SIX SIGMA'S IMPLEMENTATION IN ROMANIAN SMES

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ABSTRACT
This paper investigates the benefits of Six Sigma's deploying highlighting the field of SMEs. After a brief related literature review it is presented the history of Six Sigma's evolution and a short list of the main top companies to use it. The paper introduces the statistical base of Six Sigma and presents the major improvement methodologies used by Six Sigma. There are also presented the infrastructure of Six Sigma and specific Six Sigma tools for each of its five phases: define measure, analyze, improve and control. The paper presents the position of Romanian SMEs in the Romanian economy and their evolution during the last years; some of the problems met by SMEs while deploying Six Sigma are underlined.

KEYWORDS: *Six Sigma, DMAIC, DMADV, SMEs.*

JEL CLASSIFICATION: *L10, L15, L26, M10, O30.*

1. RELATED LITERATURE

Powerful management tool used the last years in order to improve the customer satisfaction and to increase products quality level Six Sigma is a modern management strategy, based on statistical measurement and creating a new quality culture. Within Six Sigma the quality level is measured by a statistical measure of process variation.
According to Pyzdek (2003) Six Sigma is different. It demands results. These results are delivered by projects that are tightly linked to customer demands and enterprise strategy. It combines project management and business process improvement in a way that greatly improves the chances for success. For Breyfogle (2004) Six Sigma is a methodology for pursuing continuous improvement in customer satisfaction and profit that goes beyond defect reduction to emphasize general business process improvement. This includes revenue improvement, cost reduction, cycle-time improvement, increased customer satisfaction, and any other metric important to the company. It implies an entire culture of methodologies to improve the overall health of the organization.
For Pande & Holpp (2002) Six Sigma puts the customer first and uses facts and data to drive better solutions. Six Sigma efforts target three main areas: improving customer satisfaction, reducing cycle time, reducing defects. Improvements in these areas usually represent dramatic cost savings to businesses, as well as opportunities to retain customers, capture new markets, and build a reputation for topperforming products and services.
In the opinion of Kumar et al. (2008) Six Sigma will continue to grow as a powerful management initiative for achieving and sustaining operational and service excellence. However, what will eventually determine whether Six Sigma is viewed by businesses as just a passing management fad or not, largely depends on the leadership and success of its execution.
For Smith et al. (2002) Six Sigma, the highly statistical quality improvement technique born in the manufacturing bays of Motorola in the mid-1980s, is often used at an operational level inside

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companies today to help them cut costs, improve processes, and reduce business cycle times, while for Peter et al (2002) Six Sigma is uniquely driven by close understanding of customer needs, disciplined use of facts, data and statistical analysis, and diligent attention of managing, improving, and reinventing business processes.

Breyfogle (2003) underlines that the application of Six Sigma techniques to all functions results in a very high level of quality at reduced costs with a reduction in cycle time, resulting in improved profitability and a competitive advantage. Organizations do not necessarily need to use all the measurement units often presented within a Six Sigma. It is most important to choose the best set of measurements for their situation and to focus on the wise integration of statistical and other improvement tools. In customer service according to Antony et al. (2007) Six Sigma has been widely accepted as a business strategy to improve business profitability and achieve service excellence through the effective application of both statistical and non-statistical tools.

Six Sigma has wider applications, as shown by Antony (2008) in his paper concerning SMEs, where he underlines that a Six Sigma-based business strategy is applicable to all kinds of businesses irrespective of the size and type of industry; manufacturing or service; this is also sustained by Jaglan et al. (2011): One of the major advantages of Six Sigma as an improvement drive is the ability to introduce a common metric of customer-perceived quality, which should be applicable to any size and type of organization.

Between the benefits of Six Sigma there are the reduction of defects number, with the associate cost reduction, the reduction of cycle time, with the associate improvement of process productivity and the increase of customer satisfaction.

The goal of six sigma methodology is for Antony (2006) to reduce variation within the tolerance or specification limits of a service performance characteristic. In order to improve the quality of a typical service, it is imperative to measure or quantify variation and then develop potential strategies to reduce variation. Concerning the Six Sigma implementation in SMEs Antony (2008) highlights that Six Sigma is equally applicable to both large corporations and small companies. In fact, the results are quicker and much more visible in smaller companies than in larger corporations.

2. BRIEF HISTORY

Six Sigma was originally developed by Bill Smith in the middle of 1980s in Motorola, USA, playing a major role in improving the quality of products. By that time Motorola spent up to 20-percent of its revenues on correcting poor quality and within the first four years after implementing Six Sigma the company the company had saved $2.2 billion. So, Six Sigma succeeded to recovery the company and Motorola won in 1988 the Malcolm Baldrige National Quality Award. Based on Six Sigma implementation Motorola also saved $17 billion from 1986 to 2004, reflecting hundreds of individual successes in all Motorola business areas.

In the 1990s the focus of Six Sigma shifted from product quality to business quality and Six Sigma became a business-centric system of management for companies. Jack Welsh, the CEO of General Electric by that time, ushered in the second generation of Six Sigma in the company. Six Sigma saved to General Electric $320 million in the first two years and $1 billion by 1999. Further to Six Sigma implementation General Electric cut invoice defects and disputes by 98% by speeding the payments and also improving the productivity. After the deployment of Six Sigma in General Electric other large United States companies also implemented the Six Sigma program. So was the case for Honeywell (former Allied-Signal) which deployed Six Sigma in 1992 and saved more than $600 million a year by 1999. To mention also that Honeywell has reduced the time from design to certification of new projects, like aircraft engines, from 42 to 33 months. Other US companies like Bank of America, Caterpillar, Amazon.com, Boeing and 3M have also implemented Six Sigma.

Following United States companies example some other world-class outstanding companies such as Toshiba, Sony, Hewlett Packard, Dell, Citibank and Hilton Hotels adopted Six Sigma management. In this manner Six Sigma has spread first to the United States and then worldwide.
After the year 2000 a third generation of Six Sigma is born, by combining Lean Manufacturing techniques and Six Sigma, showing companies how to deliver products or services that have real value for their customers.

3. SIX SIGMA CONCEPT

Sigma has become the statistical symbol to indicate standard deviation, a statistical way to describe how much variation exists in a set of data or a process. The term sigma is a measure indicating the deviation in the performance characteristic of a service from its mean performance. (Antony, 2006).
Before the issuance of Six Sigma concept, the usual level of quality of different organizations was usually corresponding to ± 3 Sigma or standard deviations which are equivalent to achieve a conformity rate of 99.73% for products. This percentage corresponds to 2,700 defects per million outputs, one of the first objectives of Six Sigma being the reduction of defects number. According to D. C. Montgomery and W.H. Woodall in their paper "An overview of Six Sigma" the quality objective of Six Sigma is ± 6 Sigma, reaching a conformity rate of 99.9999998%, i.e. a total of 0,002 defects per million opportunities.
All these are valid for a perfect centered Gaussian distribution, so for an ideal situation. Practice shows that the fluctuation in time of processes (characterized by their mean value) is at least of ± 1.5 sigma from the target and thus decreases the conformity percentage to 99.999660% and accordingly the number of defects per million opportunities reach 3.4 defects. This ±1.5 sigma shift was introduced by Mikel Harry, meaning overtime mean drifts by 1.5 sigma. This value is an empirical value rather than a theoretical one. Considering this ±1.5 sigma shift many people do not agree with the concept of this shift.
However, the objective of Six Sigma quality is the realistic number of 3.4 defects per million. According to Antony (2006) the primary means to achieving six sigma quality level is to eliminate the causes of quality or process related problems before they are transformed into defects. The focus of "six sigma" is not on counting the defects in processes, but the number of opportunities within a process that could result in defects.
The main Six Sigma key concepts are: Critical to Quality, which could be considered one of the most important attribute for the customer, Defect, Process Capability, Variation, Stable Operations, meaning to ensure a predictable processes in order to improve the variation of the process and Design for Six Sigma, meaning to design in a manner to meet customer needs and process capability. Selecting the right projects for Six Sigma is another issue to be taken into account. So, projects' importance must be noticeable and projects viable and doable in a short time. Also the success of the projects has to be readily quantified.
There are also several opinions criticizing Six Sigma program. So, there are all the difficult problems faced in order to get things done with Six Sigma; Six Sigma is considered good for some companies, but useless or not acceptable for others.

4. METHODOLOGY

Two major improvement methodologies are used in applying six sigma in different organizations either for already existing processes or for new ones. The two key methodologies are DMAIC, used for improving existing processes and DMADV, used for creating new design for products or processes and also used for already optimized processes that still fall short of expectations.
The first methodology, DMAIC is Six Sigma's improvement methodology used for existing processes. DMAIC could be divided into five phases: define measure, analyze, improve and control.

Different studies demonstrated a series of successful cases of DMAIC application in healthcare, manufacturing processes, thermal power plants, retailing and financial services.

DMAIC includes the following phases:

- "Define" phase, which includes defining the process improvement goals, customer requirements definition ("Voice of Customer") and therefore the opportunities to satisfy them, development of a high level process map and team charter;
- "Measure" phase includes the performance measurement for processes in terms of quality, time and cost in order to identify potential improvements. This phase is done by measuring current level of quality into Six Sigma and collecting relevant data from many sources to determine types of defects and find out all potential causes for such problems;
- "Analyze" phase includes the analysis of collected data in order to find out the gaps between current performance and the goal process performance. The analysis have to identify the root causes of defects and look for improvement opportunities;
- "Improve" phase includes the improvement of process in order to eliminate the main cause of defects. So, for each verified root cause a solution has to be found in order to fix and prevent problems. Improve is also a phase to explore the solution how to change, fix and modify the process. For a planned period of time after improving the process a trial run must be carried out in order to ensure the revisions and improvements implemented result in getting the targeted values;
- "Control" phase includes the control of the process variation in order to be sure of decreasing the number of defects and to prevent the emergence new ones. So, it is necessary to follow the improved process continuously in order to ensure long term sustainability of developments.

The second methodology, known as DMADV, is used for new processes or when the existing processes are unable to achieve business objectives. DMADV could be also divided into five phases: define, measure, analyze, design and verify. The new specific phases are:

- „Design" phase which includes the design made to meet the needs of customers;
- „Verify" phase includes the check of the design performance and of customer satisfaction.

A variant of DMADV is DMADOV where there is an extra step for optimization.

There are also some other approaches, such as for example DFSS, which stands for Design for Six Sigma. DFSS phases are defined by different organizations to use it, adapting them to specific they own. DFSS aims to design according to customer specifications and also achieving at the same time a quality level close to Six Sigma standard. Thus DFSS is used to design a product or service at a level expected at least of 4.5 Sigma, meaning no more than about one defect per thousand opportunities.

There are several options for DFSS such as DCCDI, IDOV or DMEDI. DCCDI includes the steps of „Define", „Customer", „Concept", „Design" and „Implementation"; IDOV includes the steps of „Identification", „Design", „Optimization" and Validation"; DMEDI includes „Define", „Measure", „Explore", „Develop" and „Implementation".

5. INFRASTRUCTURE AND TOOLS

In their guide for implementing Six Sigma, called „Leading Six Sigma- A Step-by-Step Guide Based on Experience with GE and Other Six Sigma Companies", Snee and Hoerl pointed out, in 2003, that there are three keys to success in the deployment strategy used for Six Sigma, and these are the top management commitment and involvement; the use of top talent and the supporting infrastructure.

In order to implement Six Sigma the necessary infrastructure includes Green Belts, Black Belts, Experts, Master Black Belts, Champions and the top management. Six Sigma's belts skilled in project management, are responsible for the implementation of Six Sigma within the company, leading a variable number of teams in function of their level and working accordingly part-time or full-time for the deployment of Six Sigma, under the coordination of the Master Black Belt. This

last one is appointed by the Champion, usually one of Senior Managers, known as "Quality Leader" who is also a mentor for Belts. The general vision and strategy for Six Sigma within the company is done by the CEO and the top management, responsible also for the appointment of the Champion. In some cases, such as in aerospace and in the defense industry, an external Expert could be used where necessary to improve services, processes and products.
The full commitment of the company management is necessary for the deployment of Six Sigma, but also is necessary to have the involvement of company employees in process improvement. In this idea Lee et al. (2011) underlined that leadership ability plays a critical part in any quality improvement program, particularly the six sigma project that is always said to be a top-down quality revolution approach.
Different key tools are used in the methodology known as DMAIC, tools specific to each of its five phases: define measure, analyze, improve and control. So, the key tools of the define phase are cost of poor quality (COPQ), voice of customer (VOC), voice of the stakeholder (VOS), project charter (SIPOC) and as-is process maps (Ishikawa diagram, Why-Why, PDPC).
Key tools for the measure phase are Critical to Quality Requirements (CTQs), sample plan, capability analysis, failure modes and effect analysis (FMEA). The key tools of the analyze phase are root cause analysis, failure mode & effect analysis, analysis of variance (ANOVA, ANOVA Gauge R&R), scatter diagram, regression analysis, quality function deployment (QFD).
For the improve phase main tools are design of experiments (DOE), solution selection matrix and to-be process maps. Finally, key tools of control are control charts, known as Shewhart Charts, statistical process control (SPC) and also contingency and/or action plans.

6. SIX SIGMA IN ROMANIAN SMES

According to the annual report, conducted by the European Commission, concerning EU SMEs in 2013-2014, there are 21.6 million SMEs located in sectors such as industry, construction, distributive trade and services. SMEs held a number of 88.8 million employees and generated EUR 3.666 trillion in added value in 2013. In other words, 99 of every 100 enterprises in these sectors are SMEs, any 2 of 3 employees are employed in SMEs and 58 cents of every euro added value is sourced by SMEs. All this underlines the great importance hold by the European SMEs.
In 2008 the number of Romanian SMEs reached the value of 504,581 companies, representing 99.6% of the total number of companies on the Romanian market. As a result of the economic crisis in Romania the number of SMEs reduces continuously from 2008 to 2011, reaching finally the value of 404,338 companies in 2011. The growth tendency returns in 2012, when growth marks an upward trend so far. Thus, 2012 marks an increase up to 410,210 SMEs; in 2013 the number of SMEs reached 426,295 SMEs and in 2014 their number increased to a value of 433,858 units. In 2013 and also in 2014 SMEs number represented 99.7% of the total number of Romanian companies. In 2014 most of the employees, i.e. 67% of the total, were working in SMEs and the total added value by SMEs was of 50% of the total.
In Romania after 1990 the main bodies responsible for quality and quality management were founded: Romanian Association for Quality, RENAR and CNCAN. RENAR, respectively CNCAN for the nuclear field, are in charge of the national laboratory and national bodies accreditation, namely in the field of nuclear installations.
After 2000 Six Sigma has spread in Romania first to large organizations, where Six Sigma has been implemented with success. As the demand for quality products increases and also large organizations competition is tougher, Romanian SMEs had to consider the implementation of Six Sigma strategy.
Modern quality management systems are not placed on top of Romanian SMEs priorities, according to Ceptureanu et al. (2010). The performances of SMEs largely depend on the priorities adopted by entrepreneurs and managers. According to the survey results the most frequent management

priorities indicated by the Romanian SMEs include: introduction of modern quality management systems (32.03%), management restructuring/upgrade (29.03%). So, implementing modern quality management systems is placed for Romanian SMEs after expanding marketing activity, diversifying production, training or acquisition of new technologies and is not treated with the necessary importance.

Nowadays the principles of Six Sigma are applied in many Romanian organizations, either big ones or SMEs. Concerning Six Sigma in Romanian literature we found a lack of literature concerning Six Sigma implementation in Romanian SMEs; there is limited documented evidence of its implementation in SMEs. Based on our studies we found that implementing Six Sigma impacts positively the SME organization, through the greater efficiency of employees' deployment and also through the utilized techniques of operational management. We noticed also an enhanced employee productivity results for Six Sigma SMEs' rate of improvement relative to the rate of improvement of SMEs not using Six Sigma.

Implementing Six Sigma in SMEs is more difficult compared to larger organizations as in SMES the employees perform many different functions unlike big organizations; also SMEs could heavily support costs associated to Six Sigma training and even could not support full time of Black Belts or Master Black Belts. That is why in SMEs Six Sigma infrastructure will be basically of Green Belts, coached by external experts. In other words SMEs are confronted, due to their structure, with problems associated to limited human capital and also limited budget for Six Sigma. That is why SMEs have to be very careful in selecting projects for Six Sigma application, in order to choose projects with a high success probability, able to provide a boost to the morale of management and employees. Another important issue for a successful implementation is the top management support and enthusiasm; the top management has to be deeply involved in Six Sigma program.

Munteanu et al. (2015) noticed that Six Sigma programs in Romanian SMEs do not guarantee a sustainable competitive advantage for the companies due to their focus on existing processes, products, and customers. This is due to the fact that they have not been developed to address radical improvement in organizational processes and routines. There is no doubt that Romanian SMEs can benefit from Six Sigma programs; however, such benefits are not sustainable until Six Sigma programs develop mechanisms to address product innovation, pattern of change in customer base, and environmental uncertainty while improving organizational processes. This is complementary with Antony (2008) highlighting that as small companies are more agile, it is much easier to buy in management support and commitment, as opposed to large organisations. The education and training component is much harder for smaller companies. Moreover, small companies do not have the slack to free up talented people to engage in training, followed by the execution of Six Sigma projects.

As a succes key for Six Sigma implementation in SMEs Antony (2008) noticed that in SMEs, the senior management team must be visibly supportive of every aspect of a Six Sigma initiative. They must demonstrate by their active participation, involvement and actions that such support is more than lip service. Six Sigma is about overall business strategy, culture and change, and the small companies embarking on Six Sigma initiative need to build all of this into a sound corporate strategy plan.

Six Sigma implementation in SMEs is a path to increase the customer loyalty as it increases employee's engagement; Six Sigma also increases the quality of the customer experience and at last but not at least it increases the benefits of the company.

7. CONCLUSIONS

Implementing Six Sigma in Romanian SMEs could be more difficult compared to larger organizations, but is the only way for increasing quality products and facing large organizations concurrence. Six Sigma must be between the priorities of the SMEs strategy plan for their top

management; top management commitment and involvement are necessary. SMEs employees must also support the implementation of Six Sigma. The supporting Six Sigma infrastructure has an important place in reaching projects' targets. The selection of projects for Six Sigma application must be done carefully in order to choose improvements with a high success probability and able to provide a boost for the morale of SMEs management and employees.

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