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Optimization Methods in Continuous Improvement Models

A Relational Review

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ABSTRACT

There are numerous processes used to implement quality, such as TQM, 6 Sigma, and Lean. For these quality processes to remain effective, a continuous improvement model is required and implemented from time to time. Some of these models include Define, Measure, Analyse, Improve and Control (DMAIC); Plan, Do, Check, and Act (PDCA); Identify, Measure, Problem Analysis, Remedy, Operationalize, Validate, and Evaluate (IMPROVE); and Theory of Constraint (TOC). Furthermore, continuous improvement tools need to remain effective through the use of optimization techniques to produce the best possible outcomes. This article discusses some of the current utilization of these tools and proposes different optimizing techniques and variations to make robust quality implementation tools.

KEYWORDS

Continuous Improvement Model, DFSS, DMAIC, IMPROVE, Optimizing Techniques, PDCA, TQM

INTRODUCTION

Background

One of the weak links in quality is sustaining good quality. It is easy to assume that once a quality system is implemented, it will operate at the desired and expected quality for an extended period. However, this is hardly realistic. A quality improvement project needs to be continuously monitored and tweaked to produce and maintain the desired level of quality. One way to achieve this is a continuous improvement model. Therefore, this paper seeks to discuss some of the ways to optimize the tools and techniques used to improve and maintain good quality in projects. Some tools for a continuous improvement model include:

- Define, Measure, Analyse, Improve and Control (DMAIC)
- Plan, Do, Check, and Act (PDCA)
- Identify, Measure, Problem Analysis, Remedy, Operationalize, Validate, and Evaluate (IMPROVE)

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There are special events known in the industry as the "Kaizen Event." This is when the above-stated tools get utilized by employing an optimizing technique. This maintains and further improves the quality of a process.

RESEARCH OBJECTIVE AND PROBLEM STATEMENT

The problem with continuous improvement process optimization begins when the DMAIC process is repeated continuously with the expectations of achieving the same level of success gained prior. This may lead to failure of the process. This paper discusses some implementation techniques of continuous improvement models to enhance the tools' success rate since there is a false expectation that these tools will produce the same successful results.

Research Gap

The existing literature exemplifies what gap exists in the current research. Although much literature demonstrates the pivotal role optimization has concerning continuous improvement projects, there is a gap relating to how this optimization enables a smooth progression in continuous improvement projects. As a result, this study focuses on the gaps existing in related literation regarding optimization and continuous improvement projects. The study evaluates the elements and applicability of modern optimization tools as well as concepts in regard to continuous improvement projects. Thus, this study seeks to fill in the gaps in existing literature.

Originality

This study seeks to contribute to existing literature concerning the effectiveness of optimization methods in continuous improvement projects. By focusing on assessment tools, this study provides a comparison of project optimization methods with other continuous improvement environments. Combining data from different studies helps present this study's analysis and findings in an understanding manner. Furthermore, the study is based on original research conducted to check the overall hypotheses.

The study incorporates viewpoints from varying researchers to recommend innovative ways to resolve the issues arising in continuous improvement environments. The study discusses the methodology used to research along with the overall findings. A design-science-investigate strategy was implemented to permit for identifying both reasonable and hypothetical applications and developing a valid assessment model of continuous improvement environments in conjunction with optimization methods. The study provides an outline of development models by focusing on evaluation instruments to test the hypothesis and reach conclusions. Results from meetings during the research are also provided in the analysis. Initial discovery and suggestions are then provided in the conclusion which further annotates investigative limitations and future research ideas.

Finally, this paper is a vital contribution to the profession. It adds to the gaps in existing literature regarding continuous improvement environments and optimization tools. Findings describing the benefits of this combination are discussed, as well as the pitfalls that may occur, should project management not seek integration of optimization and sustainability. The study employs real-world examples to highlight the value of applying this study's reasoning in the context of real business environments. The study stresses that there is significant value in the study of continuous improvement practices with an emphasis on optimization.

One of the guiding principles of Six Sigma is that the sigma levels (to lower defects, i.e., parts per million opportunities, or DPMO or PPM) are difficult to achieve as one progresses down the path of quality improvement (see Table 1).

Therefore, setting improvement benchmarks without accounting for this phenomenon leads teams to experience lower confidence for not being able to achieve expected results. Furthermore, it gives

Table 1. Sigma level and PPM levels

Sigma Level	PPM Defects
1	691,462
2	308,538
3	66,807
4	6,210
5	233
6	3.4

the false impression that the following two processes, one with 6,000 defects and the second one with 500 defects, are the same with four sigma level (see Table 1). Thus, reducing the expectation of improvement by a certain amount is a way of accounting for this phenomenon. This way, the team can achieve the expected results and be inclined to repeat the continuous improvement process to achieve other goals.

Contribution to the Industrial Engineering Profession and Research Field

This study contributes to the Industrial Engineering (IE) profession and research field. It provides engineers with the opportunity to learn how to save their time, so they can more effectively work on achieving their goals. Engineers may benefit in learning how to better organize and maintain a system by employing current technologies. Overall, benefits to engineers include but are not limited to saving time, materials, machine time, money, energy, work hours, and other resources that impact productivity. In providing all these benefits, engineers ought to see an improvement in their productivity and quality of the overall work. Furthermore, these benefits trickle down into the organization level as it helps the organization learn how to make more innovations and become a more efficient organization.

Regarding the research field, this study helps educate industrialists and general readers. The easy to understand vocabulary and writing style is geared to accommodate all types of readers. The study also demonstrates new sizes to optimization methods about continuous improvement environments, thus shedding light on the many benefits available to those in the industry and the general reader. This study may also be used as a reference for future studies. It may prove helpful to organizations seeking to improve their performance and achieve more of a competitive advantage in the global marketplace.

Finally, this paper examines real-world examples to see how the continuous improvement process benefits from optimization techniques such as gradually lowering or increasing benchmarks to accomplish similar or better results. It further permits researchers to create varying models that incorporate optimization techniques regardless of the field of implementation.

This paper is organized as follows: section two presents a high-level literature review of the current literature in these fields of research. Section three presents the research methodology utilized to execute the research study while section four presents findings and discussion of the two concepts. Finally, section five outlines the implications of these findings for the practitioner, suggestions for future research, limitations of the research, and general conclusions of the research study.

LITERATURE REVIEW

The paper emphasizes continuous improvement models in different fields to see how it is utilized both in the present and the past.

Production and Manufacturing Field

(Jevgeni, Eduard, & Roman, 2015) Talks about the necessity of having a framework that allows for continuous improvement for the reliability of production processes and required key performance indicators (KPI). This framework allows engineers to locate the problematic processes and find causes quickly. (Jevgeni, Eduard, & Roman, 2015) researched three areas to create a continuous improvement framework:

1. **Failure Classifier (FC):** Captures the causes of faults/problems. The primary goal of using this framework is to define problems which can occur during any operational phase of production processes. Once a problem is identified, corrective measures can be defined accordingly.
2. **Failure Mode and Effect Analysis (FMEA):** Identify and prevents problems before they occur by assigning Risk Priority Numbers (RPN). RPN is created to determine the effects of failure. The formula is as follows:

$$RPN = S * O * D$$

where:

S = severity (the consequence of the failure that might occur during the process)
O = occurrence (probability or frequency of the failure occurring)
D = failure being detected before the impact of the effect is realized

3. **Theory of Constraint (TOC):** Allows us to think at a systems level by identifying the constraint in the chain or process.

(Khayrullina, Kislitsyna, & Chuvaev, 2015) Introduces the discussion of combining total quality administration and lean assembling. A thought of coordinating the Theory of Constraints with Lean Manufacturing has been identified as it applies in many practice areas.

Throughput improvement is considered the primary goal of operations management. Specifically, the TOC focuses on Buffer Management; Drum-Buffer-Rope methods, and Dynamic Buffer Management Prioritization. Lean focuses on the following: value creation stream; Just-In-Time process implementation; production time and inventory turnover improvement, and kanban implementation (Galli, Kaviani, Bottani, E., & Murino, 2017). The exploration has demonstrated that the proposed execution of coordinated TOC and Lean apparatuses and techniques is a sensible and promising thought. This is highlighted in Table 2.

Statistical Process Control

Gejedos (2015) talks about continuous quality improvement by using statistical process control. Gejdos (2015) states that if customer expectations are defined in any system, it is critical those expectations be satisfied sooner rather than later. Additionally, process variations, which prevent us from meeting customer's expectations, mainly arise from two areas:

- Random causes
- Definable causes

(Wisner) discusses statistical process control for quality improvement as one of the indispensable tools for total quality management (TQM) in both manufacturing and services. (Wisner) Also talks about process capability analysis techniques, which gauge the ability of the process to meet

Table 2. General comparision of lean and theory of constraints

Characteristic	TOC Approach	Lean Approach
Origin	E. M. Goldratt, 1980-s	T. Ohno (Toyota), 1950-s
Process steps	Step 1. Identify the constraint Step 2. Exploit the Constraint Step 3. Subordinate and Synchronize to the Constraint Step 4. Elevate Performance of the Constraint Step 5. Repeat the process	Specify Value Design a map for value creation stream. Value Flow through the Value Stream. Pull the Value from the Value Stream Strive for Perfection.
Focus	Managing constraints	Eliminating waste
Environment	Complex stream	Naturally stable stream
Methodology framework	Cause-effect relating / conflict management	Value flow mapping
What to be changed	Management rules	Process flow
Key concept/ improvement tool	Buffers control	The Kanban system

Source: (Khayrullina, Kislitsyna, & Chuvaev, 2015)

requirements. Wisner also combines this with Taguchi Loss Function, which states that all variations have a cost. Statistical process control provides a method for monitoring and evaluating process variations before it is too late to respond.

Medical Hospital Field

(Uriarte, Zuniga, Moris, & Ng, 2017) have looked into the continuous improvement in a hospital's emergency department, a highly dynamic and unpredictable environment. They discuss using Discrete Event Simulation (DES), simulation-based multi-objective optimization (SMO), and data mining techniques to optimize the ER. The simulation used benchmarks such as Time to Triage (TTT), Time to First meeting with Doctor (TMD) and Length of Stay (LOS) to gauge the effectiveness and validity of simulation results. The simulations turn out to be an indispensable tool in the continuous process improvement model because one can run different variations in the simulation and gain a general idea of what to expect before disrupting the existing process (Uriarte, Zuniga, Moris, & Ng, 2017).

(Williams, 2016) Introduces a continuous improvement system called IMPROVE. It is intended to provide an organized way to deal with persistent change. It is a well-ordered process for central leadership and critical thinking that gives quantifiable and practical changes. This system was utilized as a part of patient security conditions to decrease dangers and operational costs (Galli, Kaviani, and Margulis, 2017). A consequence of actualizing this model is a culture of progress, which persuaded staff to search for regions of progress. IMPROVE stands for:

I = Identify a problem
M = Measure the impact
P = Problem analysis
R = Remedy
O = Operationalize
V = Validate improvement
E = Evaluate over time

Finally, (Health Information Technology Research Center, 2013) researched continuous quality improvement in the Electronic Health Records (EHR) implementation lifecycle using Lean, Six Sigma, and Baldridge Qualification.

Systems Engineering Field

(Redding, Cannata, & Haynes) Discuss the methodology of the plan, do, check, and act (PDCA). This technique relies on the authoritative "ability" to fuse eagerness and "conviction" to hierarchical objectives. This philosophy was utilized as a part of a tutoring condition to test system consequences. "Ability" alludes to modifying current practices and operations. "Conviction" refers to authoritative information development. Utilizing these associations leads to proposing advancements to resolve issues.

(Gomes & Trabasso, 2016) Discuss a method for continuous improvement in discrete manufacturing. Due to its complex implementation, the study also mentions a simulation process, which gives responses to change caused in the simulated real system. Melhoria Auxiliada Por Simulacao (MAPS or simulated aided improvement) is also one tool used in continuous improvement model optimizing techniques researched by (Gomes & Trabasso, 2016). The maintenance optimization model, as a value-adding activity, mainly falls into the following three categories (Sharma, Yadava, & Deshmukh, 2011):

- Preventive maintenance
- Corrective maintenance
- Predictive maintenance

(Tesfaye & Kitaw, 2017) Discuss a coordinated structure of Just-in-time (JIT) and Total quality management (TQM) (see Figure 1). The general approach of this new model replicates the proposed TQM and JIT incorporated model and has TQM and JIT builds/rehearses (Estrada, Shunk, & Ju, 2017). The goal of the model is to bring about organizational success by implementing continuous improvement.

Education Field

The National Center on Scaling Up Effective Schools (NCSU) developed another model for educational systems to scale up practices of viable secondary schools. The model for distinguishing, creating, testing, and executing an artistic practice at scale has isolated each stage. The work has ordinarily occurred in particular areas. PDCA is a model for change that requires recognizing the point of a specific change, testing the change and thought, and checking whether the scrutinized changes prompt the proposed change.

Finally, (Sahni, Piepel, & Naes, 2009) discuss the continuous improvement model optimization technique in a mixture process for low-fat mayonnaise in three different situations using bootstrap regressions. (Biegler) talks about advanced optimization techniques for dynamic chemical process operations.

RESEARCH METHODOLOGY

This paper organizes existing literature about the relationship between optimization techniques and continuous improvement model. A traditional literature review was implemented (Card and Krueger 1995). The research strategy followed a previous approach taken by Stuck et al. (1999), which consisted of searching universal databases for relevant literature. Among some of the databases are EBSCO and Pro-quest.

Figure 1. Overlap and coordination of Just-in-time and Total Quality Management (TQM)

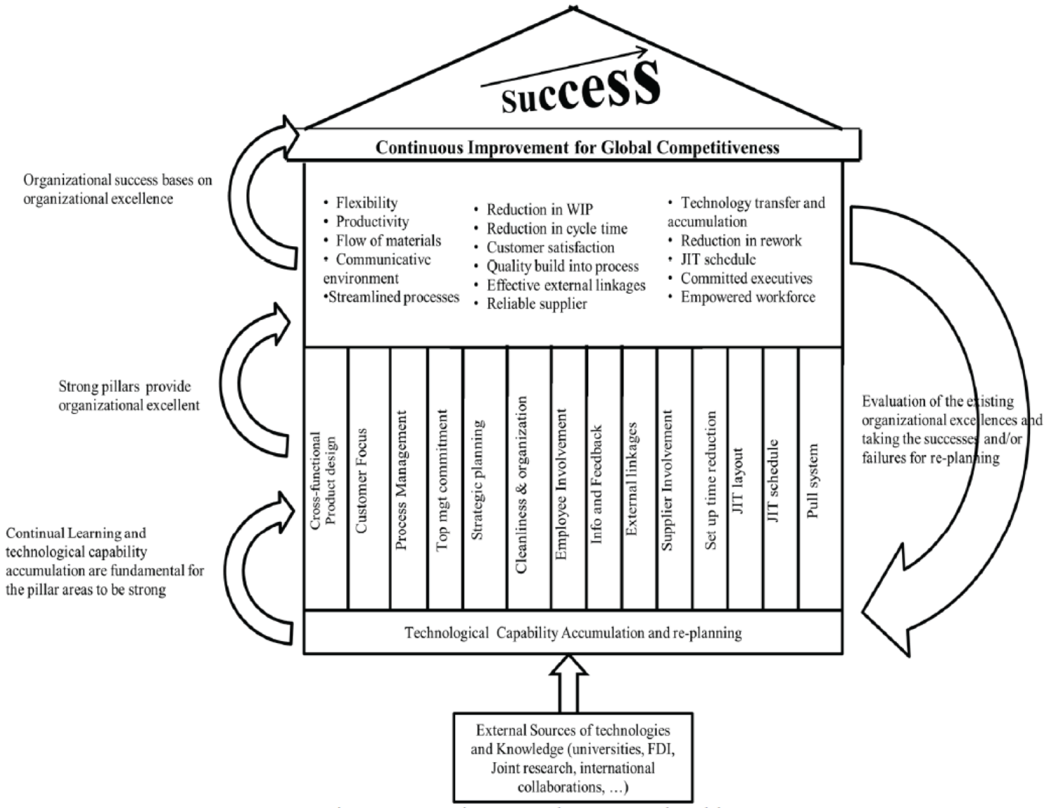

Fig. 1. An Innovative TQM and JIT Integrated Model

Additionally, experts were asked for their recommendations on the collected and reviewed literature. To ensure a sample of high-quality findings, the focus was on peer-reviewed articles and chapters in the book. Several keywords, including continuous improvement model, optimization techniques, DMAIC, PDCA, Kaizen events, and so forth were used. Resulting from these searches, 40 pieces of literature (N=40) were identified. A meta-analysis was used to filter the identified literature. When the saturation point was met, the search was terminated. The saturation point was when the literature identified was the same as what was previously collected. The next step was to perform searches using the author names as keywords. Search filters made this process more efficient. In other words, Boolean algebra was utilized to form relationships between the searchable words those functions employed were AND, OR, and NOT.

An additional search filter balanced sensitivity with precision. Sensitivity regards the ability to identify all relevant material. Precision, on the other hand, involves the ability to reject unrelated material. If a filer has a too high emphasis on sensitivity, less relevant material might result whereas if there is too high emphasis on precision, potentially relevant information is more likely to be objected. At first, we had a high level of sensitivity, but then adjustments were made until the optimal level of precision was obtained. The study incorporated some wildcard terms in the filter to help define the level of sensitivity to precision. Finally, reviewing common categories of foreign materials benefiting in adjusting the filter's precision level.

Unfortunately, the filter results were not the most beneficial in identifying grey literature, or literature that's not commercially published. That category includes working papers, business documents, government, educational, and institutional reports, dissertations, technical reports, and conference proceedings. To identify this sort of grey literature, manual searches ought to be conducted on books, reference lists, and online search engines.

By conducting such a search strategy. We reduced the N of 40 studies to a size of 20 (n=20). In other words, 50% of the total literature identified then serves as the basis for performing a subsequent analysis. The next step was to conduct a textual analysis to identify common themes and concepts better. Textual analysis helps identify all traits in the literature to map and describe the content, functions, and structure of all identified literature. One of the conventional methods then used is content analysis, in which research employs literature to identify, process, enumerate and analyze the specific identified themes and characteristics embedded in the chosen literature. Finally, a qualitative content analysis was implemented to suggest meanings associated with messages and the frequency that specific messages occurred.

Following these analyses, results could be more easily categorized into specific themes and patterns via an affinity diagram. Such categorization served as a basis for identifying the sections marked in this study. As mentioned, the complete search procedure reduced the total of 40 papers down to 20 (50% of the original population). Compiling these 20 pieces of literature helped us realize from the narrative and trait perspective that the relationship of ethics in continuous improvement models with optimization techniques involves three themes/traits. These include: "Define, Measure, Analyse, Improve and Control (DMAIC)", "Plan, Do, Check, and Act (PDCA)", Identify, Measure, Problem Analysis, Remedy, Operationalize, Validate, and Evaluate (IMPROVE), and "Design for Six Sigma (DFSS)". Finally, from the relationship and casual perspective, we identified that the 20 pieces of literature analyzed improvement models and optimization techniques through the use of different statistical methods. Statistical analysis helped improve the value and depth of the conclusions drawn from this study. Thus, this entire procedure helped us construct one dataset. With this dataset, we were able to proceed into the research and analysis phases. The following section presents the findings of the employed research method regarding the themes and topics discussed in subsequent sections.

FINDINGS AND DISCUSSION

Now, time to take a closer look at each phase of the DMAIC process in three real projects and try to identify optimization techniques. The first project is (Bereskie, Haider, Rodriguez, & Sadiq, 2017) who tries to use continuous performance improvement in Small Drinking Water System (SDWS). They do so by benchmarking water quality index (WQI) against other systems and implementing new technologies and innovation.

The second project is by (Ras & Visser, 2015) who try to use continuous process improvement in an African mineral beneficiation plant. Lastly, the third project is by (Arslankaya & Calik, 2016) who discuss the continuous improvement and optimization of production processes for trial tires by reducing unproductive tasks and steps. Now, look at the different phases where the DMAIC tool was implemented and optimized using different techniques in the three projects.

Define-M-A-I-C Phase

In the Define phase for the SDWS project, (Bereskie, Haider, Rodriguez, & Sadiq, 2017) started by setting a business case and indicating that small drinking water systems (SDWS) are not widely studied in comparison to some of the large water systems. (Bereskie, Haider, Rodriguez, & Sadiq, 2017) Also mention that out of approximately 2,000 drinking water systems in Canada, almost 80% are small drinking water systems. They also conducted some process mapping to come up with a list of data to collect, accurately measure, and analyze to reach the goal of improving water quality. Some of the data they wanted to collect was at the source water, after treatment, and at multiple points within the distribution network.

In the Define phase of the mineral mining project, (Ras & Visser, 2015) state that the South African Ferro-alloys smelter did not achieve its production targets. Thus, it was selected for the

DMAIC tool application to come up with an improved process. (Ras & Visser, 2015) mention that mining contributes to roughly 8.8% of the GDP in 2011, providing jobs for 500,000 people.

In the Define phase for the tires production project, (Arslankaya & Calik, 2016) discuss the production of trial tires to evaluate the tires' performance and see if they are within quality standards. Since the benchmarks from these tires are used to measure and analyze future production tires, it is essential to set the process and limitations to follow.

D-Measure-A-I-C Phase

In the Measure phase for the SDWS project, (Bereskie, Haider, Rodriguez, & Sadiq, 2017) use the collected data to come up with a water quality index (WQI), which is a unitless number. They would then use the WQI against other SDWS WQIs to compare their system performance to other Canadian SDWS. This benefits future decision making.

In the Measure phase of the mineral mining project, (Ras & Visser, 2015) demonstrate that the plant was struggling to control and manage the tapping cycles of the submerged furnaces (SAFs). It was decided through historical and comparison data that an improvement to the adherence-to-tapping cycles would result in improved yield. The measurement was done on a 24-hour basis over two weeks (Ras & Visser, 2015). Furthermore, process mapping identified vital value drivers (KVD) and a universal key performance indicator (KPI) (Ras & Visser, 2015).

In the Measure phase for the tires production project, (Arslankaya & Calik, 2016) discuss collecting all defects and inconsistencies from the trial tires production run to analyze later and reduce any non-conformances. Furthermore, various charts and tables were used to capture how the current batch varies.

D-M-Analyse-I-C Phase

In the Analyse phase for the SDWS project, (Bereskie, Haider, Rodriguez, & Sadiq, 2017) compare the current WQI to the benchmark of a comparable system. If it is seen that their system performs below the benchmark, then immediate action is required to make the necessary improvements to bring the water quality index up to acceptable levels. However, if the WQI is performing above the benchmark, then (Bereskie, Haider, Rodriguez, & Sadiq, 2017) needed to look at the benchmark selected. If the benchmark selected is less than the maximum value, then maybe they need to set a higher benchmark manually.

In the Analyse phase for the mineral mining project, (Ras & Visser, 2015) compared their performance against historical data and benchmarked it against similar plants and processes in the industry. Upon doing a Pareto analysis, it was discovered that the adherence-to-tapping schedules were extremely poor. Furthermore, slag and metal analysis showed variable results. It was further noted that the tapping process was not well-controlled. There was a lack of training for the tapping crew.

In the Analyse phase for the tires production project, (Arslankaya & Calik, 2016) highlight that if the data from the production trial tires are within the standards, it will be decided to produce tires and send them to the market. However, if there are variations, they will first need to be worked out until a conforming tire can be produced.

D-M-A-Improvement-C Phase

In the improvement phase for the SDWS project, (Bereskie, Haider, Rodriguez, & Sadiq, 2017) looked at the different improvements needed in the system and where to make them get the maximum return on investment.

In the improvement phase of the mineral mining project, (Ras & Visser, 2015) state that emphasis was placed on tapping cycles to achieve steady outputs between taps. However, to improve the process, it was decided to tap the furnace at fixed time intervals, instead of tapping at power inputs. New training and procedures were written for the new method of tapping for workers to follow.

In the improvement phase for the tires production project, (Arslankaya & Calik, 2016) state that one of the significant issues for trial tires was the loss of production times since many measurements were needed at each step. Furthermore, (Arslankaya & Calik, 2016) note that the adjustment on the machine's drum where the compound would be placed need manual measurements because the current light system is a rough approximate. If the light sensing system would be upgraded to signal right at the moment the compound exceeds and shuts off, an exact amount of compound will result in the loss of time.

D-M-A-I-Control Phase

In the Control phase for the SDWS project, once the improvement has been implemented (Bereskie, Haider, Rodriguez, & Sadiq, 2017) restarted the DMAIC process, until the WQI reached the maximum value. When the desired or maximum WQI was achieved, (Bereskie, Haider, Rodriguez, & Sadiq, 2017) then focused on other objectives, such as maintaining service reliability and focusing on customer satisfaction.

In the Control phase of the mineral mining project, (Ras & Visser, 2015) state that newly automated tapping indicators were put in place to control the new process. There was also an improvement team created to monitor the process for six months and document improvements.

In the Control phase for the tires production project, (Arslankaya & Calik, 2016) proposed to have a weekly trial run to make sure the production time was maintained and the quality of the raw material did not adversely affect the quality of the produced trial tires. Furthermore, (Arslankaya & Calik, 2016) state that the new light system will reduce operator induced production errors and reduce waste.

The Implication to the Field of IE/EM/PM

The continuous improvement model helps to improve a system over time to make it continuously perform optimally. Because of this basic functionality, optimizing techniques integrated into this model would help organizations improve even more. Such optimizing techniques should account for the difficulty in reducing overall defects that may arise as an organization moves up the sigma level, as indicated in Table 1. The findings of this study highlighted the notion that the DMAIC process is a robust tool that adapts to varying environments. However, an organization must remember to account for variations or even introduce some variations on occasion to identify how robust the existing continuous improvement model is.

Applications to the Field of IE/EM/PM

Optimizing techniques are easily applied to organizations, especially as new data analysis tools become available and easier to use. Applying the techniques to any field improves continuous improvement models in manufacturing, medical, education, customer service, and many other industries. Because technology is rapidly maturing and becoming more affordable, process simulation techniques may replace those optimization techniques since computer programs may run simulations that account for any array of issues that may arise. Running these simulations in real time or as a design tool helps create a better design and quality system that is specifically designed to maintain quality and reduce variations that may arise.

Implications and Applications for Project Management and Engineering Management

It is known that optimization methods and continuous improvement are core to most projects. One of the most significant issues, however, is that usually the engineers and technical professionals are out of bounds. In the past, an engineer was one who solved problems with technical knowledge and mathematical tools. Since the market has changed, the scope of an engineer's role has changed to be someone who provides economically viable solutions to solve problems alongside using technical knowledge and mathematical tools. Thus, optimization methods alongside continuous improvement are critical for engineering decision making. The variables comprising the two help engineers achieve viable decisions that must be made right at project initiation to have a smooth implementation at every project stage. It is important for engineers understand business management and maturity models to enhance the decisions they must make in their job.

Engineering is scientifically based on cause and effect relationships. Management concepts are also scientifically based. So, there is a strong correlation between management and engineering. When the two work in conjunction, they can benefit each other's fields. Over the past several years, engineering has disregarded the role management places in maturity decisions and project success. Therefore, this study explains the models that can be adapted to benefit projects in both business and engineering perspectives. It will help engineers and all types of project managers screen different projects alongside optimization techniques to solve problems and have all around successful projects.

As previously mentioned, the study is based on analysed existing literature about optimization methods in conjunction with continuous improvement models. The purpose is to present the best practice optimization methods for organizations to implement as well as to educate general readers about the integration of optimization methods with continuous improvement models.

Research demonstrates that the best way to create a different environment in the IE/EM profession is through the application of optimization methods and continuous improvement models. It is necessary to create a strategic way to formulate the necessary optimization to generate the intended project goals. Thus, the overlapping roles of optimization methods and continuous improvement cannot be ignored as project management becomes a critical feature in many organizations. The findings in this study help stakeholders maximize the role of system engineers in project management to ensure successful implementation of any project.

Although there is significant literature about optimization and continuous improvement models, there is minimal literature about the combination of the two. That is where this study fills the gap by exploring how optimization can impact continuous improvement development.

CONCLUSION

General Implications

It is crucial that optimization methods and continuous improvement approach are utilized together to achieve ultimate project goals. Thus, there is a need to invest in optimization and continuous improvement before thinking of the type of technology that will be employed in project management. In other words, such an investment signifies the important of a top-down and bottom-up approach to leadership and strategic planning regarding process improvement, continuous improvement, and systems engineering. As a result, this study displays the important of integrating optimization methods with continuous improvement to achieve all project goals and efficiency.

This study further demonstrates how optimization methods and continuous improvement impact different aspects of an organization. As a result, management and leadership must understand how to manage the varying aspects of an organization impacted by the two methods working in conjunction. If leadership has the appropriate tools and knowledge to manage the two methods, then overall organization performance can improve.

Contribution and Relevance

As mentioned, there are evident gaps in existing literature between continuous improvement models and optimization methods. This study attempts t close the gap, thus contributing to many bodies of knowledge, including systems engineering, continuous improvement project management, leadership, team dynamics, capability levels, and risk. Because of this thorough study, we have a better grasp of the advantages and disadvantages of combining continuous improvement models with optimization techniques. Finally, this study contributes new ideas for future research in the areas of research. Practitioners may also benefit from this study and bring the ideas discussed here into implementation in a real-world context.

Final Conclusion

This paper highlights the use of optimization techniques to improve old processes. Furthermore, as technologies evolve, so will optimization techniques which will increase the effectivity of these continuous improvement models and make them more robust. It is also misleading to think that two projects with different performances and defects level with significant variations (see Table 1) can experience the same sigma level.

Limitations

This study was limited due to several research limitations. The main limitation was that there was a limited sample size which resulted in studying fewer key factors. As a result, there may be bias behind the findings and conclusions. Such a limitation can be overcome by studying a larger sample size. Another limitation involved examining only a few critical factors so that the results are specific to those key factors and environments. As a result, the applicability of the findings to other industries may be more limited.

Recommendation for Future Research

Future researchers may explore a variety of different areas. The investigation can be made into the factors and relationships discussed here in the context of other industries and managerial settings. It would be interested in analyze the strength of continuous improvement and optimization methods in these contexts as well as what other factors influence them. Another avenue of research may be to explore these factors and their relationships from organizational, strategic, and cultural points of view. Doing so may help researchers understand the degree of the impact such factors, including culture, strategy, human resources, and operations may have on success in combining continuous improvement models with optimization techniques.

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