

Integration Quality Management Methods to reduce wasteful processes in an Industrial Context

Hadis Nouri, Armin Babaie, Roozbeh Dargazany

Abstract—Reducing wasteful or non-value processes is one of the most important concerns in an organization. The organization, which approaches to reduce its wasteful processes, will achieve business improvement and satisfied customer and boosts its profit. To reach this goal organizations use various quality improvement methods such as Lean Management, ISO 9000 Series, Total Quality Management, Six Sigma and etc. Base on the situations companies often use more than one method simultaneously to increase the effectivity of those models and to benefit their advantages. Organization which knows how various Quality improvement methods should be integrated can profit more and increase the affectivity of those methods. Although, there are some studies, which are investigated the possible integration between two models like Six Sigma and Lean Management, however, there is not clear how to integrate and optimize various quality and management methods to reduce wasteful or non-value activities. We propose an integrated method for some quality and management methods such as Total Quality Management, Lean Management, ISO 9000 Series, Six Sigma and EFQM Excellence Model, which could be used by organization to improve its quality, reduce wasteful processes and optimize quality improvement methods.

Index Terms—Integration System, Lean Management, Quality Improvement Methods, Total Quality Management.

I. INTRODUCTION

In today's complex global marketplace, customer's demands are ever expanding as they ask for better quality in services and products. Endless enhancement of business activities throughout the entire organizations with emphasis on the customer satisfaction, flexibility, and quality are the main challenges that companies have to face. In the last two decades, companies have been paying extra attention to meeting the requirements of the marketplace by increasing the quality of their products, services, and processes. There are numerous ways to boost business activities to have a successful company and satisfied customer. One of the important approaches to improve business performance is focus on reducing wasteful and non-value processes in an organization. Waste processes are in every workplace. Often more than half of works done qualifies as waste and therefore organizations should learn to deal with it [1]. Waste reduction is accomplished with various available quality improvement methods. Quality improvement methods are all methods and

approaches, which create an improvement in an organization. Generally quality management methods have an indirect influence on non-value and wasteful processes by increasing the quality. Furthermore, there are some quality and management methods, which directly try to recognize and reduce wasteful processes in an organization. Due to the high number of available quality and management methods, selection and integration of the proper methods can be a cumbersome and often very complicated process for companies. Many methods are essentially similar in most of their features and vary slightly in their effectiveness. However, even similar methodologies in different organizations can yield considerably different results, and the proper methodology should be chosen with specific care based on the needs of different industries

A. Objectives

Waste reduction and Quality improvement are becoming more and more important in the last couple of years. Several approaches have been developed such as Six Sigma, Total Quality Management (TQM), Lean Management and their ever-increasing variety even makes a challenge for quality managers since enterprises often should or by following value improvement exclusively and preventing waste. Waste prevention is reachable with methods that help organization to improve the quality of its products and services and try to avoid waste and non-value processes. Total quality management is the most important method to reach the goal of waste prevention. Therefore, in this study the main method to reach total quality management are considered and analyzed. Waste elimination is achieved by application of methodologies like Lean Management, Six Sigma, etc. with the main focus on identifying waste and non-value processes in the organization and eliminates them. In this study, a comprehensive literature review on those important methods to reduce wasteful processes is presented. The aim is find a proper integration model, which has a significant impact on reducing wasteful processes an organization. The results of this work can help organizations to take an appropriate choice in selection of proper methodologies based on their technical, operational, organizational, and administrative aspects to reduce waste in an organization.

B. Methodology

The review is organized to answer the question, which quality and management methods are suitable to be integrated to improve quality and simultaneously reduce waste in an organization. It should be considered that there is

Manuscript Received on February 2015.

Hadis Nouri, M.Sc. Department of Mechanical Engineering, Institute Sales Engineering and Product Management (SEPM), Ruhr University Bochum, Bochum, Germany.

Armin Babaie, M.Sc. CEO, Cryptolock, Aachen, Germany.

Prof. Roozbeh Dargazany, Department of Civil and Environmental Engineering, Michigan State University/ East Lansing, USA.

a poor understanding of the integration of quality management methods by many organizations [2]. The main focus was to identify those combinations of methods that are often dealt with in literature (e.g. Six Sigma and Lean Management, TQM), the underlying motivation for the integration effort as well as the steps taken for performing the integration. It became obvious that in studies usually the result of the integration is presented. A systematic procedure or even guidelines on how the methods have been integrated are not given. It is hoped that results are helpful for researchers and practitioners in the field of quality management. This remainder of this paper is organized as follow: section II and III analysis and comparison methods to find out how various methods should be integrated and interpretation of the data and IV Integration way of Quality and Management methods V concludes the literature review in the paper and highlights the ideas for future.

II. AN OVERVIEW OF VARIOUS QUALITY IMPROVEMENT METHODS

Organizations desire to consistently enhance the ratio of value to non-value adding activities.

There are two ways to reach this object: 1) by elimination and reducing waste or 2) by following value improvement exclusively and preventing and reducing waste.

Waste prevention requires strong understanding of system, procedure, and product design and it is not possible by Muda displays. About 80% of cost is set at the design stage. Of that 80% of cost, a great extent will be waste. For instance, system design waste prevention includes thinking through the development of data, product, and customer through the future framework. Actually waste prevention is likely to assume a far more noteworthy role than waste elimination in the Lean organization of the future in the same way the prevention in quality is now widely regarded as more effective than inspection and fault elimination [3]-[4].

Waste elimination is attained by wearing Muda spectacle (a skill that might be developed), and point and flow varieties. Elimination is assisted by 5S (Sort, Set, Shine, Standardize, Sustain) activities, standard work, mapping, and level scheduling and intensification reduction. The elimination of waste is the primary goal of any Lean system. Organization should eliminate all forms of wastes in any process or product until only what are valuable remains. The key is to spot waste and then stop waste [3]-[4]. Waste elimination is considered as a tool to reach the idealized state of Lean.

A. Lean Management

One of the most important management methods, which be used in reducing waste is Lean Management. The development of Lean Management to manufacturing began shortly after the Second World War, pioneered by Taiichi Ohno and associates in the Toyota motor company [5]. The principle of the Lean Management emphasizes on the individual product and its value by recognition of value and non-value added activities, and on elimination of all waste (Muda) throughout the system [6]. Value is measured by total revenue, a reflection of the price of the firm's product, which can sell. All activities, which do not supply value, are waste, however the value improvement is far more important than

waste reduction, especially in service industries [4]. 'Muda' in Japanese means waste and refers to non-value adding activities. In Lean Management the waste is classified in seven types: waste of overproduction, waste of waiting, waste of unnecessary motions, waste of transporting, waste of inappropriate processing, waste of unnecessary inventory and waste of defects. Lean principle is strongly customer value based, which makes it appropriate for many manufacturing and distribution situations [6]. The five fundamentals of Lean Manufacturing are generally given as: 1) Understanding customer value, 2) Value stream analysis, 3) Flow, 4) Pull, 5) Perfection. Lean principles do not always fully apply, especially when market demands are unstable or uncertain. But even in these situation depends on organizational requirement several approaches are used [6].

B. Total Quality Management

Total quality management is the highest level of quality management, which includes the application of standards to all parts of the system, including customers and suppliers, and their mix with the key business processes. TQM is defined as a philosophy embracing all activities through which the needs and expectations of the customer and the community, and the objectives of the organization are satisfied in most efficient and cost effective way by maximizing the potentials of all employees in a continuing drive for improvement [7]. TQM is applicable to any organization regardless of size, and motives, even the public sector organization are quick adopting the ideology in order to make them effective in meeting public demands [7].

Implementation of TQM further guarantees that organizations change how they perform activities in order to eliminate inefficiency or wastefulness, enhance customer satisfaction and accomplish the best practice pointed out that constant improvement in the effectiveness of operation is fundamental and essential however not a sufficient variable for organization to be profitable [8], [9]. According to Sila (2007) TQM helps in enhancing the quality of products and reduces the scrap, rework, and the need for buffer stock by building a stable production process. He contended that TQM would decrease the cost of production and time of production [10].

Furthermore, TQM is both a philosophy and a system that includes principles, practices strategies, and techniques to improve quality and guarantee customer satisfaction [11]. However, the implementation of TQM is mostly hindered by its time-consuming, bureaucratic, and rigid implementation approach [12]. Studies show that organizations are mostly willing to implement only those aspects of TQM, which are supported by existing organizational culture [13]. TQM can be successful if it is adequately planned for and implemented according to plan. The failure of TQM requires a certain measure of logical effort in term of its operation and implementation. TQM is mostly attributed to the inappropriate implementation procedure rather than TQM itself [14]. Because of the difficulties with TQM implementation, many researchers tried to define a framework for TQM. Following methods are the most agreed TQM operational frameworks [15] :

- 1) Deming Prize (DP Model) (1951), Japan
- 2) ISO9000 Series (1987), (ISO: International Organization for Standardization), international

- 3) Malcolm Baldrige National Quality Award (MBNQA) (1987), USA
- 4) EFQM Excellence Model (1992), European Foundation for Quality management), Europe

These models are improving our understanding of the concepts and practices associated with TQM. Each model has its own description of TQM and provides a unique set of principles, methods, and tools to discover customer needs, bring efficiency to products and respond to market changes [16]. In the following, ISO 9000 and EFQM will be described, compared and their steps toward TQM will be analyzed. The validity range of each model with respect to TQM framework will be investigated. The result will be helpful to find out the proper integration system, which has the significant effect on reducing wasteful processes in an organization.

C. ISO 9000 Series

ISO (International Organization for Standardization) is one of the most common systems to reach TQM. ISO system provides a set of standards each obtained by agreement of international experts and therefore includes a huge asset of international management experience and appropriate practice. These guidelines could be applied to large and small organization, regardless of their area of activity. ISO 9000 defines several quality administration systems as measures that have to be taken by organization to approach TQM. ISO 9000 is planned to guarantee that an organization has an agreeable quality policy, continually monitors the quality, standardize its systems, and has a management review the system. The purpose is to have a systematic quality assurance and control. It is the universally goal of control, which are characterized in the standards, and not the particular systems for controlling.

D. EFQM Excellence Model

EFQM Excellence Model is a non-prescriptive system which considers the maintained excellence to be attained by using diverse methodologies [5]. Excellence Model is focused on the concepts that customer, employee and supplier satisfaction positively affect the society and helps to build excellence business results [17]. Organizations through the cyclical procedure of self-assessment acquire a powerful instrument to apply continuous learning, improvement, and innovative thinking. Philosophy of Excellence model is that the organization achieves remarkable results by integrating employee and process improvements together [8]. In the last decades, the model has witnessed continuous improvement, and a general shift in attentions from TQM model, although many of total quality principles have been remained to be improved [8]. Experiences of diverse organizations demonstrate that self-assessment influences positively on teamwork, minimizes problems, and leads to excellence. The customary self-assessments systematically encourage the organizations and their employees for continuous learning, improvement, and innovation. In summary, application of the EFQM excellence model is a long-term, strategic tool, which monitors, assesses, and improves all organizational perspectives and areas. Overall EFQM model leads organizations to organizational excellence by recognizing their areas of weakness. Then these areas and their strengths points will be integrated in organization's strategic plans to reduce weaknesses and enhance the improvement to reach the excellence. Furthermore, by utilizing the dynamic system

of EFQM, organizations can learn from their past difficulties to find new ways to avoid facing similar difficulties [18].

E. Six Sigma

Six Sigma is a quality management method, which help the organization to reduce wasteful processes by waste elimination. Motorola created the concept of Six Sigma in mid-80s to improve the performance of key processes, productivity, and quality and at the same time reduce costs [19].

The goal of Six Sigma is value creation through quality improvement. The process by which this is attained would involve training of employees in tools and techniques as well as a problem-solving protocol. Six Sigma makes use of quality engineering methods within a defined problem-solving structure to identify and eliminate process defects and solve problems and in this improve yield, productivity, operating effectiveness, customer satisfaction, etc.

Many of the objectives of Six Sigma are similar to those of Total Quality Management (e.g. customer orientation and focus, team-based activity, comprehensive education and training, and problem-solving methodology) and it has been undoubtedly built on TQM. Six Sigma brings engineering and statistical analysis back into quality and is returning quality back to its roots. There might also be an issue about the prerequisites that need to be in place before a Six Sigma approach can be successful. For example, it might be expected that a Six Sigma approach can only be successful if an organization has already reached high levels of quality maturity and has already built up expertise in the use of quality tools and techniques. It is certainly the case that, initially, Six Sigma was introduced by organizations that had a high level of quality maturity and had been known for their quality management initiatives for more than a decade [7]. Recently Six Sigma has been developed as a largely based, integrative, and disciplined management system to fundamentally change the way organizations improve the bottom line and create wealth [11].

At a technical level, Six Sigma represents the application of probability presumption to process of quality control and management. It intends to achieve virtually defect-free operations, where parts or components can be manufactured to very exacting performance specifications. As a statistical concept, Six Sigma is essentially based on the standard deviations (denoted by the Greek letter sigma), which is a measure of variance, or distribution around the mean. Reducing variation to the Six Sigma level means reaching a performance level of 99.99966% perfection 13.4 defects or non conformance per million opportunities (DPMO). DPMO shows, which amount of defects, would be observed if an activity were repeated a million times. This means potentially a defect-free production, where an item barely fails to meet a client requirement [11].

III. COMPARATIVE ANALYSIS & INTEGRATION

Integration of methods becomes a very popular approach for handling of situation, which the organization should use several approaches in parallel. It exists often several synergies between quality management methods. However, these approaches differ in their underlying philosophy, principles, or objectives amongst others.

Integration of methods often leads to value-creating synergies. It should be considered that the parallel use of more than just one quality management method needs proper coordination. If the use of the methods is not coordinated, results achieved by one initiative may be redone by a subsequent project using another quality management method. Integrating quality management methods is a means for handling the variety of methods and generating a single process improvement-based approach. Nevertheless, guidelines on how to systematically integrate methods in quality management in a value-adding way do not yet exist [20].

There is a certain motivation for integration efforts. In many cases, synergies between methods are searched for to eliminate weaknesses of certain quality management methods. Regarding the variety of integration efforts, it is impossible to develop an integration approach that is suitable for all integration scenarios in an equal manner. Regarding the multitude of existing quality management methods, quality managers try for ways to use the strengths of various approaches. Nevertheless, the use of several methods in parallel is challenging, since a proper coordination is necessary. Different authors imply some motivation for the integration for dealing to integration management methods [20]: 1) Fear of missing trends in quality management, 2) Weaknesses in existing methods and techniques, 3) Synergies between methods and technique, 4) One method is the prerequisite for introducing another one.

There are also three possible types of integrations [21]: 1) *Partially-integration*; not all elements of management systems integrated, some elements are remained further separately. 2) *Process-based integration*; the Process-oriented integration offers the possibility of company specific situations with the construction and operation of the integrated management systems to consider. 3) *Cross- System Integration*; in this system integration via cross-elements of each management, models are identified and summarized into an integrated element.

These types are not always easy to recognize in organization. Choosing the appropriate type of integration depends not only on integrated management system but is also always a company specific question posed. The implementation an integrated management system should be easy as possible for the organization. Often the various types are mixed together and sometimes one of them is dominated.

To find an appropriate and suitable integration system, quality managers have to first find the appropriate methods according to their organizational requirements and goals. Based on literature research ISO 9000, TQM, EFQM, Lean Management and Six Sigma are some of the most important and common methods for quality improvement and waste reduction in an organization. Before finding an integration system between these approaches it is necessary to find a correlation and connection between those methods to find how and in which parts they can cover or correlate and oppose with each other.

A. Comparative analyzes between ISO 9000 and TQM

Several ideas have been proposed about the relationship

between ISO 9000 and TQM and their impact on quality improvement. Many studies have been carried out to understand if ISO 9000 certification can be used as a TQM operational framework. Another group believes that ISO 9000 is just a prerequisite for application of TQM. In addition, there is a third group which mainly opposes application of ISO 9000, and TQM together as waste of resources. TQM provides a generic idea for persistent improvement of quality and different performances. The ISO 9000 standard series is now broadly accepted as a minimum standard of a quality system in an organization, and is even necessary in the organizations that do not aim for excellence [22], [23].

Having ISO 9000 certification has become an important issue in the competitive international business Market. Business outreach is progressively influenced by possession of an ISO 9000 certificate. Moreover, implementation of ISO 9000 system can have a considerable cost reduction impact overall process which also results in a performance improvement [22].

According to the study of Hasan (1995), ISO 9000 is defined as a foundation for a broader system of TQM. Based on the results, both approaches tend to complete each other and ISO 9000 is one of the important parts of TQM and the implementation of both approaches will lead to organizational success and competitive advantage which can also reduce waste and non-value processes in an organization [22]. ISO 9000 certification is mainly considered the beginning of continuous improvement process rather than the whole, and is a good step towards TQM. In another research on 442 Spanish manufacturing companies, studies on the effects of TQM and ISO 9000 on companies' performance have been done [24]. Based on his study business performance has been increased in all companies after TQM implementation. However, the results show that organizations, which have practiced TQM and ISO 9000 together, did not get stronger results. This fact leads to the consideration that, in spite of the principle about ISO 9000 as a starting point toward TQM, once it has implemented, some ISO 9000 principles may oppose TQM philosophy.

Sun (2000) provided a survey about the relationship between TQM and ISO 9000 certification and business performance in Norway. The study finds out that ISO standards are partially related to the implementation of TQM and the improvement of business performance. It also proposes that ISO 9000 should be incorporate with the philosophy and methods of TQM. This study additionally finds that, companies which have a ISO 9000 certification have a better performance in minimizing bad products and customer complaints, productivity and benefit [25]. In line with the results of Sun (2000), studies show that these two-quality systems ISO 9000 and TQM are strongly correlated and are necessary for continuous improvement. The ISO 9000 guidelines might directly contribute to performance. They might likewise indirectly help performance by improving other TQM enablers. These two criteria are significantly correlated to performance improvement. As it is illustrated, his study found that ISO 9000 certification is related to some TQM enablers, as illustrated in Figure 1 ISO 9000 has a positive impact on them. Based on studies it can be inferred that ISO 9000 is

not a substitute for TQM. TQM and ISO 9000 standards must be totally and efficiently implemented and integrated. It also relies on how an organization wants to practice ISO 9000 standards. In cases where an organization applies for ISO just for certification and advertisement, the documents and procedure will destroy the ordinary business process and will not help to improve the performance. For this situation, the ISO 9000 certificate is unlikely to contribute [25]. Another problem could be that the organization may regard ISO 9000 certification as a substitute for TQM and does not proceed with the quality journey after ISO 9000. The suggestion is that an organization must coordinate ISO 9000 techniques with the philosophy, human resource development, and strategic management in TQM.

B. Comparative analyzes between Total Quality Management and EFQM

TQM has been conceptualized around basic standards such as customer focus, continuous improvement, and human resource management. There has been a lack of general agreement regarding its essential constructs, which prevent comparison across studies and generalizations from the experimental evidence. Therefore, there is no single measurement to assess TQM implementation. The internal structure of the EFQM model reflects the holistic character of the TQM initiatives and considers the relationship in both the enabler and the result criteria. Models based on quality awards like EFQM fit the definition of TQM, take into account its major constituents, and could therefore be considered valid framework for TQM [26], [27]. Based on this argument many researchers applied the EFQM excellence model as a guide to measure the profitability and influence of the TQM principles on the organizational performance. Santos (2007) contributes to TQM literature by proving the positive casual relationship between the EFQM enablers and firm's results and furthermore, the use of quality awards as a point of reference to measure TQM practices. His research was based on 93 companies operation in north of Spain [27].

EFQM Excellence Model has obtained a good reputation among European firms as a feasible quality standard. There are an ever-increasing number of firms that are aiming to achieve the European Quality Award. EFQM, as a self-assessment tool based on the principle of total quality management, can be mainly used to maximize strong and minimize weak sides of organizational activities [28]. EFQM is based on consistent application of the "Eight Basic Rules of Excellency" (the principles of the Total Quality Management that guarantee the success of the enterprise, its development, and strengthening of the market position). Furthermore, in organizations that want to move from ISO 9000 to reach TQM, EFQM excellence model with its nine criteria and well-defined requirements can be an excellent choice. Requirements for EFQM are clear and therefore may allow an organization's senior managements to help drive their company towards excellence. EFQM model "defines and describes" TQM in a way that can be more easily understood by senior management [29]. It can be deduced that with implementation of EFQM as an evaluating system, a company can assess its TQM implementation, understand its weaknesses and strengths, and plan accordingly to boost its performance by reduction of waste and non-value processes.

C. Comparative analyzes between ISO and EFQM Excellence Model

After analyzing the relation between ISO and EFQM with total quality management, it is concluded that both concepts can be used as operational frameworks toward TQM, although ISO and EFQM are not in the same level of quality. Developed countries are developing quality management issues in two ways. On one hand, the implementation and certification of quality systems according to the ISO 9000 standard is the most popular methodology. On the other hand, evaluations based on the European Foundation for Quality Management Model (EFQM) are gaining ground in improvement processes.

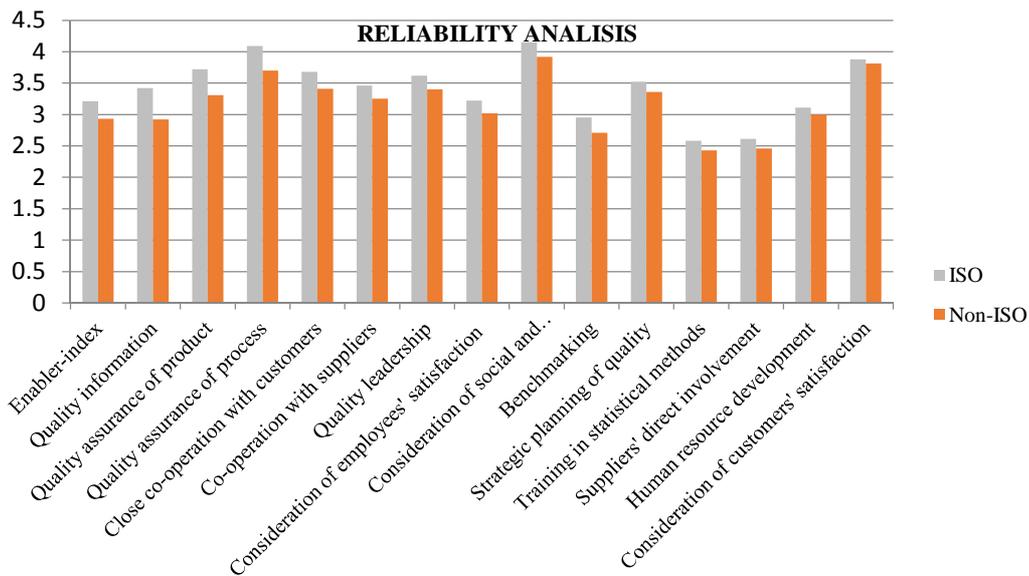


Figure 1 Differences in TQM between companies with and without ISO9000 certification. Data taken and reconstructed from [25].

Saizarbitoria (2010) did a comparative study between ISO 9001 and EFQM self evaluation model based on external independent data. He conducted an empirical work with a survey of 107 experienced and independent quality-management assessors and data from 242 external

evaluations carried out between 1998 and 2007 in 170 Spanish organizations that have adopted the EFQM model [30]. Firstly, he analyzed the most important motivations highlighted by those surveyed with regard to the implementing ISO 9001 and EFQM model (see Fig. 2)

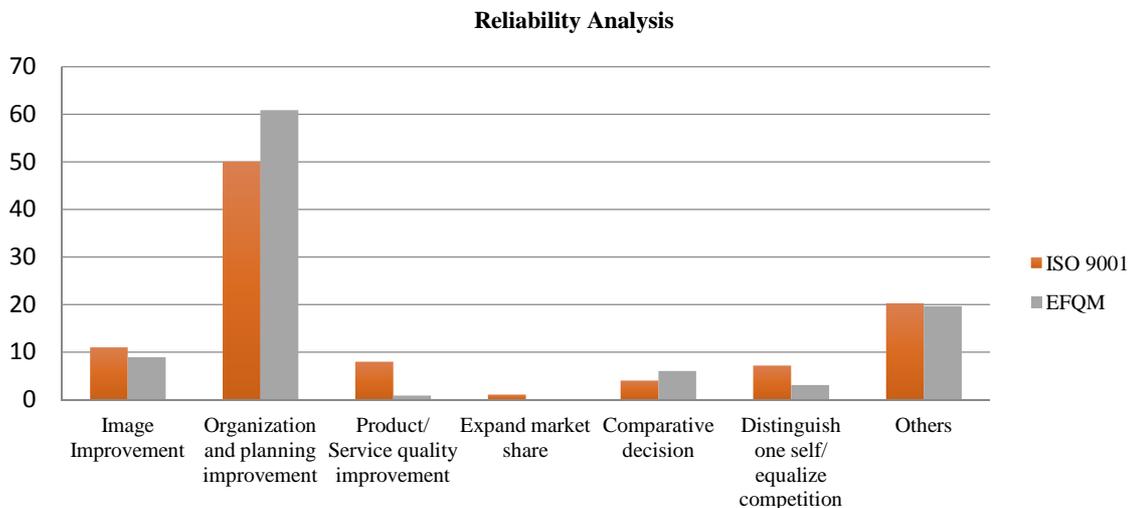


Figure 2 - Motivation for implementing ISO 9001 standards and the EFQM model. Plots are constructed from data given by [30], [31]

It can be observed, that the motives that lead to implementing the ISO 9000 are the same as those, which lead to the adoption of the EFQM. In this graph, it can be seen that the majority of the motivations are internal rather than external motivations. The motivation related to improving systems, efficiency, and internal control at the firm is the most important ones. However, the second and third most quoted are of an external character: the customer requirements and improving the public image of the firm. Furthermore, the greater parts of motives that lead organizations to use the self-evaluating model created by the EFQM are internal. It

should be also considered that there was a little value attached to the motivational factor in both model dealing with improvement in the quality of goods and services. In addition, there are no considerable differences in either the case of the ISO 9001 standard or the EFQM model based on motivation of the company for applying them [30], [31]. Regarding the drivers to adopt the models, it also was found out that the motivation of organizations to adopt the international ISO 9001 standard is diverse. However, the motivations to use the EFQM model seem to be generally internal.

Secondly, the effect of both model on the organizations outcome was investigated, the results are depicted in Figure 3. As it illustrated, there is a better average evaluation received by the European self-evaluation model. A better evaluation was offered by those surveyed on the impact of the EFQM on improving firm's profitability. The effect of improving goods and services is the only factor where the ISO 9001 receives a higher average evaluation than the EFQM [31] Saizarbitoria et al., 2010), Afterward, the result on the analyze the impact of ISO 9001 certification in the scores of the criteria of the EFQM model illustrate that the companies certified with ISO 9000 are scored higher in the EFQM model than those that are not certified. ISO 9001 enables getting a better score on the EFQM model. A strong relationship with customer and supplier is an important principle of ISO 9000, which gains more important in Excellence model. Similarly, many other principles of ISO 9000 may be used as a useful starting point towards EFQM [5]. EFQM model is more advanced than ISO 9000. Additionally, based on observation it can be concluded that ISO standard can be used as an appropriate fundamental towards EFQM through continuous quality improvement and reduction of non-value processes in an organization.

D. Comparative analyze between TQM and Six Sigma

Six Sigma has the potential of becoming lost in a consultancy practice, being oversold or being incorrectly used, in similar ways to TQM. Six Sigma is developed following the request for TQM and it would probably not exist if TQM was not proposed first. TQM, however, can be considered as the mother of all process improvement methodologies, which provides tools and different methods [32]. Almost everything one could do in a Six Sigma can be done under TQM as well. TQM is a comprehensive philosophy with a huge potential to revolutionize the management methods. Nevertheless, this also brings the weakness of TQM, which is the fact that it

is just a philosophy. Six Sigma moves beyond this perspective, and introduce itself as a technique. It guides organizations and their efforts toward an ideal process improvement model. Six Sigma can address the problems of TQM by associating quality improvement with particular business measurements. These enable organizations to quantify improvements made in their performance [33]. Six Sigma offers a number of distinct and important advantages over TQM:

- *First*, it employs a structured and disciplined approach to quality improvement, such as the use of the DMAIC method. Six Sigma is also based on more advanced statistical tools. Incorporating these tools create the opportunities for increase improvements, and development that might not have been found with just the TQM tools.
- *Second*, Six Sigma makes an explicit effort to train skilled group of process improvement personnel with differentiated skills and clear job descriptions, who will be directly engaged in mentoring, managing, designing, and implementing concrete improvement projects. In contrary, TQM does not require groups to
- *Third*, Six Sigma is a fact-based process improvement approach that uses a variety of metrics. These include performance metrics, customer-oriented metrics, and financial metrics.
- *Fourth*, Six Sigma makes use of a well-designed organizational structure for the implementation of process improvement projects. These so called meso-structure, represent a vertical or multilevel organizational integration mechanism in executing Six Sigma projects which can strongly help in reinforcing the culture of continuous improvement and reduce variation and waste in a company [34].

In every aspect of process improvement, philosophy should be united with scientific knowledge. Six Sigma has long been known as a statistics, technical approach to process control. In order to prevent it from becoming another myopic revolution of improvement approaches, it should avoid the mistakes of other models, and ensure that the wider philosophy behind the structured technicalities of Six Sigma is well-recognized and acknowledged. In other words, it should be recognized that without correct management or a proper recruit system, most technical improvements made to the processes cannot be sustained. Six Sigma requires further development to become a significant and sustainable approach for businesses. It needs to be held as a continuous improvement management philosophy to embed itself into the nature of organizations, and it has a long way to go before it is fully accepted as a broad change philosophy [35]. Six Sigma cannot be considered as a replacement for total quality management (TQM), but it mainly boosts the business side of it by providing important business metrics. This major aspect should be taken into account before incorporation of Six Sigma, into TQM approach [33]. All other programs can fit within the TQM/Six Sigma umbrella. The exception to this is Lean, which comes from the Toyota system. While Six Sigma has a strong customer focus, Lean Management is more concerned with process speed and

waste elimination. Today, Lean and Six Sigma are being merged into Lean Six Sigma [33].

The two paradigms are influential catalysts of change as stand-alone methods, if fused together, can potentially represent an exceptionally powerful tool. Six Sigma complements Lean philosophy in as much as providing the tools and know-how to tackle specific problems that are identified along the Lean journey: Lean eliminates 'noise'

and establishes a standard [36]. Six Sigma focuses project work on the identified variation from the proposed standard, which in itself does not entirely focus on the customer requirements, instead, it is sometimes a cost-reduction exercise that can lose sight of the customer if not implemented alongside Lean [37].

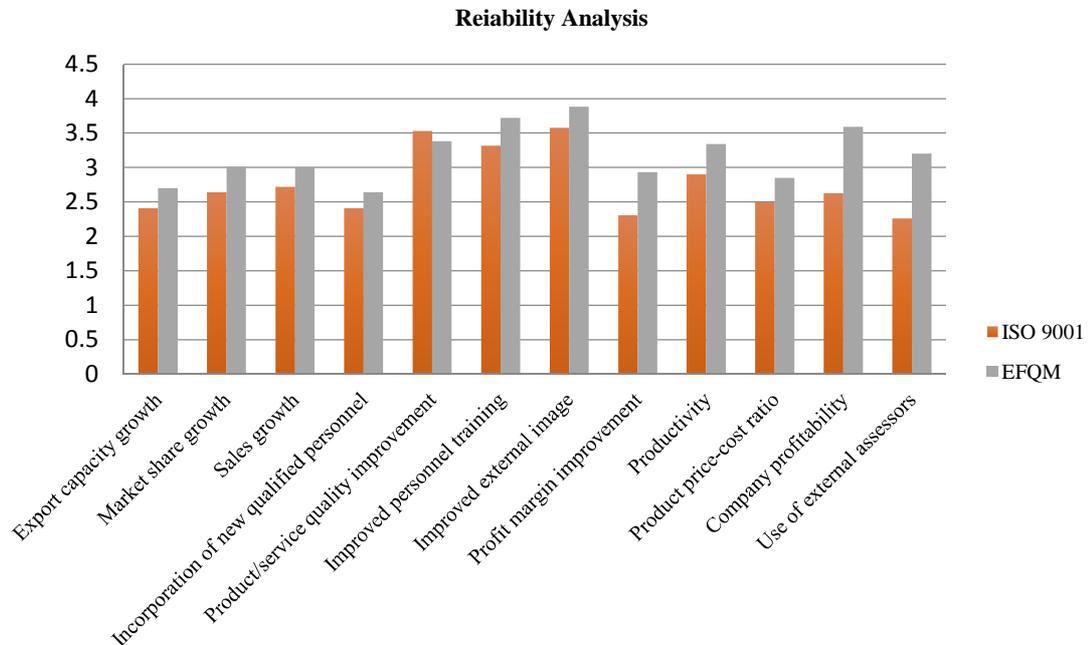


Figure 3 - Comparative results for ISO 9001 and EFQM, Plots are constructed from data given by [30], [31].

Similarities can again be drawn between Lean and Six Sigma, and the need for a culture of continuous improvement operating at all levels within an organization. Arnheiter and Maleyeff (2005) take this discussion further in their work on the integration of Lean and Six Sigma, and outline the benefits of such a consolidated approach [38]. For example, providing Lean with a more scientific approach to quality, so that through the use of control charts, processes can be kept on target, effectively reducing waste incurred through faulty processing [33].

The integration of Lean and Six Sigma aims to target every type of opportunity for improvement within an organization. Whereas Six Sigma is only implemented by a few specific individuals within a company, Lean levels the empowerment and education of everyone in the organization to identify and eliminate non-value adding activities [33]. The integration of the two methodologies attempts to provide empowerment even at the higher-level process analysis stages, so that employees have true ownership of the process. If the two are actually implemented in isolation, the outcome can result in neither being done effectively, constrained by one another's needs in the organization [33].

Both approaches have the same end objective, i.e. to achieve quality throughout, whether it is customer service, the product, the process or training and education of the workforce. They are effective on their own, but

organizations may well find that after initial improvement, they reach a plateau, and find it difficult to create an ongoing culture of continuous improvement. To overcome this, the Lean approach must integrate the use of targeted data to make decisions and adopt a more scientific approach to quality within the system Six Sigma, on the other hand, needs to adopt a wider systems approach, considering the effects of Muda on the system as a whole, and therefore quality and variation levels [33], [38]. Lean Six Sigma organizations would take advantage of on the strengths of both Lean Management and Six Sigma. Figure 4 shows how each approach can gain from being seen as a single framework, and also the balance that may be reached if effectively brought together. The balance lies in creating sufficient value from the customer's viewpoint, so that market share is maintained, while at the same time reducing variation to acceptable levels so as to lower costs incurred, without over-engineering [33], [38].

Basically it is important to recognize that Lean has moved away from being a one-stop cure all philosophy. Instead, Lean Six Sigma should be seen as the platform for the initiation of cultural and operational change, leading to total supply chain transformation. When used in combination with other complimentary continuous improvement techniques such as Six Sigma, Lean provides leverage for comprehensive strategies and therefore provides a more integrated, coherent and holistic approach

to continuous improvement. Additionally, if Lean is implemented without Six Sigma, then there is a lack of tools to leverage improvement to its full potential. Conversely, if Six Sigma were adopted without lean thinking, then there would be a cache of tools for the improvement team to use, but no strategy or structure to drive forward their application to a system. In conclusion, Lean Six Sigma should be seen as optimize integration to improve quality and reduce non-value processes and variations in an organization.

E. TQM and Lean Six Sigma Integration

TQM became a very popular concept in order to describe how organizations should work to obtain better performance and customer satisfaction. Although the definitions of TQM, Six Sigma, and Lean are different, they share the same goals: reducing waste, increasing customer satisfaction and financial results. Based on the previous analyzes Lean is slightly different from TQM and Six Sigma. However, there are great advantages in the simultaneous adoption of those concepts, because they are complementary [6].

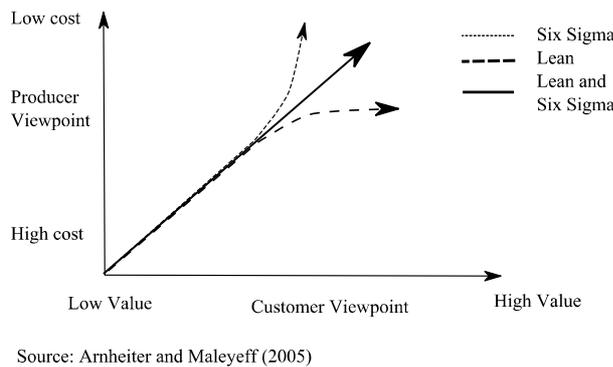


Figure 4 - Competitive analyze of advantage of Lean, Six Sigma and Lean Six Sigma on value and cost [33].

Andersson et al. (2006) goes even further and state that Six Sigma and Lean are excellent road maps and that they can be adopted individually or combined together with the values of TQM [6]. The TQM and Six Sigma highlight the need for companies to meet the customer requirements for the development of the product and service. Six Sigma allows studying and eliminating the origin of the variations of the processes, which allows a reduction in waste and inefficiency of the process, allowing costs reduction and profitability growth. Compared with TQM, Six Sigma brings greater organizational structure, focus, methodological refinement, and discipline to the achievement of continuous quality improvement. TQM and Six Sigma are both widely used process improvement tools and both produce excellent results. The main difference is that TQM is focused on the continuous improvement of processes whereas Six Sigma is focused on reducing process variation and it is normal for organizations to only use Six Sigma when the process is mature and variations become the focus. Six Sigma and Lean should rather be seen as a collection of concepts

and tools, which support the overall principles and aims of TQM. Dahlgaard and Dahlgaard-Park (2006) believe that Six Sigma and Lean have clear road maps in order to achieve business excellence, but it is important in order to be successful to stress the corporate culture and human factor in these concepts. TQM is often accused for being blurred and unclear therefore, Six Sigma and Lean can be appropriate approaches for organizations in order to make important progress in the field of quality management [39].

F. Integration ISO 9000 and Lean Six Sigma

The main criticism against TQM is that there is a widespread confusion about the understanding TQM system. A number of failures of organizations trying to implement TQM have been documented. In more detail, a number of organizations have put a large amount of resources on implementing TQM, but with no tangible improvements achieved [40]. ISO 9000 can be used as a fundamental and initial approach for the organization, which has the purpose to reach TQM. ISO 9001 certification leads to increased organizational efficiency. ISO requires documentation of all processes and any changes, errors and discrepancies within a system or organization ensuring consistency throughout production and accountability of all staff. It also guarantees traceable records are available in case of non-compliant products or raw materials. Perhaps the most obvious is that an organization that takes on the challenge of ISO 9001, it essentially guarantees itself of being in a constant state of readiness, ready for change, ready for the future and ready to grow.

However, it should be noted that ISO 9001, for all of its benefits, it is not a panacea, it can simply not solve all of the ills of an organization [41]. Lean management and Six Sigma is both focused on reduction process variation and waste. Six Sigma are only used when the process is mature and have a base quality system so that waste and variation become the focus. Building a Lean manufacturing system requires the development of a current state map and then proceeding toward a much more efficient future state map (a map of what the production flow will resemble after Lean manufacturing improvements are implemented), while achieving major cost, inventory and lead-time reductions. ISO 9000 also requires the building of a current state map. So if Lean Six Sigma is implemented and is made a permanent part of quality system, ISO 9001-based quality management system would be improved. So Lean Six Sigma is not only compatible but also mutually reinforcing and support, while being perfectly integrated [33], [40], [41], [39]. Additionally, the existence of a system of quality management with a process approach facilitates the implementation of Lean Six Sigma. Integration Lean management and Six Sigma with the base quality system ISO 9001 will leads organization more towards our goal which are improvement and waste reduction in a company. So that it will move, company towards business excellence and reach the higher level in quality improvement and reduce non-value activities.

G. ISO and Lean Six Sigma with EFQM Excellence Model Integration

As is mentioned EFQM known, as excellence model is one of the methods used to help the organizations implement the TQM. This model is one of the most comprehensive frameworks to improve and develop all aspects of the business of an organization. Based on the model, the organizations perform regular EFQM assessments that give them feedback for continuous improvement and reach a zero defect based on the best practices used by different organizations.

There are also other improvement methods based on waste elimination such as theory of constraints (TOC), agile manufacturing, and business process re-engineering (BPR). These methods offer specific elements that can supplementary complement and strengthen the Lean enterprise system, mostly at the strategic and operational levels [11]. For instance, applying theory of constraints TOC methods could help Lean with identifying and removing constraints or bottlenecks hinder or delay the production process, using business process re-engineering BPR methods is one part of the value stream mapping approach, adopting

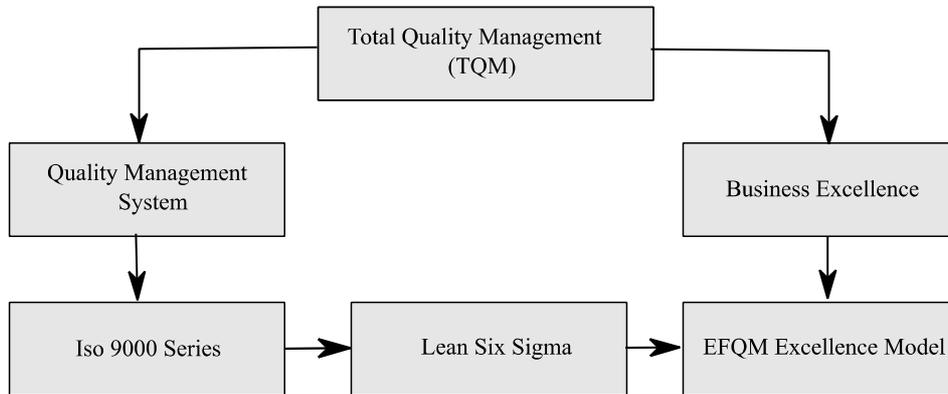


Figure 5 - Integration system (Core Concept)

The EFQM Excellence Model foundation has been a very important driver on spreading and promoting a culture inside the organizations that accepts the challenge of implementing a culture of total quality management. The EFQM Excellence Model foundation promotes guidance for those organizations that have a dream to achieve higher levels of excellence. Business excellence is the highest level of organization where the organization reaches its highest level of quality and lowest level of waste. Based on these advantages, EFQM will be the next method, which should be integrated with the previous methods. EFQM will complete the route to move toward quality improvement and waste reduction in an organization.

The integration begins with the ISO as frame system to implement the basis of TQM so that the company fulfills the prerequisite to implement the Lean management to recognize and eliminate the seven wastes and non-value processes. Then the system will be improved continuously with the help of Six Sigma in the organization. The variation in the company will be also decreased with the help of this integration. The route of quality improvement and waste reduction will be continued with the implementation of EFQM to reach the business excellence, which considers the highest level of quality and lowest amount of waste (see Fig. 5). This can be an appropriate integration between those important and common quality and management methods. Integration of those Quality and Management methods can help the company to reach its highest level of quality and move towards decreasing level of waste (attempt to reach zero defects). Moreover, it considered the both side waste prevention by implementing TQM, ISO, EFQM and waste elimination by implementing Six Sigma and Lean Management.

agile manufacturing awareness of external environmental possibility conditions [11]. These methods can be used and integrated with the core integration concept (see Figure 5) based on the situation to help the Lean Management.

IV. CONCLUSION AND LIMITATION

Reducing wasteful processes is one of the most important concerns in an organization. Organizations use various improvement methods to decrease wastes and non-value processes. To reduce wasteful processes effectively, it should be both side of waste reduction considered: waste elimination and waste prevention, although the border between them is not so clear. There are number of methods, which can help the organization to improve quality and reduce waste. Each methodology has its strengths and weaknesses. The large number of these methodologies can make any organization confuse when choosing the appropriate methodology. The selection of right methodology should depend on various technical, organizational, project and team considerations. This may happens that the organization should combine and integrate more than one method. This thesis provides a clear vision on the available common methodologies, their phases, their focuses, which helps organizations to make the right decision in choosing the appropriate methodology.

Although there are certain differences between methods, they potentially complement each other in significant ways. Lean management system is one of the essential waste elimination methods for identifying and eliminates wasteful processes in a company. In recent years, Lean management and Six Sigma methods have been increasingly integrate and generally known as the Lean Six Sigma continuous process improvement tool-set. Lean Six

Sigma is an end-to-end method. Therefore, the result of Lean Six Sigma implementation will be more efficient if it applies in a mature organization, which has a good level of quality in it. It has been demonstrated that Lean management system, total quality management and Six Sigma, in particular are strongly interconnected and are highly complementary approaches. These models can be brought together to define the estimate “core” integrated management system with the Lean enterprise system serving as the central organization framework. Specific elements of the other approaches can be selectively and occasionally incorporate in to the “core” to enhance its success like TOC, BPR, agile manufacturing. ISO and EFQM excellence model are the common method in the Europe which are used as TQM framework to implement TQM in a company, based on previous analysis, a system which has implemented EFQM excellence model has more advanced system than the organization with ISO standard system. So that the integrated system which is described in this thesis as a core concept to continuous improvement and reduce wasteful processes in the organization, is a system with the combination between ISO 9001 as a basic to improve the organization and Lean Management to identify and eliminate waste and non-value activities in an organization. Moreover, the integration of Six Sigma with its useful tools will avoid variation and improve value of the processes. Afterward, integration of ISO, Lean Six Sigma with EFQM should help the organization to reach the excellence level of quality and move organization toward zero defects.

There is no general agreement about a general integration system which is appropriate to every system. It is verified based on the organization and the culture. Integration in quality management is a poorly understood discipline yet. The main problem is that the guidelines on how to systematically integrate various methods in quality management in a value-adding way do not exist yet. It is also not clear how each method should be applied if methods have conflict in some aspects. Furthermore, the exact influence of integration method in decreasing non-value added activities is not clear. Analyzing the influence of integration methods based on reducing non-value adding activities could be a base for the future research.

REFERENCES

- [1] B. Peterson and G. Nielson, “Fake Work: why people are working harder than ever but accomplishing less, and how to fix the problem,” 2009.
- [2] F. Johannsen, “State of the art concerning the integration of methods and techniques in quality management—literature review and an agenda for research. Citeseer,” 2010.
- [3] D. Goetsch and S. Davis, “Quality management for organizational excellence,” 2014.
- [4] J. Bicheno, *The Lean Toolbox for Service Systems*. 2008.
- [5] S. Russell, “ISO 9000:2000 and the EFQM Excellence Model: Competition or co-operation?,” *Total Qual. Manag.*, vol. 11, no. 4–6, pp. 657–665, Jul. 2000.
- [6] R. Andersson, H. Eriksson, and H. Torstensson, “Similarities and differences between TQM, six sigma and lean,” *TQM Mag.*, vol. 18, no. 3, pp. 282–296, 2006.
- [7] B. G. Dale, T. van der Wiele, and J. van Iwaarden, *Managing Quality*. John Wiley & Sons, 2013, p. 640.
- [8] M. Porter, “What Is Strategy?,” *Harvard Business Review*.
- [9] A. Oluwatoyin and A. Oluseun, “A Test of the Effect of TQM on Performance and Stakeholder Satisfaction,” 2008.
- [10] I. Sila, “Examining the effects of contextual factors on TQM and performance through the lens of organizational theories: An empirical study,” *J. Oper. Manag.*, vol. 25, no. 1, pp. 83–109, Jan. 2007.
- [11] K. Bozdogan, “Towards An Integration Of The Lean Enterprise System , Total Quality Management , Six Sigma And Related Enterprise Process Improvement Methods ,” no. August, 2010.
- [12] J. Oakland, “Total quality management: text with cases,” 2003.
- [13] I. Ugboro and K. Obeng, “Top management leadership, employee empowerment, job satisfaction, and customer satisfaction in TQM organizations: an empirical study,” *J. Qual. Manag.*, 2000.
- [14] D. McCabe and A. Wilkinson, “The rise and fall of TQM: The vision, meaning and operation of change,” *Ind. Relations J.*, vol. 29, pp. 18–29, 1998.
- [15] G. Uysal, “Total Quality Management Awards: Performance Acquisition,” *J. US-China Public Adm.*, vol. 9, no. 4, pp. 451–457, 2012.
- [16] P. Corredor and S. Goñi, “Quality awards and performance: is there a relationship?,” *TQM J.*, vol. 22, no. 5, pp. 529–538, 2010.
- [17] M. Sokovic, D. Pavletic, and K. Pipan, “Quality improvement methodologies—PDCA cycle, RADAR matrix, DMAIC and DFSS,” *J. Achiev.*, vol. 43, no. 1, pp. 476–483, 2010.
- [18] W. Khairuzzaman, W. Ismail, H. Darestani, and M. A. Irani, “Quality excellence model : A review of researches in Developing countries,” vol. 1, no. 2, pp. 35–38, 2011.
- [19] K. R. Bhote, *World Class Quality: Using Design of Experiments to Make It Happen*. 1999.
- [20] F. Johannsen, “A Holistic Approach for Integrating Methods in Quality Management,” no. March, pp. 999–1013, 2013.
- [21] C. Hermanutz and P. D. F. Lobeck, “Managementmodellen im Sinne eines ganzheitlichen Qualitäts- / Excellenceverständnis am Beispiel von EFQM und BSC. PhD thesis, University Duisburg-Essen,” 2006.
- [22] M. Hasan, M. Ali, and T. Lam, “ISO9000 and TQM for Business Excellence,” *bm.nsysu.edu.tw*, pp. 2–3, 1995.
- [23] D. W. Marquardt, “ISO 9000: A Universal Standard Of Quality,” *Manage. Rev.*, vol. 81, p. 50, 1992.
- [24] M. Martínez-Costa, A. R. Martínez-Lorente, and T. Y. Choi, “Simultaneous consideration of TQM and ISO 9000 on performance and motivation: An empirical study of Spanish companies,” *Int. J. Prod. Econ.*, vol. 113, pp. 23–39, 2008.
- [25] H. Sun, “Total quality management, ISO 9000 certification and performance improvement,” *Int. J. Qual. Reliab.*, 2000.
- [26] J. C. Bou-Llusar, A. B. Escrig-Tena, V. Roca-Puig, and I. Beltrán-Martín, “An empirical assessment of the EFQM Excellence Model: Evaluation as a TQM framework relative to the MBNQA Model,” *J. Oper. Manag.*, vol. 27, no. 1, pp. 1–22, Jan. 2009.
- [27] M. L. Santos-vijande and L. I. Alvarez-gonzalez, “TQM and firms performance: An EFQM excellence model research based survey,” *Int.*, vol. 2, no. 2, 2007.
- [28] J. Michalska, “Using the EFQM excellence model to the process assessment,” vol. 27, no. 2, pp. 203–206, 2008.
- [29] A. Van der Wiele, “ISO 9000 series registration to business excellence: the migratory path,” ... *Process Manag.*, 2000.
- [30] I. H. Saizarbitoria, F. M. Viadiu, and M. C. Fa, “ISO 9001 Vs . EFQM : A comparative analysis based on external independent data,” pp. 1575–1582, 2010.
- [31] I. Heras-Saizarbitoria, M. Casadesús, and F. Marimón, “The impact of ISO 9001 standard and the EFQM model: The view of the assessors,” *Total Qual. Manag. Bus. Excell.*, vol. 22, no. 2, pp. 197–218, Feb. 2011.
- [32] M. Gershon, “Choosing which process improvement methodology to implement,” *J. Appl. Bus.*, pp. 61–69, 2010.
- [33] M. P. J. Pepper and T. a. Spedding, “The evolution of lean Six Sigma,” *Int. J. Qual. Reliab. Manag.*, vol. 27, no. 2, pp. 138–155, 2010.
- [34] R. G. Schroeder, K. Linderman, C. Liedtke, and A. S. Choo, “Six Sigma: Definition and underlying theory,” *J. Oper. Manag.*, vol. 26, pp. 536–554, 2008.
- [35] R. McAdam and B. Lafferty, “A multilevel case study critique of six sigma: statistical control or strategic change?,” *International Journal of Operations & Production Management*, vol. 24, pp. 530–549, 2004.
- [36] B. Wheat, C. Mills, and M. Carnell, “Leaning into six sigma,” *Columbus: McGraw-Hill*, 2003.

Integration Quality Management Methods to Reduce Wasteful Processes in an Industrial Context

- [37] T. Bendell, "Structuring business process improvement methodologies," *Total Quality Management & Business Excellence*, vol. 16. pp. 969–978, 2005.
- [38] E. D. Arnheiter and J. Maleyeff, "The integration of lean management and Six Sigma," *TQM Mag.*, vol. 17, no. 1, pp. 5–18, 2005.
- [39] J. J. Dahlgaard and S. M. Dahlgaard-Park, "Lean production, six sigma quality, TQM and company culture," *The TQM Magazine*, vol. 18. pp. 263–281, 2006.
- [40] L. Gonzalez Bolea, "Lean and ISO 9001. Are they compatible?," *Technical report, Andalusian Institute of Technology.*, 2012. .
- [41] M. Micklewright, "Lean ISO 9001: Adding Spark to your ISO 9001 QMS and Sustainability to your Lean Efforts," 2010. .

M.Sc. Hadis Nouri, is graduated from the Department of Mechanical Engineering, Ruhr University Bochum, 44801 Bochum, Germany.

Prof. Roozbeh Dargazany, Faculty member at Department of Civil and Environmental Engineering, Michigan State University, East Lansing, MI 48824, USA.

Armin Babaie, CEO, Cryptolock, Aachen, 52072 Aachen, Germany.