources of the problems are analyzed, improvement is de-

signed and implemented, variables are monitored until the expected sigma level is attained, and customer satisfaction is optimized (Abdul and Purwatmini, 2018). Implementation of this method in a healthcare service company was reported to generate significant cost savings and improvement at the sigma level (Rohini and Mallikarjun, 2011). Large numbers of successful Six Sigma projects in the hospitality industry were reported that demonstrated improvement in productivity, menu redesign, resort concierge, e-mail marketing, waiting for time, billing error, occupancy rate, and sales (Chakraborty and Tan, 2012). Abdul and Purwatmini (2018), also found that the five stages of DMAIC reduced loss caused by the withdrawal of customer loyalty from unhappy customers who got bad experience with the service. This reduction led to an improvement in the service quality of a call center company.

The benefits of the implementation of Six Sigma's DMAIC have been reported in numerous papers (Antony et al., 2016; Cunha and Dominguez, 2015; Rahman et al., 2018). Smêtkowska and Mrugalska (2018), suggested that DMAIC concentrates heavily on production process improvement, thus leading to boost the firm's profitability. Moreover, it was found that Six Sigma projects demonstrated substantial cost reduction and intangible gains including better employee morale, teamwork, and productivity (Antony et al., 2016).

In terms of challenges, lack of awareness of the advantages of Six Sigma, and inadequate communication regarding the need for change at all management levels of employees were discovered to be a typical challenge (Antony et al., 2016). Furthermore, Deniz and Çimen (2018), found out that the challenges were different at each management level; for instance, top managers found that inadequacy of knowledge about Six Sigma and beliefs regarding the complexity of Six Sigma were the biggest challenge. Similarly, middle-level managers also considered their dearth of comprehension about Six Sigma to be the biggest challenge. First-level managers, however, discovered that they did not have enough time for Six Sigma projects, which do require a considerable time commitment. Chakrabarty and Chuan (2009), identified that these challenges

differed between companies that have adopted Six Sigma; most reported difficulty in gathering data, prolonged effort, difficulty in determining process specifications, and complexity. The companies that had not implemented Six Sigma, mentioned that their decision was made based on unfamiliarity, irrelevance, or a lack of interest.

Since these methods were originally used in manufacturing, the most common tools used are statistical, such as hypothesis tests, non-parametric tests, simple regression analysis, and control charts (Antony et al., 2016). However, Cunha and Dominguez (2015), pointed out that it is not always necessary, to emphasize statistics to find opportunities for improvement since the process is usually time-consuming, but that it was more necessary to concentrate on defining the highest priority problem, performing root cause analysis, and executing the solutions instead. Meanwhile, Antony et al. (2016), highlighted several non-statistical tools that are commonly used as alternatives, including supplier-input-process-output-customer (SIPOC), fishbone diagram, Pareto chart, process mapping, and box plots.

METHOD

Data collection

Data was collected from the observation of 16 companies by undergraduate-level students in a Business Process Improvement (BPI) course. Furthermore, five service companies located in Jakarta and South Tangerang region were selected for the case studies, since they were focused on improving service-related activities. The result of the obser-

vation was then summarized to help researchers explore the benefits, challenges, and commonly used tools and techniques in DMAIC methodology adoption in the BPI project.

The BPI project was designed according to the problem-based learning approach, in which students in a group were given a task to apply the course concepts to a real-world improvement project. Collaboration between local companies and a group of 4 to 5 students are conducted. Students were allowed to identify a company to be improved with DMAIC methodology.

In accordance with the DMAIC framework, the BPI project consists of five phases: (1) define, (2) measure, (3) analyze, (4) improve, and (5) control. For better monitoring, the following objectives for each phase were set:

1. Define: Students identify the most prioritized problem
2. Measure: Students measure the company’s current performance and set a specific, measurable, attainable, relevant, time-bound (SMART) goal to be achieved by the end of the semester
3. Analyze: Students analyze the causes of a problem and perform root cause analysis
4. Improve: Students propose some improvement alternatives to be implemented, select the best solution, and implement it
5. Control: Students report the changes that occurred in the business process; if the goal was not achieved, they had to make a Problem Identification and Corrective Action (PICA) plan. Furthermore, various tools and techniques of

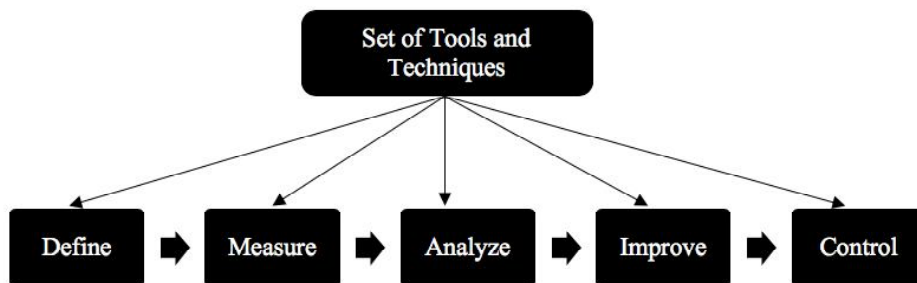


Figure 1 Conceptual Framework for DMAIC Implementation in BPI Project

Six Sigma were used to generate measurable outputs from each phase.

The students collect data during the DMAIC process by conducting observations from the beginning and end of the project and sometimes perform semi-structured in-depth interviews with the company owners, employees, and customers. Data obtained from the observations are then reported and organized so students can see the outcomes of each phase. This arrangement also helps them to identify in which phase the challenge takes place. Additionally, tools and techniques for every phase are documented, and thus the most commonly used tools and techniques can be identified.

The data gathered by these students are then collected by researchers as part of this exploratory study. Besides, the researchers also conducted interviews with each group of students who are initiators and executors of business improvement projects in the 5 targeted companies to address the following research question:

- RQ1. What are the fundamental challenges in the implementation of DMAIC?
- RQ2. What are the key benefits of DMAIC implementation?
- RQ3. What are the most frequently used tools and techniques in the case study companies?

Case study

In accordance with the nature of the research questions, exploratory research supported by an analysis from multiple case studies was used to gain a broad view of DMAIC implementation. Multiple case studies enable the researcher to seek for patterns of similarity and difference that spread across cases, as the same issues are explored in every case (Takahashi and Araujo, 2019). Case studies also help to generalize, as the results of the findings using various cases can facilitate some form of replication (Noor, 2008). Besides, conducting other case studies can also diminish the errors and bias of a study through case study procedures and a case database development (Yin and Ma, 2015 in Takahashi and Araujo, 2019).

In the case of study research, selecting cases based on a set of a particular standard is consid-

ered to be vital (Siggelkow, 2007; Veldman et al., 2011). The criteria for the company selection include the following: a minimum of 6 months of operation must have elapsed since establishment, all participating companies must be from the service industry, and all participating companies must be willing to implement DMAIC methodology together with the students.

At first, semi-structured interviews with the companies' representatives were conducted to acquire primary data about the initial condition of each company. The representatives were all dedicated employees who were specifically assigned to implement the projects. Furthermore, observation activities were carried out for 3 weeks to monitor the progress of the improvement project. Lastly, face-to-face basis interviews were held after the projects were completed to produce the final results of DMAIC implementation. The summary for each case was then presented using the following outlines:

- (1) Company background information and the main problem/issue,
- (2) Challenges to implementation,
- (3) Benefits of DMAIC implementation, and
- (4) Frequently used tools and techniques.

Given the nature of the research objectives, an exploratory study was carried out to get a general view of the DMAIC implementation outcomes as the students' course semester project. For this study, data were collected from interviews, observations, and secondary data, which were then summarized to help researchers explore the benefits, challenges, and commonly used tools and techniques in DMAIC methodology adoption in the BPI course semester project. To validate the data taken, the researchers used the triangulation method proposed by Denzin (1978, 2018) and Patton (1999). Data triangulation is done by confirming the results of interviews and observations to respondents. In addition to checking the truth of information from interviews and observations, researchers can compare it with available documents for instance financial reports and inventory records in the company.

Data analysis was conducted based on the Krueger (1998), the method where initially the in-

terview was formally recorded and transcribed. Descriptive analysis of all case studies was then performed based on the transcribed interviews and observations, furthermore mapped into summary tables. The last stage is interpretation and recommendations where the mapped data is evaluated based on the existing concepts from previous research within the DMAIC methodology of Six Sigma.

RESULTS

Case study results

This study involves five improvement projects conducted in five different service companies. These projects have shown that service time, operational cost, customer complaints, and defective products are the main problems reported through the service companies.

Company A: Cooperative store

Background. Company A is a cooperative store located inside a university in Indonesia and is man-

aged by its employees. It was established in 2015 to provide quality products that support the teaching and learning processes of students, lecturers, chancellors, and all employees at the university while also empowering employees who participate in managing business entities and providing a contribution to the employees' cooperative store. The priority problem discovered in this company was the long queue at the cashier, thus the objective of the improvement project conducted was to decrease the average customer waiting time by around 45%.

Implementation challenges. The root cause of the problem was identified as unclear instruction to customers so the queue line was often disorganized. The company initiated the installation of a visual control instrument on the floor that provided clear instructions about where they should make the queue line. The first initiative was unsuccessful because customers were not accustomed to observing the instruction on the floor; therefore, the company added another visual control instrument on the wall near the entrance/exit. In general, the challenge in the

Table 1 Outputs from each phase of DMAIC

Company	Define	Measure	Analyze	Improve	Control
A	Long service time	Reduce service time	Unclear procedure	Visual control tool on the floor for marking the queueing line	13% average wait time reduction
B	High operational cost	Reduce operational cost	Unclear procedure	Determine the standard criteria for operation	50% operational cost reduction
C	High customer complaint rate	Reduce customer complaint rate	Lack of competency	Determine the standard operating procedure	77% customer complaint rate reduction
D	Long service time	Reduce service time	Inefficient procedure	Redesign the working process	The project finished 2 days earlier
E	High delivery errors	Reduce delivery errors	Complicated procedure	Apply the use of check sheet	1% delivery errors reduction

adoption of DMAIC in this company was in the “Improve” phase, since it required a lot of customer cooperation. The company needed to extend the “Improve” phase for a longer period so the customers would have enough time to adjust to the new process flow.

Benefits of DMAIC. The main purpose of this improvement project was to reduce the average waiting time for customers in the queue line. By the end of the project, the average waiting time was shortened from 150 seconds to 130 seconds; however, the designated target of around 45% reduction was not achieved. Results showed that this project generated a positive impact on the bottom line. It was reported that the reduction in customers’ waiting time generated an increase in the company’s revenue after the implementation of the DMAIC methodology.

Frequently used tools and techniques. Several tools and techniques were utilized during the process of DMAIC adoption. Based on the interviews, we found that the tools and techniques used were: (1) SIPOC, (2) Severity-urgency matrix, (3) Performance-importance matrix, (4) Fishbone diagram, (5) Interrelationship diagram, and (6) Visual control.

Company B: Financial service platform

Background. The next case represents a peer-to-peer (P2P) lending platform developed to support the working capital of farmers. The company was founded in 2015 and intended to enhance the welfare of Indonesian farmers, most of whom live in poverty. The method used in the platform is crowd-lending, which is an online method of providing capital loans from lenders to borrowers involved in both individuals and business organizations. The project results from farmers will be returned with capital values based on the scheme provided. Currently, this company employs 29 people. It was discovered that the most prioritized issue in Company B, inefficient research activities, led to high operational costs. Therefore, the main objective was to decrease operational costs by 60%.

Implementation challenges. We found that unclear standard operating procedure (SOP) was the

root cause of the problem faced. However, developing a clear SOP to obtain borrowers (farmers) was not a favorable solution due to the high difficulty of implementing it among farmers. The company then decided to develop standard criteria for selecting farmland. The implementation of this solution reduced operational costs; however, the company was unwilling to share the precise amount of cost savings. This unapproachability made it difficult to validate the results of the improvement.

Benefits of DMAIC. Although the precise amount of cost reduction was not shared, the company shared that it experienced a 50% decrease in operational cost. Similar to the previous case, even though an impressive cost reduction occurred, the objective of the project was not successfully attained. In terms of benefits, it was reported that this initiative produced a significant amount of reduction in operational expenses; unfortunately, the result was not supported with validated data. Thus, the amount of cost savings could not be presented.

Frequently used tools and techniques. Several tools and techniques were applied in this project: (1) SIPOC, (2) Severity-urgency matrix, (3) Performance-importance matrix, (4) Why-why analysis, and (5) Interrelationship diagram.

Company C: Barbershop

Background. Company C has two businesses inside its store, a barbershop, and a coffee shop, but this study focuses on the barbershop only. The company has been operating since the end of 2016. The problems found in this company mostly related to its employees. It was discovered that the employees showed a lack of hospitality to their customers. This issue was then highlighted to be solved using the DMAIC approach. The target of the improvement project was to decrease the customer complaint rate by 50%.

Implementation challenges. Lack of managerial competence was found as the root cause of the highlighted issue. The manager of this company did not demonstrate satisfactory performance; thus, the other employees lost their respect for the manager. Consequently, the employees became undisciplined and lacked hospitality toward their customers. It was

clear that the solution was intended to improve the quality of the management by training or acquiring a new, more talented manager. Nevertheless, the company did not support these alternatives due to the limited resources and the period required for the improvement project. The standard operating procedure was then selected as the solution and it generated a significant decrease in the customer complaint rate.

Benefits of DMAIC. Company C adopted DMAIC, which led to a successful result; the number of monthly customer complaints was reduced from 8 customers to 2. This demonstrated a reduction of more than 50%; thus, the target stated in the “measure” phase was achieved. As a result of DMAIC implementation, Company C experienced an increase in customer retention of around 20%. This result also indicated that the company experienced an increase in revenue.

Frequently used tools and techniques. We found several tools and techniques applied in all stages of DMAIC: (1) SIPOC, (2) Severity-urgency matrix, (3) Performance-importance matrix, (4) Why-why analysis, (5) Fishbone diagram, and (6) Interrelationship diagram.

Company D: IT consultant

Background. The next case represents an information technology consulting company that provides applications as a solution within the banking industry. One of the products is a core banking system for a bank in Indonesia. The company was established in 2009 and currently employs 31 people. The business process of company D generally consists of 5 steps: (1) initial presentation, (2) learn the old system, (3) develop a program, (4) create a user training and acceptance test, and (5) migrate the data from the old to the new system. The main issue of this case was reported as the delay in project completion. In that case, the purpose of the improvement project was to eliminate the delay in a pilot project which had to be completed in 24 days.

Implementation challenges. The root cause of this case was the inefficiency of the initial presentation and implementation phases. There were redundancies in the process, in which initially the di-

rector of the company was involved in the initial presentation and the early implementation phases. The old method produced a long period of project completion and higher operational expenses. Thus, a new way was suggested which eliminated the involvement of the director in the presentation and implementation phases. Initially, the director was resistant to this suggestion because he was accustomed to the old system. After the explanation of benefits was projected by this transformation, the director finally agreed to accept it and executed a pilot project using the new system.

Benefits of DMAIC. The pilot project showed positive results through which the completion of the project could be achieved without delays. Moreover, the project was completed before the determined deadline. It was supposed to be finished in 24 days, but the project was finished in 22 days. The results indicated that the process had a positive impact on the bottom line. Shorter project duration facilitated a significant reduction in the operational cost. Additionally, the non-involvement of the director in the initial presentation and implementation phases also contributed to the cost savings in this project.

Frequently used tools and techniques. We discovered various tools and techniques that were used in this case: (1) SIPOC, (2) Severity – urgency matrix, (3) Performance-importance matrix, (4) Why-why analysis, (5) Fishbone diagram, and (6) Interrelationship diagram.

Company E: Health food store

Background. Company E is a retail store that sells various healthy foods and provides both online and offline shopping services. It was originally started as an online shop in 2016, but due to high demand, the owner decided to open a physical store. Today, around 800 varieties of products are provided, and the company has employed 9 staff members to support the business. The highest priority problem faced by Company E was delivery errors in its online shop, and thus the improvement project aimed to minimize the delivery error rate.

Implementation challenges. We discovered that a long and complicated working process was the root cause of the problem. This problem increased

the probability of human error, thus resulting in a higher probability of delivery error. Utilization of a check sheet at some inspection points was selected as a solution to ensure the accuracy of the process and to record who was responsible for each order. Company E claimed that the implementation of this solution reduced delivery errors; however, the company refused to share the precise delivery error rates. This made it difficult to get the validated results of the improvement.

Benefits of DMAIC. It was reported that a significant decrease in delivery errors occurred after the solution was implemented. However the definite result was unknown, so it was difficult to conclude whether the adoption of DMAIC methodology in Company E was a success or not. Company E claimed that the reduction in delivery errors converted penalty costs into revenue. Therefore, additional revenue was claimed to be found after the company successfully implemented the DMAIC methodology. Unfortunately, the result was not supported by validated data. Thus, the specific increase in revenue could not be provided.

Frequently used tools and techniques. Several tools and techniques were identified during the completion of this project: (1) Severity–urgency matrix, (2) Performance–importance matrix, (3) Fishbone diagram, (4) Interrelationship diagram, and (5) Check sheet.

DISCUSSION

The findings from the five case studies above are compared and contrasted in this section. Specifically, we explore the fundamental challenges to DMAIC implementation, benefits, and frequently used tools and techniques. The results of the study show that DMAIC implementation tends to have a positive effect on service companies. Three case study companies have proven that the implementation of the DMAIC method is beneficial to the company; however, the other two claimed a positive impact but were unwilling to share details about the exact result.

We found some similarities in terms of challenges in implementing DMAIC. The most obvious challenge that arises among companies is their lack

of openness. As aforementioned, two companies, Companies B & E, did not fully share their relevant data related to the problem; thus, the implementation of DMAIC could be hampered due to difficulties with measuring performance. This issue arises due to a lack of direct involvement from the top management in every phase of the project, hence they most likely did not give full support. As mentioned by Antony et al. (2016), the need for change was not well informed to all management levels of employment; in this case, the top management was not fully aware of the benefits of the project. Unlike Companies B & E, the other companies, especially Company D have shown that resistance from the top management also emerges but can be addressed through good communication, and an explanation of the projected result of the improvement. Consistent with the findings from previous studies, limited resources and time spent in the improvement phase also appears to present a challenge to some companies (Antony and Desai, 2009; Chakrabarty and Chuan, 2009). These challenges obstructed several alternative solutions that might be effective in solving problems.

The five case study companies described that their company performance tended to be positively influenced. The findings of the study showed that various results could be attained by service companies. This study shows that DMAIC methodology can be used successfully to enhance customer satisfaction through the reduction of customer complaint rates and improved service time. Moreover, a reduction in customers' waiting time in a queue was also identified, although the final result was not as improved as expected. Furthermore, this study also revealed that DMAIC implementation reduced operational costs and minimized delivery errors, but it requires further research to obtain more validated findings.

This study supports the suggestion by Cunha and Dominguez (2015), that it is not always necessary to utilize numerous statistical methods to find opportunities for enhancement, but the usage of non-statistical tools and techniques also enables companies to gain benefits from DMAIC implementation. The most frequently used tools in the define phase

included: SIPOC, the severity-urgency matrix, and the performance–importance matrix. These tools are used to qualitatively define the business process and priority issue to be improved. Meanwhile, some tools in the analysis phase including the why-why analysis, fishbone diagram, and interrelationship diagram, which are commonly used in sequence to determine the root cause of the problem. Furthermore, in the improvement phase, most companies selected simple yet effective solutions such as visual control and check sheets to be implemented.

Another interesting finding from this study is that most benefits are found during the post-production phases of the value chain, which is considered to be an important value-added activity in service companies, especially food and beverage businesses (Subagyo et al., 2019). From a broader perspective, the implementation of DMAIC helps enrich the value perceived by customers. This finding is also consistent with the Six Sigma principle, which focuses on the voice of customers; in other words, the activity that has a greater impact on the fulfillment of customer needs and wants must become a priority to set the objective or goal for an improvement project (Rahman et al., 2018).

All five case study companies have demonstrated that the adoption of DMAIC methodology has positively affected the bottom line. Service companies can obtain revenue increases or cost decreases or both. This study demonstrates a lack of discussion of intangible benefits since all the benefits discovered are tangible. However, prior research claimed that numerous intangible benefits could be achieved, for example, employee morale, improved teamwork, and increased productivity (Antony et al., 2016).

CONCLUSIONS & RECOMMENDATIONS

Conclusions

This study has explained the fundamental challenges, the benefits of DMAIC methodology implementation, and the frequently used tools and techniques in service companies as a course project. These case studies have presented another lesson regarding DMAIC application by providing insights from various service companies. The lack of open-

ness of a company regarding information and lack of time to execute the improvement phase are the main challenges to implementing the DMAIC method in service companies, especially as a course project. These findings reveal that to enhance the quality of a BPI course project, it is necessary to emphasize top management accessibility as a vital criterion of company selection, and the duration of project implementation also needs to be extended.

In terms of the tools and techniques applied and the possible benefits provided, the findings of this study are coherent to the existing literature (Antony et al., 2016; Cunha and Dominguez, 2015). The use of non-statistical tools and techniques that are relatively easier to apply will encourage companies to implement the DMAIC method and benefit from it. In addition to the tangible benefits that have been discussed, interesting insights about the potential added value in the value chain have also been revealed.

Recommendations

The results show several positive impacts of DMAIC on company performance, but further research is required to confirm the findings related to the reduction of operational costs and delivery errors. The aforementioned is the discussion, potential added value in the value chain of service companies would be a fascinating finding that can be validated as well. Another interesting topic to be investigated is the intangible benefits gained by companies since most studies only find the tangible benefits of the implementation. Besides, differences in employee perspectives on the DMAIC project would add additional insight to be explored, since it would generate various intangible benefits for various levels of employees.

The limitations of this research include the number of companies, the information accessibility of the companies, and the capability of the students of implementing DMAIC methodology. Another empirical study that involves a larger number of companies would be worth investigating to find out the most common issues related to the topic. Furthermore, future research could focus on the lessons learned from students' perspectives of DMAIC

implementation as a semester project; this approach could seek to make future suggestions to improve the quality of the course.

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