Trends in business process quality management methodologies.

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ABSTRACT

People, process and IT are amongst the most important assets of any organization. Optimal utilization of these resources has been the question of research in business and academia for many decades. The business world have responded by inventing various methodologies that can be used for addressing problems of quality improvement, efficiency of processes, continuous improvement, reduction of waste, automation, strategy alignments etc. Some of these methodologies can be commonly called as Business Process Quality Management methodologies (BPQM).

In essence, the first references to the process management can be traced back to Frederick Taylor and scientific management. Time and motion study was addressed to improvement of manufacturing process efficiency. The ideas of scientific management were in use for quite a long period until more advanced quality management techniques were developed in Japan and USA. One of the first prominent methods had been Total Quality Management (TQM) which evolved during 1980’s. About the same time, Six Sigma(SS) originated at Motorola as a separate method. SS spread and evolved; and later joined with ideas of Lean manufacturing to form Lean Six Sigma. In 1990’s due to emerging IT technologies, beginning of globalization, and strengthening of competition, companies recognized the need for better process and quality management. Business Process Management (BPM) emerged as a novel methodology that has taken all this into account and helped to align IT technologies with business processes and quality management.

In this thesis we studied various aspects of above mentioned methods and identified their relations. An extensive amount of information exists on these methodologies and they have been commercialized by various consulting firms. However, a comprehensive understanding of what these methodologies can do and deliver is missing.

Purpose of the thesis is to study these three related methods in business process quality management; identify their relation to each other and how they have developed. An extensive literature review has been done prior to data collection to understand theory behind each methodology. Research data was collected by studying existing case studies describing implementation of above mentioned methodologies.

Below are some of our key findings

- BPQM methodologies evolved with time either by becoming more focused or through better integration of people and Information Systems
- Processes are key for operations of any organizations. Processes need to controlled and developed over time. As BPQM methodologies evolved, they became more process centric.
- Quality can be achieved as outcome through increasing process performance. Quality and processes are very closely linked to each other. It is impossible to expect high quality end-results without understanding what needs to be done to get a desirable output from various inputs.
- Management support is vital for any BPQM methodology implementation.
- Modern organizations are result oriented. Therefore the choice of BPQM methodologies is heavily influenced by their ability to improve bottom line performance.
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1 Introduction

In the late 1800s, Fredrick Taylor encouraged use of scientific methods to study work processes. His concept suggested that there was only “one best way” to do work. Once the best way was found, it had to be made standard until the next best way is found through scientific study. We can assume that only one best way also provided the highest quality output. Scientific management has also discussed possible ways of finding that “one best way”, but is it valid in current business environments?

This research is conducted on business processes and quality management methodologies. The concept of “business processes” has been broadly discussed in business and academic institutions. Application and adherence to “business process” disciplines result in process centric organizations. According to Doebeli et al (2011), process centricity in organizations creates a shift from traditional territorial and functional structures. As result, organizations are built around work specialization instead of people and hierarchy. According to same author, a 2008 survey revealed that more than 40% of organizations had a business process management programme designed for better organization and management of core business processes. “Quality management” paradigm is relatively new, however the concept of quality is certainly well known. Quality has many parameters and therefore its management becomes complex. Management of business processes has been looked upon as tool for quality management. Quality has been looked upon as an end product of process centric organizations.

These two areas, namely business processes and quality management, developed rapidly during the last century. Management of business processes and quality assurance are the means by which organizations achieve their objectives (Lee and Dale, 1998). Methodologies surrounding this discipline have transitioned through number of generations while becoming more mature and agile to meet current organizational needs. The benefits provided by these methodologies can be visible in the performance of leading corporations of last decades. They provided with better operations with improved quality of products, increased customer satisfaction and long term sustainability of organizations.

This thesis is focused on three methodologies, Total Quality Management (TQM), Lean Six Sigma (LSS) and Business Process Management (BPM). The purpose of research has been to identify the relation between them regarding process and quality aspects. There are many more methodologies with similar focus; however literature review has shown that these three methodologies share common traits of evolution and display a possible further development. They also provide complementary benefits when implemented, therefore poses a challenge for organizations when choosing which methodology to implement. Despite widespread availability of materials and consulting agencies specializing in above mentioned methodologies, a widespread understanding of their usage is missing. Through extensive literature review and case study analysis, we are aiming to understand relations and evolutionary traits of above mentioned methodologies.
1.1 Problem discussion

The business world is experiencing transformation like never before. Economic shifts around the world are challenging previously dominant economies to meet the needs of 21st century. Instead the emerging markets are setting benchmarks. In order to sustain and even enhance competitive advantage in an increasingly global competition, companies must continuously and consistently embrace best practice management disciplines, strategy and technologies (Hung, 2006). It is easier said than done. A major challenge in this setup is keeping pace with the ever changing customer centric economies.

The management disciplines and strategies are increasingly being built around some key principles as process management, quality assurance and IT enhancements (Doebeli et al, 2011). The usage of term Business Process Quality Management (BPQM) is still maturing, however the interest towards what it is and what it can do has been increasing rapidly over last couple of decades. The term “process” has been discussed in various disciplines such as systems thinking, system dynamics (Senge, 1990), cybernetics etc (Hung, 2006). From strategic point of view, Porter (1985) described unique processes to be key factors of competitiveness for any value chain. Process thinking is increasingly becoming more common amongst various organizations as it leads to flattening of hierarchy (Armistead, 1999). The result of such flat hierarchical orientation has been improvements leading to more customer focussed organizations (Hung, 2006). It is undeniable that processes provide certain structure and in complex business environments, structure is crucial for sustainability. A saying exists amongst process professional which says, “Processes do not do the work, people do”. This saying articulates the fact that, processes are only as good as the people working with processes. Discussions on this topic are available plenty in both academic and business organizations.

Another key aspect describing BPQM has been quality orientation. The concept of quality can be traced back to stone ages, when human beings appreciated fine stone tools (Elshennawy, 2004). Increasing transparency in world economy and rise of IT has made modern day consumers extremely quality conscious. High quality in products and services are considered to be norm in most parts of the world. Organizations however have been focused around another quality aspect, Quality of Operations (Sidirova et al, 2010). There is a relation between quality of operations and processes. Once any organization perceives themselves and their business in terms of process, then there is considerable amount of possibilities for the processes to be constantly redesigned for continuous improvement in order to improve quality. Continuous Process Improvement (CPI) is a term commonly used to describe Total Quality Management (TQM) and Lean Six Sigma (LSS) (Williams, 2007).

Whilst CPI managed to address two key aspects of BPQM, ie process and quality, a challenge crept slowly during last couple of decades in form of IT. At the end of twentieth century, ICT technologies advanced significantly. These developments allowed massive digitization of organizational business processes (Houy, 2010). IT has become a powerful enabler of business processes. It has also been very successful in transforming business (Hung, 2006). Quality of business process and operations has become increasingly dependent on IT. The possibilities of IT are immense and it is not the scope of this thesis to discuss this. However, the influence it had on BPQM is tremendous and a whole new approach called BPM came into existence. Increased interest in business processes, quality and technological advancements fuelled a change towards technology driven BPQM (Houy, 2010). It started with process integration done by ERP systems, and more recently through BPM systems.

A major challenge for today's leaders is to identify means for optimal performance in an ever changing customer centric economy considering processes, quality and organization wide implementation of IT infrastructure. Various methodologies have been developed for addressing such challenges and it is costly if they are not used properly. Steering through these methodologies can at times be a herculean task for even mature organizations. The processes in current organizations are increasingly becoming complex and along with that, the needs for controlling and maintaining BPQM is changing. Changing needs have caused rise and evolution of various methodologies. We are aiming to bring more understanding to this
phenomenon of evolution of these methods and rise of new ones. By understanding what drives their evolution, we may better understand the drawbacks of current methodologies.

1.2 Problem formulation and purpose

Problem formulation:

Current turbulent business environments require firms to be agile in their response to financial and market changes. Such responses always require financial backing and eventual returns on investment. In order to deliver economical results, enterprises are functioning globally with complex structure and are exposed to massive amounts of data and information. At the same time, to survive in high competition, they must ensure quality of products, services and operations. It is becoming increasingly difficult to run large international corporations, remain innovative and profitable, and ensure operational excellence. Growing complexity of business demands for approaches on business processes and quality assurance that can be implemented rapidly and through entire organization.

During the last 5-6 decades, quality management and business process orientation has been put forward as a new management theory. Various methods have evolved and their definitions have been quite different, however the aim was quite similar (Roy et al, 2006). Business process quality management (BPQM) methodologies address various aspects as quality improvement, efficiency of processes, continuous improvement, reduction of waste, automation, strategy alignments etc. Irrespective of the problem to be addressed, BPQM methodologies must deliver improvement in bottom-line performance. Joseph Juran, a renowned management thinker, have highlighted that executives only understand the language of money and therefore the choice of these methods is heavily influenced by their ability to provide tangible financial improvements through combination of process and quality improvements. Among many of the methods, our choice has fallen on three following: TQM, LSS and BPM. This selection was dictated by their focus on above mentioned aspects, ability to provide tangible financial improvements, and author’s familiarity with these methods.

These methodologies offer complementary opportunities, but it is extremely costly for companies to use trial and error method to discover what fits their needs. Widespread commercialization of these methods by consulting firms adds further distraction to this confusion. Certainly companies need certain methodical way of managing processes and delivering quality products or services. The methodologies exist, but a comprehensive understanding of which method addresses which needs is missing. Ultimately it is not about the methods, but we need to know how they are used and what they are used for.

Purpose of this work: Purpose of the thesis is to study three related methods in business process quality management, identify their relation to each other and how they have developed. This will provide a broad understanding of these methods which can later be used for practical assessment of their usability in a given context.
1.3 Thesis Structure

This work is organized in five parts: theory, methods, case studies, summary and conclusions. Suggestions for future work are added as part of summary. In the first two chapters we give introduction and present literature overview of the methodologies. Then we present case studies, their analysis, discussion and conclusions.

Chapter 2 is devoted to description of TQM, LSS and BPM. We will discuss history and main principles of these methodologies. It is followed by discussion on their evolutionary aspects such as criticisms, integration with each other and also future challenges. Discussion based on literature review will describe similarities and differences between all three methods. This should give a good description of as-is status of selected methodologies.

We will also present a theoretical framework that will be used for analysis and conclusion from the case studies. Theoretical framework had been identified to get a clear scope for research.

Chapter 3 describes research methodology, which we applied.

Chapter 4 contains brief descriptions of 6 case studies that give practical examples of implementations. In the case study analysis we will compare the methods, demonstrate their evolution and reasons for their development.

Finally Summary and Conclusions are presented in Chapters 5 and 6. There we present our findings regarding relationships among the methods and reasons for their evolution. Future research presents the ideas on possible development of this subject.
2 Theory

This chapter presents theoretical background of each process and quality methodology. We will not supply deep descriptions of the methods; this area is too big and interested reader can find a large variety of literature on this topic. Instead of that, brief overview and main characteristics of each method will make a good beginning for the future analysis.

Key terms that we intended to investigate were business processes and quality management. While process management maybe an unfamiliar term for many, we all are aware of what is quality. We all have our own understanding of what quality is. Quality management has been of concern amongst all institutions providing some kind of service or product. Williams et al (2006) divided quality management into two types, Old and New. In terms of timeline, Old can be considered what existed before mid 90s and New is what exist after. Williams et al(2006) argued that TQM managed to handle aspects of Old quality management. But rising complexity in production, increased emphasis on people, increased competition from East etc led to a situation when focus moved to processes. The most prominent methodologies from this new perspective were Toyota Production System and Lean thinking. We found concepts of these methodologies well embedded into LSS; hence the choice was made to include LSS in our study. William et al(2006) also highlighted that growing challenges of New quality management have increased dependency on IT and necessity of quick communication between different market players. If we search for BPM in Google today, about 29.5 million hits are revealed. Majority of them are related to BPM software. This just highlights that BPM is mostly known via IT and IT is one of the challenges of New quality management. It however retains majority of the concepts from TQM and also LSS, mainly the process orientation, but also added the IT perspective (Hammer cited in Rosemann, 2010). When we drew this line of relation between these methodologies, the relation to our problem formulation and purpose is evident.

TQM, LSS and BPM are only few of various other methodologies that exist for tackling business process and quality issues. While doing pre-study research, we discovered historical relations between TQM and LSS. BPM originated at later stages, however similarities were evident. The key message were same from all three, however their implementation characteristics differed. The problems that can be addressed also vary. In various aspects, these methods are complimentary to each other. This is discussed further in this chapter.

The choice of these methodologies was also dictated by their widespread usage in current business and governmental organizations. LSS for example is considered to be state of the art methodology for increasing profitability and enhancing customer satisfactions. Pioneering work done by Motorola and Toyota has been further reinforced by such companies as General Electric, ABB, Honeywell, DuPont, Alfa Laval, Toshiba and others (Watson, 2004). TQM on the other hand is considered to be “dead” in most of the industries, however still widely present in some Asian countries. Certainly today’s TQM differs significantly from its original definition. BPM is relatively new and still evolving to have a common definition for widespread usage.

We have identified many criticisms regarding all three methodologies, which will be presented in following chapters. However all three are prominent and present both in academic and business institutions. TQM has been prominent in past and therefore has been taken as foundation. It is the oldest methodology that has been reviewed and discussed in this thesis. TQM was replaced by Six Sigma, and finally BPM came emerged. We will present the methods in this order.
2.1 History and principles of Total Quality Management (TQM)

In early 1980s, Phillip Crosby defined 14 steps for quality improvement. Edward Deming, in his work Out of Crisis, further developed these 14 steps that formed the basis for TQM. In 1986, Joseph Juran identified the three basic functions of quality management process: planning, organization and control. Armand Feigenbaum developed the concept of Total Quality Control which was later incorporated into TQM. Feigenbaum stressed the need for commitment from the leadership and involvement of the entire workforce for success of TQM.

TQM became popular in USA during the 1980s and thereafter it spread rapidly. During 1980s and 1990s, many organizations worldwide followed TQM and improved the quality of the products, services and operational performance measures. One of the main selling points of TQM was its ability to reduce cost. Many organizations saved millions of dollars by successfully implementing TQM.

TQM has been defined as:

“... as a continuously evolving management system consisting of values, methodologies and tools, the aim of which is to increase external and internal customer satisfaction with a reduced amount of resources.” (Hellsten, U. and Klefsjo, B. 2000)

The definition above is one of many that exist in various literature sources. One of the weak points TQM has been its vague definition. Despite the divergent views on what TQM is, there are few common elements. It refers to a set of management and control processes designed for an organization and its employees to do everything possible to provide products and service that satisfies the customer (Talha, 2004).

The gospel of TQM has been customer orientation. It emphasizes that the customer’s needs should be integrated into the design and development of products and services. In order to achieve this, importance of quality had to be embedded in all the organizational processes. TQM requires that all activities in an organization must be linked with one purpose; to provide customer satisfaction. To be customer focused is the key idea of TQM.

TQM includes processes, methods and tools for developing product quality, process control, quality assurance and improvement. Major part of TQM focus is quality which can be achieved only if everyone involved in production of a product or service is responsible for quality.

Appendix A provides some principles of TQM

2.2 History and principles of Lean Six Sigma (LSS)

The concepts of Lean management can be traced to the Toyota Production System (TPS), a manufacturing philosophy pioneered by the Japanese engineers Taichi Ohno and Shigeo Shingo. TPS was developed between 1948 and 1975. Majority of the ideas of TPS were included into Lean management which was developed around 1980s.

The roots of Six Sigma can be traced to two primary sources: Total Quality Management and Six-Sigma statistical metric originating at Motorola Corporation. In 1980s, Motorola developed a new business management strategy which they named as Six Sigma.

Over the years, many organizations and scholars have identified the possibilities of combining these two methodologies as their objectives and methods coincided. The figure below depicts this relation.
LSS is necessary for organizations and individuals as a methodology for improvement and problem solving. Business processes do not get better by themselves and their performance always deteriorates unless improved on some periodic basis. LSS provides a systematic approach to improve performance measured by quality, cost, right delivery and customer satisfaction.

Lean philosophy is focused around elimination of waste in all aspects within a particular system. In order to do so, Lean identifies seven forms waste:

a. Over-production
b. Defects
c. Unnecessary inventory
d. Inappropriate processing
e. Excessive transportation
f. Waiting
g. Unnecessary motion

The first step in any lean initiative, is to identify the value adding and non-value adding processes. The tool that lean management provides for this task is called Value Stream Mapping (VSM). In order to sustain developments, lean management provides techniques such as 5S method, setup-time reduction, cycle-time reduction and etc.

The term “Six-Sigma” refers to a statistical measure of defect rate within a system. Heavily armed with statistical techniques, Six Sigma method provides a structured and systematic approach to process improvement, aiming for a defect rate of 3.4 defects for every million opportunities.

The concept of Lean Six Sigma as an approach to process improvement has not fully matured yet (Bendell, 2006). Six Sigma complements Lean philosophy by providing the tools and know-how to tackle specific problems that can be identified using lean management tools (Wheat et al, 2003). Appendix B describes LSS in more detail.
2.3 History and principles of Business Process Management (BPM)

BPM has its roots in the quality management traditions and business process reengineering introduced by Michael Hammer (1990). Founder of reengineering, Michael Hammer stated in his famous article “Don't Automate, Obliterate” (Hammer, 1990). It was a call for reorganization of non-industrial, service and office processes. BPM is often called as the third wave of business process reengineering, because it has evolved from TQM through Business Process Reengineering and Enterprise Resource Planning (ERP).

In essence, the first references to the process management can be traced back to Frederick Taylor and scientific management (Lusk et al., 2005). Time and motion study was addressed to improvement of manufacturing process efficiency. The ideas of scientific management were in use for quite a long period until more advanced quality management techniques were developed in Japan and USA. In 90’s due to emerging IT technologies, beginning of globalization, and strengthening of competition; companies recognized the need for better process and quality management. At the same time company’s strategy and maximization of stakeholders value became more important aspects of the business. Additionally amounts of transactions and customers has dramatically increased, which resulted in large amounts of data that the companies had to store, process and analyze. BPM emerged as a novel methodology that has taken all this into account and helped to align IT technologies with business processes.

Appendix C represents historical development of BPM (Lusk et al., 2005).

BPM is quite young methodology, and therefore it is still lacking enough of research body. Moreover, there is some confusion between all the acronyms, which are used for the concept of business process management. For example, what is the difference between BPM, business process re-engineering (BPR) and business process management systems (BPMS)? Although it is difficult to give exact definition of BPM principles in the same way as it was done for Lean and Six Sigma, one approach of 10 steps implementation is schematically outlined in the Appendix D.

The main idea behind BPM is optimization and automation of business processes:

“The achievement of an organization’s objectives through the improvement, management and control of essential business processes.” (Jeston and Nelis, 2006).

“BPM is supporting business processes using methods, techniques and software to design, enact, control and analyze operational processes involving humans, organizations, applications, documents and other sources of information.” (Aalst, 2003)

A typical scenario of BPM implementation (Harmon, 2011) can be found in Appendix E. It demonstrates a simple car renting process. In the first step all the users, suppliers and stakeholders of the process are defined. Next steps of process modelling involve mapping of different processes, that occur between customer, car rental company, internal and external stakeholders. After analysis and definition of all the processes, they will form the ground for the next step - software development. A new car-rental web service will enable customers book a car conveniently from home via Internet. Additional internal software will simplify invoicing and payments, monitor status of cars in-house and rented-out

The crucial part of BPM methodology is computer systems, which are called Business Process Management Systems (BPMS). Those are computer systems and technologies, aimed to monitor, execute, and implement business processes. To name a few, there are SAP, ORACLE, SOA and etc. Some vendors have even introduced their own business process management concepts.
2.4 Evolutionary aspects

The description made above on the methodologies illustrates that they have evolved over a long period of time. It is undeniable that certain form of these methodologies has always existed and they have evolved along with evolution of needs of the industries. Similarities and differences also changed over time. The similarities and differences are not always visible in the definitions. Some authors argue that they have different definitions but the same aim, i.e. to minimize waste and resources while improving customer satisfaction and financial results (see Roy et al. 2006).

In this chapter, we describe why these methodologies evolved. This is done mainly by analysing their differences and criticisms. To complete our understanding of evolutionary aspects, we will conclude with a review of future challenges faced by BPQM methodologies.

2.4.1 Criticism of TQM and shift to Six Sigma

Failures of TQM are widespread and properly documented. For instance, according to a research by Harari (1997), only one-fifth or one-third of TQM programmes in US and Europe succeeded in achieving improvements in quality, productivity, competitiveness and financial improvements (Roy et al., 2006).

Another study done by McKinsey & Company found that two-third of TQM efforts were stopped due to lack of tangible results (Dooley and Flor, 1998). Ernst and Young found in a 1992 study, that the effectiveness of TQM largely depended upon the maturity and performance level of the company attempting to implement TQM (Ernst & Young, 1992).

Another problem identified with TQM has been related to its definition. Boaden (1999) for example wrote following:

"... attempting to define TQM is like shooting at a moving target. As it is more widely practised, and other initiatives emerge, the emphasis on different aspects change."

It is obvious that problems with definition resulted in problems with practical implementation. Edward Deming is considered to be one of the influencer of TQM; however he has never used the term and didn’t know what it meant. He called it a “buzzword” (Petersen, 1999). Once asked about TQM, he said following:

“... the trouble with TQM, the failure of TQM, you can call it, is that there is no such thing. It is a buzzword. I have never used the term, as it carries no meaning.”

TQM had limited success but then it “crashed and burned” according to Black and Revere (2006). It was impossible to assign financial benefits to TQM initiatives, root causes were not identified and not eliminated; and TQM didn’t provide any metrics for future evaluation of the work. Six Sigma on the other hand managed to retain TQM principles and also fill in the gaps described above. Six Sigma also introduced various new approaches such as Time and Money Deliverables, the Six Sigma Metric, and a Critical to Quality Customer Focus. (Black, Revere 2006)

Pepper and Spedding (2010) stated that TQM was a profound and all inclusive philosophy with huge potential for managing business. This is however was the weakness as well - the fact that it was only a philosophy. Six Sigma tries to move beyond being a simple philosophy; instead it tries to turn into company culture through chain of practitioners as Champions, Green Belts, and Black Belts etc. It also tries to anchor to the company strategy by focussing on delivering bottom-line financial results.
Dr. Tom Pyzdek differentiated Six Sigma and TQM with one word, Management. In his view, TQM was created by techies while Six Sigma was created by some of America’s most gifted CEOs as Bob Galvin from Motorola and Jack Welch from General Electric. These CEOs had only one thing in their mind, to make their business as successful as possible. The tools and techniques presented within TQM needed to be developed into a framework, which got to be known as Six Sigma (Antony, 2009).

TQM practitioners did consider learning some lessons from their failures. In a survey within an IT organisation, done by (McManus, 1994), some drawbacks of TQM were identified. The drawbacks were related to lack of communication, lack of involvement of the entire organization and lack of systematic training. Interestingly, some TQM practitioners put these as some of the key principles of TQM.

McManus (1994) argued that keeping TQM amongst the elite of a company is a sure way to failure. It was also argued that, unless a quality initiative touches everyone in an organisation then it is destined to fail (McManus, 1994). McAdam and Lafferty (2004) claimed that TQM had two streams of development: mechanistic perspective and organic perspective. And that Six Sigma evolved out of the mechanistic stream of TQM. This is illustrated in below figure:

![Figure 2-b Six Sigma as driver and subset of TQM. (McAdam, Lafferty 2004)](image)

Companies with successful Six Sigma implementation had once established TQM programs as well. Even Six Sigma practitioners consider it as a natural offspring of TQM. Antony and Banuelas (2002) suggested that SS can achieve tangible results while keeping the TQM culture intact. In order to identify how SS has complimented TQM, following has been found (Erwin and Douglas, 2000):

- SS provides much focused improvements by being strongly focused on reduction of defects. This adds focus to TQM programs, which may at times can be very diverse.
- SS has evolved very quickly and incorporated ideas such as customer centricity at very early stages, thus becoming close to TQM.
- SS has provided more involvement of employees in the improvement programs. This has been achieved by implementation of various roles within SS projects and programs.

It is clear from above that SS had both people and process aspects, similar to mechanistic and organic aspects of TQM.

McAdam and Lafferty (2004) highlighted one failure in SS implementation on top of TQM. Their case study showed that SS programme was implemented without considering existing TQM programs. This perhaps occurred because top management considered SS to be so powerful that success was guaranteed. This is also highlighted by Moosa and Sajid (2010) who state that SS was oversold at all stages of its development. Such “quick and dirty” implementation of SS resulted in lack of understanding of human factors, such as necessity for empowerment, proper communication, reward and recognition programme etc.
2.4.2 Lean and Six Sigma integrate as Lean Six Sigma

On the other hand, looking at Lean we also see a mix of success and failure. Despite successful “lean” applications in a range of settings, the lean approach has been criticized on many accounts. Most of the criticism is related to the lack of human integration or its limited applicability outside repetitive manufacturing environments. This also led to lack of proper definition; something TQM also suffered from. Ultimately with time, success in various other industries broadened the definition of LSS.

As Lean thinking spread into various industries and attracted academic research, various drawbacks were identified. Hines et al (2004) have identified following drawbacks with Lean:

- Lack of contingency: according to Hines et al (2004), there is lack of understanding on level of contingency required at companies wishing to implement Lean. Lean has been mostly applied to shop-floor operations, and it is always a challenge to implement in other areas.
- Human aspects: Lean production system can be considered to be exploitative towards employees.
- Scope and lack of strategic perspective: lean initiatives were not anchored to strategic initiatives.
- Coping with variability: another stream of criticism evolved regarding the ability of lean production systems to cope with variation.

To overcome the problems above, Hines et al (2004) suggested that, Lean could be integrated with other approaches and particularly the tools offered by other approaches. This doesn’t contradict the objective of Lean, i.e. to provide customer value. The rising fame of SS has been noted by Lean practitioners. George (2002) suggested that SS provided various tools that attack and control sources of variation; and they should be very compatible with Lean principles and ideas.

Lean Six Sigma is considered to be better than several of other approaches because it enables integration of process and human aspects into improvement initiatives. Snee (2000) identified following aspects of improvements:

<table>
<thead>
<tr>
<th>Human Issues</th>
<th>Process Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom line focus ($)</td>
<td>Process improvement</td>
</tr>
<tr>
<td>Management and leadership</td>
<td>Analysis of variation</td>
</tr>
<tr>
<td>Sense of urgency</td>
<td>Disciplined approach</td>
</tr>
<tr>
<td>Customer focus</td>
<td>Quantitative measures</td>
</tr>
<tr>
<td>Project teams</td>
<td>Statistical thinking and methods</td>
</tr>
<tr>
<td>Culture change</td>
<td>Process management</td>
</tr>
</tbody>
</table>

Table 2-a Human and process aspects of improvements (Snee, 2000)

According to Snee (2010), many quality management initiatives managed to focus on a subset of elements shown in Table 2-a. But only LSS managed to address them all. LSS stood out with these three features, i.e. integration of human and process aspects, focusing on bottom line results and providing a structured methodology for implementation.

Additionally SS puts a strong focus on bottom line financial results; which results in management backup of any LSS initiative. Joseph Juran, a key quality expert, has pointed out decades ago that management understand the language of money very well. According to Snee (2010), companies succeeding with LSS received very attractive returns. Large companies had return 1-2% of sales per year; SME receive double of that. Although relative to return on investment (ROI), LSS has also been criticised for being overly costly in implementation. Main cost of implementation goes into training huge amount of personnel. However, the same author argued that all successful LSS program implementations managed to receive breakeven point on their ROI in 6-12 months.
Finally, the success of Six Sigma and Lean can also be explained by their successful implementation at large corporations as Motorola, Toyota and GE. TQM didn't originate in any company and it is also not clear who coined the term. During 1980s, when there was a huge increase in management consultants due to focus on new management trends, and most likely TQM was picked up by these consultants and used in various ways (Petersen, 1999).

2.4.3 BPM: common traits and deviations from LSS and TQM

Although BPM, TQM, Lean and Six Sigma differ by their concepts, they have much in common. For example, improvement of quality and minimization of waste, while improving customer satisfaction and financial results (Anderson et al., 2006).

According to Hammer (2010), BPM has two antecedents: BPR and Deming’s works (which resulted in TQM and further in Six Sigma). BPR has deserved a reputation of ‘slash-and-burn’ radical approach of organization reorganization. Obviously, such radical changes could not be implemented regularly, and therefore they had episodic character and lacked continuity. Although BPR practices were often criticized for failures in implementation, they succeeded in changing management focus from digging into process execution performance to consideration of the better process understanding and design. According to Lindsay et al. (2003), BPM was an approach to “soften” BPR and capture long-term process improvements.

Since BPM has roots in TQM too, not surprisingly these two methodologies have so many similarities. And they suffer from the same drawbacks as vague concept definition and lack of concrete implementation tools. Certainly, there are many BPMS implementation suites. But in the same way as there are many interpretations of TQM (see Petersen, 1999), there is a wide range of BPMS tools. Ryan K.L. Ko et al. (2009) mean that there is a myriad of BPMS standards, languages and systems, and that “at the end of 2006, the BPMS market reached nearly US$1.7 billion in total software revenue”.

The main common feature of TQM and BPM is process orientation. BPM inherited the best practices of TQM, and streamlined with information technology. Another similarity between TQM and BPM is that in contrast to Six Sigma and Lean, which originate from particular companies (Motorola and Toyota, where they were spread through the whole company and mastered), TQM and BPM have no particular origin. It might explain why they had so wide and unfocused development.

The next close to BPM methodology is Six Sigma. Jeston and Nelis (2006) proposed implementation of BPM in 10 steps, see Appendix D. Comparison of DMAIC steps with ten steps of BPM implementation reveals that BPM is only adding the strategy means, and otherwise both methodologies have very much in common. BPM is not neglecting more mature LSS approaches, but instead of that it benefits of using its tools and expertise. Essentially BPM is a combination of the previous methods, making them more powerful by applying the latest advances in computer technologies. According to Williams (2007), BPM is simply the next stage of continuous process improvement programs.

Snee (2010) formulated 8 success factors of LSS:

1. creates bottom line results ($);
2. active senior management leadership;
3. use a disciplined approach (DMAIC);
4. rapid project completion (three-six months);
5. clear definition of success;
6. infrastructure created (Master Black Belt, Black Belt, Green Belt);
7. focuses on customers and processes; and
8. sound statistical approach.
These characteristics explain main disadvantages of BPM, such as lack of infrastructure and skilled implementation experts, too long implementation projects, absence of clear implementation techniques such as DMAIC and statistical tools. Additionally, low level of involvement of senior management, lack of adequate customer orientation and deficit of a big picture view hinder implementations of BPM (Spanyj, 2010).

Although BPM has many similarities with previous methods, it has so much own specifics, that it is difficult to compare it with anything else. First of all, it relies heavily on IT technology. Final product of BPM implementation is almost always creation of software application or the whole system. As it will be demonstrated in case studies, BPM applies computer technologies even when analyzing the processes. Secondly, BPM implementation must have “strategy in mind”. Also, it is not aiming for general improvements of some processes only. It might re-align the whole workflow if necessary. The problem here is that BPM experts often have quite limited “domain knowledge”, i.e. details of process implementation. And because BPM implementation is located on the IT side, there is a big gap between BPM practitioners and process users. BPM would definitely benefit from LSS approaches, when real process owners are involved into improvement projects and they even perform the work.

Lindsay et al.(2003) implied that emergence of BPM was merely caused by changes in the industry and shift from production to service and office work. Previous quality and process improvements methodologies were not fitted for the new processes, which involved too many human actors, too much information, too big number of transactions and social collaborations in desire to achieve some business goals. It was also related to knowledge workers productivity problems raised by Peter Drucker and Davenport (2010).

In conclusion, BPM can be compared to a bridge between business, LSS, and IT solutions:

*Recent web enabled technologies and other methods to extract, analyze, and apply data to decision steps and information flow have enhanced the ability to manage complex and demanding processes with relative ease. Process Management tools, and the problem solving methodology of Six Sigma, have come together to increase the efficiency, effectiveness, and ongoing control of a process to levels of performance not achievable before* (Redinius, 2004).

### 2.4.4 Future challenges of BPQM

When contemplating on future of the business process quality management methods, professionals need to recognize that it’s not about the methods per se but it’s about what they can do. LSS remains the most popular until now. With time it will evolve and be used more broadly and deeply. LSS will also continue to be a tool for leadership development. This was identified by Jack Welch when he implemented LSS at GE. Companies will always want to have bottom line financial improvements; so as long as LSS provides this in some manner, it will exist in some form or shape.

While comparing strengths and limitations of LSS, Bendell (2006) has criticized practitioners for over selling the concept and training of LSS. What started as small in-house development program has turned into a commodity. Major amount of publicly offered trainings have diluted many initial core values of LSS. The same author criticized LSS programme for being too stiff and using only the “left-brain” capabilities. Creativity and innovation, which are part of “right-brain” thinking has been neglected. Another key criticism has been on criterions for project selection within LSS programme. Even though it is widely promoted that key in LSS implementation is to improve customer satisfaction, the project selection process is mostly driven by “cost down” initiatives. Last but not least, Bendell (2006)
underlined the difference between LSS implementation in US and Europe; thereby highlighting the cultural and management influence on LSS.

Despite all above, the merge of Lean and Six Sigma to LSS is seen as combinations of complementary methods, tools and approaches. SS is considered to be very complicated with techniques and analysis, while Lean is seen as too simple. Finding the right balance is part of maturity of any LSS implementation (Moosa and Sajid 2010).

One of the future challenges of LSS is its ability to drive creativity, innovation and invention. It is no more sufficient for companies to be constantly improving existing performance and trying to be best. Companies need to innovate incrementally. Companies such as Google and Apple have shown that disruptive innovation can change the entire market (Hoerl and Gardner, 2010).

LSS also faces the challenge of increasing amount of data and information. LSS is a data driven methodology that relies heavily on existence of data and information. Integration of LSS into Enterprise Resource Planning (ERP), CRM and other company wide systems is absolutely necessary.

Nauhria et al(2009) in their research on ERP claimed following: “A well implemented ERP system is the foundation on which an effective lean six sigma program can be built.”

Any ERP system will support LSS to eliminate waste and variation by collecting real time data and converting them into valuable information. The figure below depicts this relation.

![Figure 2-c ERP enabled LSS(Nauhria et al, 2009)](image)

This claim is valid as LSS is said to be extremely data driven. The speed of execution of LSS projects are also an important factor dependent on ERP solutions. Creating a holistic view of the IT systems and LSS programs can also be considered as a big challenge for LSS in near future.

BPM seems to complement LSS in many aspects. It is data driven, and strategy oriented. As it name implies, the first key aspect of BPM is business process. But what do we mean under “business process” and even “process”? A common definition of a process is: “A process is a sequence of activities which transform inputs into outputs” (Lindsay et al., 2003). Business literature refers to the process as a set of activities contributing to customer value:

“A process is a logical, related, sequential (connected) set of activities that takes an input from a supplier, adds value to it, and produces an output to a customer” (Harrington et al, 1997)

But what if the process does not directly create any customer value? Then better definition of the business process would be:

"Series or network of value-added activities, performed by their relevant roles or collaborators, to purposefully achieve the common business goal." (Ko, 2009)

Melao and Pidd (2000) categorized business processes into four groups:
- Business processes as deterministic machines
- Business processes as complex dynamic systems
- Business processes as interacting feedback loops
- Business processes as social constructs

The first type of process is similar to the production workflow, characterized by routine work, which can be automated. Sometimes they are called as Main, Core or Operative processes. The second could be compared with an organism, where different parts play its own important role. It is difficult to define any rule for this type of process. This is a black box, transforming inputs into outputs by applying some changes. The third can be compared with an electrical circuit. Although there is also much uncertainty, but communications between parts of the processes are regulated by internal laws and policies. Software development is an example of such process. This type of process also allows some degree of automation. The most difficult process is the fourth, where seemingly no rules exist. It is characterized by presence of many actors, independent experts in their field. Efforts to describe such business processes have vague results. They are too informal, good examples are scientific organizations, health and social services. Similar classification provides Davenport (2010): transaction model, collaboration model, integration model, expert model.

Business processes can also be seen from two perspectives: the Level perspective and the Core competency perspective (Ko, 2009). The Level perspective consists of:
- Operational control (assuring that tasks are carried out adequately)
- Management control (assuring that resources are obtained and used adequately)
- Strategic planning (deciding on the objectives of the organization)

The Core competency perspective consists of:
- Core business processes (revenue generating processes)
- Management business processes (ensuring of corporate compliance and governance)
- Support business processes (necessary but non-revenue generating processes)

BPM advocates have criticized LSS and TQM practitioners for being overly process oriented, narrowly focused and lacking mechanisms for integration with enterprise IT systems (Williams, 2010). While trying to fill this gap, BPM has created a challenge for itself by overly emphasizing on automation to fix complex process issues. Companies around the world has made massive amount of investments in various CRM and ERP systems for the sole purpose of process automation. It is questionable if such investments were instigated by BPM implementations and whether there were enough ROI on the investments. The reality is that people are an integral part of any processes (Breyfogle, 2004). BPM will continue to be challenged to deliver the level of process automation it advocates.
2.5 Theoretical Framework

An extensive amount of information exists on these methodologies that can address the aspects described in below table. Various consulting companies have emerged focusing specifically on implementation of certain BPQM methodologies. This has led to commercialization of these methods and marketing campaigns have always focused on positive aspects. A comprehensive and unbiased understanding of what these methodologies can do and deliver is missing.

In the table below, we have summarised various concepts of the methodologies we have looked into.

<table>
<thead>
<tr>
<th>Concepts</th>
<th>TQM</th>
<th>Six Sigma</th>
<th>Lean</th>
<th>Lean Six Sigma</th>
<th>BPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Origin</td>
<td>The quality evolution in Japan</td>
<td>The quality evolution in Japan and Motorola</td>
<td>Toyota Production System (TPS)</td>
<td>TPS and Motorola</td>
<td>TQM, BPR, ERP</td>
</tr>
<tr>
<td>Theory</td>
<td>Focus on customers and end quality</td>
<td>Improve quality by minimising variations in outcome.</td>
<td>Improve process and quality by removing wasteful activities</td>
<td>Improve process and quality by removing wasteful activities and reducing variation in outcome.</td>
<td>Achieve business/organization objectives through improvement of business processes</td>
</tr>
<tr>
<td>Process View</td>
<td>Improve and uniform processes</td>
<td>Reduce variation and improve processes</td>
<td>Improve flow in process</td>
<td>Improve flow in process and improve quality.</td>
<td>Support processes with help of information technology Optimization and automation of business critical processes</td>
</tr>
<tr>
<td>Approach</td>
<td>Let everybody be committed.</td>
<td>Project management</td>
<td>Project management</td>
<td>Project management</td>
<td>Project management Focus on IT and automation</td>
</tr>
<tr>
<td>Methodology</td>
<td>Plan, do, study, act</td>
<td>DMAIC and DMADV</td>
<td>Understanding customer value, value stream, analysis, flow, pull, perfection</td>
<td>Lean tools and extensive use statistical analysis.</td>
<td>Analyze, understand, improve, redesign, embed into software systems</td>
</tr>
<tr>
<td>Effects</td>
<td>Increase customer satisfaction. Achieve customer loyalty and improve performance</td>
<td>Save money Achieves business goals and improves financial performance</td>
<td>Reduce lead time Reduce inventory, increases productivity and customer satisfaction</td>
<td>Reduce lead time, improve product and process quality, cost savings, improve customer satisfaction.</td>
<td>Save time and money through more effectively automated and optimised processes.</td>
</tr>
<tr>
<td>Criticism</td>
<td>No tangible improvements, resource-demanding, unclear notion</td>
<td>Does not involve everybody, doesn’t improve customer satisfaction, doesn’t have a system view.</td>
<td>Reduces flexibility, causes congestion in the supply chain, not applicable in all industries.</td>
<td>Too high focus on cost, Marxist in nature.</td>
<td>Difficult to understand processes without domain knowledge and deliver required level of process automation. BPM projects tend to be expensive, and not always bring enough ROI on the investments.</td>
</tr>
</tbody>
</table>
As it was demonstrated above, each of these methods comprise of many aspects. It is impossible to analyze all aspects within the scope of a master’s thesis. After thorough literature review on history of these methodologies and also their current implementation, we were able to identify key concepts. We therefore have chosen following aspects for our study:

- Quality improvement: how much quality improvement can be delivered?
- Process orientation: how process oriented the method is?
- Problems addressed: what kind of problems can the method tackle?
- Implementation characteristics: is there any specific about implementation of the method?

These concepts will be used to analyze case studies and drive findings.
3 Methods

The objective of this research is to study relationships between three business process quality management methodologies TQM, LSS and BPM. Before starting with the research, we need to learn and understand theoretical background behind each of the methodologies. There is a significant amount of literature available about this subject. We worked with a broad range of articles and books, describing each of the method and their comparison. This overview was presented in the first chapters.

Further this theoretical background will be used for analysis of data in accordance with the theory. Typically analysis is performed in two steps: data collection and analysis of the data. In this section we inform the reader about chosen combination of research design and data collection methods.

3.1 Research approach

The purpose of the thesis was defined in Chapter 1 as “to study three related methods in business process quality management, identify their relation to each other and how they have developed”. To get full understanding of the business process quality methodologies, we needed to see their practical implementation, and then link theory with the real world examples. This could have been done using appropriate type of data and research design strategy, which would bring together theory and data. Ideally, data analysis would come to the same conclusion as analysis of theoretical proposition. This is called “strengthen theory with data evidence”.

Saunders et al. (2010) wrote that “research strategy will be a general plan of how you will go about answering the research question(s)”. Instead of research question we have purpose of the research. The same author outlined 11 research strategies: experiment, survey, case study, grounded theory, ethnography, action research, cross-sectional and longitudinal studies, exploratory, descriptive and explanatory studies. After considering all these methods, the combination of explanatory case study research was that what we needed “The emphasis here is on studying a situation or a problem in order to explain relationships between variables” (Saunders et al., 2010). More detailed the steps of research design selection will be explained below in the “Case study strategy”.

The steps of research design selection will be more detailed explained below in the “Case study strategy”.

Having theory in hand and seeking for it confirmation by data, choice of deductive approach was logical. Saunders et al. (2000) described this approach as “where you develop a theory and hypothesis and design a research strategy to test the hypothesis”. Inductive approach is opposite, because it helps to figure out theory based on available data. This is relevant to such research, where the researcher has large amount of unexplained observations and needs to develop a theory based on this data.

3.2 Data collection methods

If the research design belongs to strategy, then collection of data is tactics of the research. The data should answer the purpose of the research, and supply foundation for the analysis. The amounts of data can be large or small, but the most important is how it helps to understand the field of research, to gain new insights, to perform analysis, and data quality is good enough for confirming or rejecting theoretical findings. In our case, first of all we needed to observe how objects of research behaved in practical environment. When it comes to such data collection, then the most common approaches are direct observations, questionnaires, surveys, and interviews. Direct observation of the implementation of each method, TQM, LSS and BPM, would supply the best quality of data, but it would take too much time.
Apart from that questionnaires would be the most effective approach, because it is the least time consuming and able to retrieve the largest amounts of data. This type of data is called qualitative. Qualitative data is unstructured, where main emphasis is put on words, opinions, understanding and interpretation of the observations.

Quantitative data provides more exact results, which are collected through laboratory experiments, measurements, counts, frequencies etc. In other words, this type of data is numerical, and this would not help in achieving objectives of this research. The advantage of this data collection method is precision of the results that can be compared, analyzed and visualized, for example in form of graphs and diagrams.

Apart from the type of data, i.e. qualitative or quantitative, we had to choose between primary or secondary. Secondary data is the data that has already been collected for some other purpose (Saunders et al., 2000). It can be found in organizations reports, books, journals, surveys, case studies and other publications. When it is not possible to find secondary data, then the only choice is to collect primary data. This is new data, especially collected for the research, for example through experiment, observations, survey. We have found enough of secondary data already available. In particular, case study data was best suitable because case study is “development of detailed, intensive knowledge about a single “case”, or a small number of related “cases”… of particular interest to you if you wish to gain a rich understanding of the context of the research and the processes being enacted” (Saunders et al., 2000). Case studies include observations, interviews and even analysis of the data. As it will be explained below, this research is completely relying on the use of secondary data in form of case studies.

### 3.3 Case study strategy

Case study research method has been indispensable in medicine and law research since ancient times. It was adapted by the other scientific fields, and mostly associated with situations when “the phenomenon under investigation is difficult to study outside its natural setting and also when the concepts and variables under study are difficult to quantify” (Ghauri and Grönhaug, 2005). We have consulted literature sources, which performed similar research on business process quality methods, and relied on case study analysis (Yusuf and Aspinwall, 2001, Motwani et al, 2005, Firka, 2010). Thereafter we have investigated Yin (2003) guidelines on selection of research strategy. He wrote that this choice depends on the following conditions:

(a) the type of research question
(b) the control an investigator has over actual behavioral events
(c) the focus on contemporary as opposed to historical phenomena

Research questions can be for example “who, what, where, how much, how, why”. Yin explains that if the research seeks to answer questions “how and why”, then it definitely should be performed as the case study research. In our case, instead of research question we have problem formulation and purpose of work. Both of them can be formulated as “how and why did the business process quality management methodologies evolve”.

Regarding the last two conditions, only experiment allows to have control over events. By the degree of involvement of past events, this research is closer to archival analysis, history and case study. Archival analysis is more related to statistical analysis. It does not show behavioral aspects, which we need. History is close to what we need, but it deals with the past events only and does not describe behavioral aspects in such extent as required. Only case study research describes contemporary events, behavioral aspects and can even be considered similar to observation of an experiment. It presents information about whole process of implementation from start-to-end, encountered obstacles, implications etc. Therefore case study research was the most favorable framework and strategy.
However type of research strategy always lean toward choice of research design, which can be explanatory, exploratory, descriptive and causal. In the next step we examined these four options. Causal design was definitely not applicable, because it is related to experiment and “cause-and-effect” problems, when cause is known and it is necessary to evaluate effect of it. In our case we don’t have that “cause” at hand, but we need to get it and explain. Descriptive design was close, but did not fit either, because our aim was not to describe the methods, but to find relations between them. Exploratory research was characterized by Ghauri and Grönhaug (2005) as “When the research problem is badly understood a (more or less) exploratory research design is adequate”. Our problem was not badly understood, it was rather too broad and unfocused. Finally Yin (2003) explained that when “why and how” questions are inbuilt into the research, then explanatory design is the most suitable.

Also, only explanatory case study research based on the data from multiple case studies was suitable for our needs because it combined answers to “how” and “why” questions with observation of contemporary events over which investigators have little control. Further we implemented case study research framework proposed by Yin (2003), which consists of 5 components:

1) Study questions
2) Its proposition, if any
3) Its unit of analysis
4) The logic linking data to the propositions: and
5) The criteria for interpreting the findings.

We are clear about the questions, which were described above. The second component describes theoretical proposition of the problem. This we have done in the first two chapters dedicated to the literature overview. This sets the plan and direction of the research.

By summing up theoretical characteristics of the methods, we outlined four most important factors. The analysis should examine which of these factors had the biggest influence on the development of the business process quality methods. Therefore the units of analysis are three methods and their four characteristics: quality improvement, process orientation, problems addressed and implementation characteristics.

Yin describes 4 models of case study researches, as a combination of single and multiple cases, holistic and embedded. Multiple-case model suits nature of our research, because we have several case studies. Embedded model suits better than holistic, because the analysis is not general, but variable-specific:

- three units of analysis: TQM, LSS, BPM
- each unit includes 4 subunits-characteristics: quality improvement, process orientation, problems addressed, implementation

Among the methods of linking data to theoretical proposition, the most suitable was “Logic model”. Yin described it as “The logic model deliberately stipulates a complex chain of events over time. The events are staged in repeated cause-effect-cause-effect patterns, whereby a dependent variable (event) at an earlier stage becomes the independent variable (causal event) for the next stage”. This model will allow us to show how imperfections of one method led to the need for a new method, which consequently became less effective and was transformed into another. The data collection will be specially designed for this purpose, and will be described in more details below. The criteria for interpreting the findings are presented below in reliability and validity chapter.

We were considering both data collection methods: quantitative and qualitative. Quantitative data is very useful in many cases, but for this research strategy was not enough to have statistics. To answer questions “why and how”, we needed description of the whole “experiment”. Therefore we used qualitative data. Direct observations were out of scope of this research, questionnaires, surveys and interview would not provide the whole picture. Such data could be rather compared with a collection of separate points,
interpolated into a complete image. Only the case studies would give the most comprehensive view on the problem, because they “cover contextual conditions” (Yin, 2003). Case studies also include wide range of qualitative and quantitative data: interviews, questionnaires, observations, financial reports. Eisenhard (1989) suggested the number of cases between 4 and 10. The reason for this is that cases less than 4 will not provide sufficient amount of information, and more than 10 will be difficult to overcome high volumes of data. In our cases we decided to take 6 cases, 2 for each methodology (TQM, LSS and BPM). She also recommended that for the best success of case study analysis, researcher should analyze cases of polar types. Ideally, one case should demonstrate extreme success, and another extreme failure. Such contrast provides better options for comparing within group similarities and between group differences (Eisenhardt, 1989). It would almost visually demonstrate factors that led to fading away of one methodology and emerging need of a new better next-generation methodology. Unfortunately in our research we did not succeed to find negative cases except for some case studies related to BPR failures.

Therefore by selection of case studies for this research we considered following factors:

- Cases should belong to service and manufacturing industry (polar cases)
- Cases should have all the details of methods implementations
- Cases should show some patterns

### 3.4 Case study selection

Although there exists a plethora of case studies about each of the method, it was challenging to find such case studies that would satisfy all our criteria:

- Cases should reflect 3 units of analysis: TQM, LSS and BPM methods.
- Each case should contain description about each of subunits: quality improvement, process orientation, problems addressed, implementation.
- Cases from different industries: service and manufacturing. The decision was taken to take 1 case study from manufacturing and 1 from service industry. It was relatively easy to find LSS cases for both industries. Although LSS in manufacturing prevailed, we managed to find case study in financial department. It was nearly impossible to find BPM implementation in manufacturing. Therefore instead of that we accepted case study in healthcare industry, where implementation was close enough to how it could have been implemented in manufacturing. TQM was traditionally implemented in manufacturing, and it was not possible to find any good case from service industry that would satisfy other criteria.
- Cases should have all the details of methods implementations. Most of the case studies were too vague and general, describing problem formulation and achieved results only. Again, it was easier to find detailed cases for LSS, than for BPM and TQM. Maybe because of too vague TQM methodology, case studies did not describe details of implementation. In contrast to that, both LSS cases had an excellent quality of description. BPM cases had high quality of details too.
- Cases that show some patterns. We reviewed a number of case studies, and our selection is representative for the whole group of case studies for a particular method. The selected case studies were more detailed, but otherwise they followed pattern in the same method/industry.

Totally we considered:

- TQM – 22 case studies. From which we selected 2 manufacturing case studies. One at Sona Koyo Steering Systems (SKSS) Limited India and one at UK automotive SMEs.
- LSS – 18 case studies. We selected 1 manufacturing case at ZadePack, Brazil. And 1 service case at financial service improvement in City Government in Ohio USA.
- BPM – 23 case studies. Both cases belong to service industry. Selection was made in favor of a case study at Credit Suisse Swiss bank. Another case study was taken from healthcare service describes business process reengineering, which we considered to be close enough to example of BPM implementation.
Reliability and validity

Reliability of research can be tested if another study, conducted on the same conditions, will gain the same results. It could be equivalent to assessing that another measure would gain the same results, and other researchers would make similar observations (Saunders et al., 2000). General critics of the case study research emphasize the fact that too often case studies provide too vague theory, often influenced by observer bias. Another risk is that process of research can be poorly documented, and later researcher will not follow the same way. Yin (2003) suggests two tactics to minimize this threat: use case study protocol and develop case study database. The protocol is a “cookbook” of the research: who, when and how will prepare the data. Case study database might contain a variety of data sources: documents, archival records, interviews etc. In our case, the data was collected from the case study articles, which can be found in the list of references. Theoretical sources are also listed there.

Validity is a measure of how analysis and findings are representing the real situation. Yin (2003) stated that validity consists of: construct validity, internal validity and external validity. Construct validity is ensured if the research is correctly performed and is free of subjective bias. This can be achieved by:

- Be clear and specific about the problem being studied, objectives, units of analysis etc
- Check that the measured changes really have influence on the evolution process
- Use multiple source of evidence
- Research should reflect real findings, not investigators impressions

Internal validity is related to spurious conclusions about causal relationships (Yin, 2003). We made inferences through the chain of evidence and had to make sure that the conclusions drawn during causal analysis were correct. To address this, we considered other contrasting rival explanations. For example, “Was the change in a particular condition X accountable for evolution of one method into another? Was there anything else that had bigger influence?”

External validity tests if the findings are not too specific and can be generalized to larger sample (Saunders et al., 2000, Yin, 2003). On the one hand, it might seem attractive to include as much data as possible into the research. But the risk is that overwhelming amount of information might delay the research and even mislead the analysis. It is more reasonable to concentrate around the most important variables. Therefore we intentionally limited amount of methods and their parameters. On the other hand, the collected data could be very specific and related to some unique situation. We reviewed 63 case studies, and can ensure that they were not specific to any particular phenomenon. They described similar situations, but implementations of the methods were performed in different environments. Another way to check validity was comparing cases with theory. If cases deviated too much from proposition, then it would mean that either theory was wrong (too many cases differed from theory). Or those cases were describing some particular situation (if majority of cases were in accordance with theory, but only single cases differed). Therefore our findings, supported both by theory and data, are not specific to any country, company or particular implementation. They are global, cross-industry and implementation independent.

An additional criterion of validity was ensuring that we strictly followed the logic of linking data to the theory. For example, we removed “strategy” as a subunit of analysis. One reason was that our collected data, i.e. case studies, did not provide enough of evidence. Although the aspect of strategy was extensively discussed in the literature and some case studies (Jeston and Nelis, 2006, Breja et al, 2010, Motwani et al., 2005), because it is an important characteristic of TQM and BPM methods, it was not observed in the same extent in LSS. And since linkage between data and theory would be too vague, we decided to leave it outside the scope. Another reason was that this is a more profound area of research, which needs separate and more dedicated investigations. In case if we would make such research, it might have provided measurements of how successful were the methods with or without strategy inclusion. What benefits were achieved when strategy implementation was supported by business process quality methods? In other words, such research would have another focus.
4 Analysis of Case studies

In this chapter we will present and review six case studies. In the concluding chapter we will present cross-study analysis as an explanation on relationship between the quality methods.

4.1 Total Quality Management (TQM)

4.1.1 Case 1: Quality Strategy for transformation

In this case study, authors Breja, Banwet and Iyer (2010) studied TQM implementation at auto parts manufacturing company Sona Koyo Steering Systems(SKSS) Limited India. SKSS is a technical and financial joint venture of JTEKT Corporation (created by merge of Koyo Seiko Company and Toyoda Machine Works, http://www.jtekt.co.jp/). Products of SKSS include complete steering systems, hydraulic and electronic power steering systems, and driveline products including case differentials, axle components, rear axle assemblies and other parts for medium utility vehicles in India. Their clientele include such companies as Hyundai, Tata Motors, Toyota, General Motors and several others. It was established in 1985. By 1998 it was named as “global growth company” by World Economic Forum (WEF).

Despite all the success, sometime around 1997-1998, SKSS experienced crisis due to low net profit and massive supplier returns. This situation convinced the top management to start their TQM journey in a three phase strategy. Changes and improvements came slowly but steadily, and by 2003 it became the first steering system production company to with Deming Application Prize (DAP). DAP is awarded to the organizations that succeed in implementing TQM (JUSE, 2011)

Major aspects of TQM implementation

SKSS started their TQM implementation in 1997. It was decided to implement TQM using a three phased strategy. These three phases were following:

- Retainment
- Improvement
- Breakthrough

TQM doesn’t provide a step by step guide of its implementation; therefore SKSS formed their own three steps as described above. Once the steps were outlined, various tools and techniques were placed into appropriate phases. At early phases, i.e. around 1997-98, SKSS implemented simple techniques such as 5S, Poka Yoke, Visualization, Kanban etc. The influence of Lean manufacturing and Toyota Production System (TPS) are visible at early TQM implementation stages.

Later on, SKSS moved on to more comprehensive tools for improvements. Gap analysis, 7QC tools, Kaizen, Just-in-Time (JIT) is few of the advanced tools that were used over period of years to drive improvement. They also used some unique initiative such as “quality gate 20” and “high-volume production trial (HVPT)” for design and production of new products as part of their TQM framework.

Results

The results of TQM implementation at SKSS speaks for themselves. Between 2003 and 2007, SKSS experienced 100% or higher growth in production and sales of all steering system products. They witnessed similar improvement in process performance and dramatic decrease of cycle time in production. In best of the times, 44% of total sales at SKSS came from new products. This is higher than such innovative companies like 3M. Table below is taken from SKSS balanced scorecard describing TQM affected areas of improvement:

23
Table 4-a Balanced scorecard SKSS (Breja, Banwet and Iyer, 2010)

There were clear improvements in customer processes. And there was consistent improvement in return on capital employed (ROCE) and decrease in customer returns. The authors also stressed that TQM initiatives have led to improvements in management processes and strengthened their domestic market position. Due to other economical disturbances, SKSS failed to capture sufficient amount of international market.

Authors stressed the importance of aligning quality strategy with the business strategy as a key factor in any TQM implementation. The case of SKSS shows a success story following such alignment.

In 2003, SKSS released their vision for 2010 as following:
- To make SKSS a partner of choice to global customers
- An organization of energized and involved employees
- Growing & achieving high profitability
- Supplying to major global OEMs directly or indirectly
- At least 45% of the sales are to overseas customers.
- Continue to be no. 1 steering systems company in India

Right after the release of vision, they also released their 10 step strategy plan. One of the ten steps of strategy plan was **excelling through TQM**. This clearly indicated that the top managers at SKSS were satisfied with TQM implementation and considered it of strategic importance.

### 4.1.2 Case 2: TQM implementation in UK automotive SMEs

In this case study, we attempt to use findings from case study research done by Yusuf and Aspinwall (2001). The authors identified major aspects of TQM implementations in four companies manufacturing automotive parts, located in UK, suppliers to the major car manufacturers Honda, Nissan, Rover, Jaguar etc. The table below gives a short description of each company:

<table>
<thead>
<tr>
<th>Case company</th>
<th>Main products</th>
<th>Number of employees</th>
<th>Year started TQM</th>
<th>Certifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Wire harness</td>
<td>90</td>
<td>1990</td>
<td>ISO 9002, IIP, QS 9000</td>
</tr>
<tr>
<td>B</td>
<td>Interior trim</td>
<td>160</td>
<td>1992</td>
<td>ISO 9002, Ford Q1</td>
</tr>
<tr>
<td>C</td>
<td>Metal pressed – seat belt components</td>
<td>150</td>
<td>1995</td>
<td>ISO 9002, QS 9000</td>
</tr>
<tr>
<td>D</td>
<td>Different types of springs</td>
<td>112</td>
<td>1990</td>
<td>ISO 9002, IIP, QS 9000, Ford Q1</td>
</tr>
</tbody>
</table>

Table 4-b Characteristics of case companies(Yusuf and Aspinwall, 2001)
The major challenges that the companies were facing were inefficient processes and high defects in end product. The questions that Yusuf and Aspinwall(2001) tried to answer in their cases studies, were following:

- How was TQM implemented by the companies?
- Why a particular approach was chosen?

We believe these questions fit well into our thesis work and hence the results of this case study were analyzed thoroughly. It also indicates how undefined the term TQM is; because all four companies working in a similar industry has managed to implement TQM in various ways. By maturity of their TQM implementation, the companies were classified into two broad categories: “TQM” company and “Less TQM” company.

Major aspects of TQM implementation:

Out of the four companies, only company D had a quality program embedded into their company strategy and hence making it everyone’s responsibility. In the other three, dedicated personnel were placed in quality department. However the number of personnel responsible for quality assurance was very few. The table below shows difference in number of quality personnel in each company:

<table>
<thead>
<tr>
<th>Company</th>
<th>Total employees</th>
<th>Manufacturing employees</th>
<th>Quality department employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>90</td>
<td>45</td>
<td>8</td>
</tr>
<tr>
<td>B</td>
<td>160</td>
<td>120</td>
<td>5</td>
</tr>
<tr>
<td>C</td>
<td>150</td>
<td>90</td>
<td>5-6</td>
</tr>
<tr>
<td>D</td>
<td>112</td>
<td>Not defined</td>
<td>Not defined</td>
</tr>
</tbody>
</table>

Table 4-c Employees division per company

The table above illustrates that in company A, B and C, daily quality assurance responsibility was within manufacturing. Company D did not have quality department as such.

According to the authors, while implementing TQM as a framework the companies took initiatives that can be categorized into two approaches: hard and soft. Hard aspects included various quality tools and techniques. Soft aspects included human and motivational aspects that create quality awareness amongst employees and can transform company culture. The authors tried to identify what hard and soft aspects of TQM implementation existed in each company.
The tables below summarize the findings on hard and soft aspects implemented at each company:

### Table 4-d Hard aspects of TQM implementation

<table>
<thead>
<tr>
<th>Activity</th>
<th>A</th>
<th>Number of years</th>
<th>B</th>
<th>Number of years</th>
<th>C</th>
<th>Number of years</th>
<th>D</th>
<th>Number of years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced quality planning</td>
<td>Yes</td>
<td>10</td>
<td>FMEA, Taguchi methods, Poka Yoke</td>
<td>1</td>
<td>Yes</td>
<td>4.5</td>
<td>Yes</td>
<td>8</td>
</tr>
<tr>
<td>3M (mura, muda, muri) and SS</td>
<td>Yes</td>
<td>7</td>
<td>Not yet, but training in progress</td>
<td>Informal</td>
<td></td>
<td>Yes</td>
<td>9-7</td>
<td></td>
</tr>
<tr>
<td>Simple techniques 7 tools</td>
<td>Yes</td>
<td>4-5</td>
<td>Yes</td>
<td>&gt; 5</td>
<td>Yes</td>
<td>4.5</td>
<td>Yes</td>
<td>12</td>
</tr>
<tr>
<td>Statistical process control</td>
<td>Yes</td>
<td>10</td>
<td>No</td>
<td>Yes</td>
<td>5</td>
<td>Yes</td>
<td>5</td>
<td>Yes</td>
</tr>
<tr>
<td>Quality costs system</td>
<td>Not formal</td>
<td>3</td>
<td>Yes, computerised percentage of overall manufacturing costs</td>
<td>1</td>
<td>Yes</td>
<td>5</td>
<td>Yes</td>
<td>7-8</td>
</tr>
<tr>
<td>Customer service identification system</td>
<td>Yes</td>
<td>10-15</td>
<td>Yes</td>
<td>1</td>
<td>No</td>
<td>Yes</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Customer satisfaction measures</td>
<td>Yes</td>
<td>4</td>
<td>Yes</td>
<td>1</td>
<td>Yes</td>
<td>5</td>
<td>Yes</td>
<td>7-8</td>
</tr>
<tr>
<td>Supplier development and partnership programme</td>
<td>Yes</td>
<td>6</td>
<td>Not yet, next major project</td>
<td>Yes</td>
<td>2</td>
<td>Yes</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>QA system</td>
<td>Yes</td>
<td>20</td>
<td>Yes, ISO 9000 and now QS 9000</td>
<td>&gt; 10</td>
<td>Yes</td>
<td>5</td>
<td>Yes</td>
<td>15</td>
</tr>
<tr>
<td>Systematic training and education system</td>
<td>Yes, ILP</td>
<td>5</td>
<td>Yes, now developing ILP</td>
<td>1</td>
<td>Yes</td>
<td>5</td>
<td>Yes, ILP</td>
<td>5</td>
</tr>
<tr>
<td>Self-assessment</td>
<td>Yes</td>
<td>2</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Data collection and measurement system</td>
<td>Yes, computer-based</td>
<td>4-5</td>
<td>Yes</td>
<td>2</td>
<td>Yes</td>
<td>3.5</td>
<td>Yes</td>
<td>7-8</td>
</tr>
<tr>
<td>Benchmarking</td>
<td>Not indicated</td>
<td>Yes</td>
<td>&gt; 1</td>
<td>Not indicated</td>
<td>Not indicated</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 4-e Soft aspects of TQM implementation

<table>
<thead>
<tr>
<th>Activity</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establish communication links management and employees</td>
<td>Yes, about 5-6 years</td>
<td>Yes, already several years</td>
<td>Yes, daily production meeting</td>
<td>Yes, about 10 years</td>
</tr>
<tr>
<td>Suggestion schemes</td>
<td>Not formalised</td>
<td>No</td>
<td>Not formal</td>
<td>Yes, about 8 years</td>
</tr>
<tr>
<td>Job rotation</td>
<td>Yes, about 5 years</td>
<td>Yes, but limited</td>
<td>Yes, operator level</td>
<td>Yes</td>
</tr>
<tr>
<td>Company newsletter</td>
<td>Monthly, now in 4th year</td>
<td>No</td>
<td>Yes</td>
<td>Monthly, now in 10th year</td>
</tr>
<tr>
<td>Regular meeting with employees</td>
<td>Monthly, already 5 years</td>
<td>Monthly</td>
<td>3 monthly</td>
<td>Monthly, 6 years</td>
</tr>
<tr>
<td>Internal promotion</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes, has always been the practice</td>
</tr>
<tr>
<td>Time-off for hospital appointments</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Multi-skilling</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Team problem solving</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes, 8 years</td>
</tr>
<tr>
<td>Reward and recognition</td>
<td>Not formalised</td>
<td>No</td>
<td>Not formalised</td>
<td>Yes, 12 years</td>
</tr>
<tr>
<td>Non-designated parking space</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Interestingly, many activities described in the hard aspects are tools and techniques that can be found in the other disciplines, such as Lean and Six Sigma. The tables above also make clear that only company D had implemented almost all hard and soft aspects of TQM. Company A had also implemented almost all aspects. Therefore the authors concluded that companies A and D were more advanced in using quality tools, statistical process control and quality assurance systems than companies B and C. This was
particularly obvious in case of company D, which had comprehensive implementation of both soft and hard TQM factors.

**Results**

In order to find results of TQM implementation, the company products were analyzed using Defects per million indicators. Company B had achieved 20% reduction of defects in parts per million (ppm). Company C managed to reduce defective parts from 5000 ppm to less that 500 ppm, which corresponds to 90% reduction. Company D showed the best result of 92% reduction of defective parts by going from 5661 ppm to 478 ppm in just one year. Company A couldn’t provide such data. The results are varying, but at the same time comparable.

The differentiator for successful implementation has been following aspects:

- Long term experience and multiple initiatives
- Top management engagement. In company D, all top managers were engaged in driving TQM implementation.
- Striving towards quality certifications as QS9000, ISO 9000 etc.
- Emphasis on customer satisfaction.
- Self assessment: TQM based self assessment allows companies to continuously keep track of their current TQM status.

4.1.3 Analysis of TQM case studies

The presented above two case studies originate from the auto parts manufacturing industry. They have many similarities, but many differences as well. Especially in three aspects: cultural differences, size of the companies, differences in implementation of TQM.

The first case study describes an Indian company, and the second presents four English companies. Indian company has performed more in-depth TQM implementation and incorporated it into the strategy. They have put more efforts into their TQM program, and achieved bigger results. By contrast to this, for English companies implementation of TQM was not the main purpose. It was rather implemented as a framework for quality improvement initiatives. In 3 of 4 companies a dedicated quality control department existed with 5-8 persons. In one company it corresponded to 10% of total personnel. This indicated that quality issues were rather responsibility of the quality department, but not everyone’s responsibility.

Apart from the cultural differences, there were differences in size of the companies. The first case was from a big international company, and the second was from four small companies, where number of employees did not exceed 160 persons.

Regarding implementation, it was already described in the theoretical part, that TQM suffers from lack of definition, structure, metrics, defined methods and tools. It was noticed by Pepper and Spedding (2010), that TQM is a profound and all inclusive philosophy. Both case studies confirm this. Only 5S was used by both companies. Choice of tools of the first company was influenced by Lean and TPS. They used PokaYoke, Visualization, Kanban, Kaizen, Just-In-Time, 7QC, gap analysis, etc. The second company used: ISO9000, QS9000, 3M, Quality cost system, QA system, Customer need identification and satisfaction measures, etc. Moreover, the English companies didn’t limit TQM to purely mechanical quality improvements. They included human and motivational activities into their programs, such as: establishing communication links between management and employees, suggestion schemes, internal promotion, team problem solving, job rotation, etc. Although Indian companies didn’t make special emphasis on these aspect, their results indicated that participation of employees in the decision making process has increased via increased number of suggestions per employee (from 2 suggestions/employee in 1997 to 29 in 2006). Training per employee has also increased from 36 to 75 employee/hours.

As for results, in both cases companies doubled their production, decreased defects by 10 times, and significantly decreased cycle time. The first company had more tangible results and boosted innovation.
4.2 Lean Six Sigma (LSS)

4.2.1 Case 1: An application of the "5S" Technique in manufacturing.

This case study presents implementation of LSS at a Brazilian company ZadePack. This was a small company with less than 100 employees, specializing in manufacturing of packaging material. Namely, it produced a thin film of plastic, which was used for covering plastic cups and other packaging of food. The company had problems with variations in the thickness of the plastic film, which was caused by variations and problems in entire production process. Eventually it caused waste in production, variation in the quality of end product and financial losses.

The company had made huge investments in expensive machinery that were underutilized. The project had to identify the full capability of the processes and give projections to management on how much production capacity they had at any time. Lean principles focus on identifying process capabilities and proper resource utilization. The company didn't have a formal data collection process or an inventory keeping process. As a result, company management culture has always been reactive. Any deviations from usual have been considered to be special cases. The project identified the need for a proper measurement system that would differentiate special case variations in processes and also common variations. This would support the management team in creating quality awareness. Six Sigma helped to identify this need for fact based and data based decision making.

Last but not least, consumer satisfaction had been an issue. The company has been receiving large orders from major companies; and therefore needed to secure consistent quality production. As a test, the team took a sample of 12 rolls of plastic films to identify the rate of defects. All of the twelve films were defective. According to Six Sigma metric of Defects Per Million Opportunities (DPMO), the company had DPMO of 1 million. Companies operating at Six Sigma level could have only 3 DPMO.

The facts above made it clear to the project team and company management that they needed to run a full scale Lean Six Sigma project. The project team along with company management considered the consequences of not doing the project. The consequences were very clear: the company will be out of business in near future. This highlighted to management that this project had to have the highest priority over all other projects and activities ongoing at that time. The company decided to conduct a project using five stages from the Lean Six Sigma methodology, ie DMAIC (for details about DMAIC please see Appendix B). Five phase of their LSS project are outlined below.

Major aspects of LSS implementation

Define phase
In this first phase of the project, the project team tried to answer basic questions described below:

- Which process needs to be analyzed and improved? With this question, the team narrowed the scope of the project at a very high level. This is indeed what LSS methodology suggests, to do focused improvements project by project.

Once the team understood what process needed improvement, they tried to answer:

- Why were they doing the project? The purpose was to identify benefits to be achieved from the project. They identified couple of problems that can be addressed in the project.

One of the main problems was waste of materials caused by rework in production due to variations in plastic thickness. This problem immediately made it clear that they needed to eliminate waste in their production process. A focus area of Lean manufacturing process is to eliminate wasteful activities in processes. Elimination of waste would also positively influence the cost, quality and competitive aspects of their production.
Another two activities of this phase were using more of Lean concepts to better understand the scope and challenge of the project. The tools used were SIPOC analysis and Voice of Customer (VOC) analysis. SIPOC stands for Supplier, Input, Process, Output and Customer. SIPOC analysis allows seeing relations between processes by placing every interacting unit in place of customer or supplier. Voice of customer analysis shows what exactly a customer wants from a company.

**Measure phase:**
Next stage of the project according to LSS method is called the Measure phase. At this phase, the project team tried to obtain maximum amount of quantifiable data on the problem areas identified in first phase (Define) of the project. At this phase, the project team did three things:
- Designed an experiment to identify product quality
- Identified criteria of success and failure of experiments
- Conducted multiple experiments based on above design for analysis.
LSS has various tools that allow practitioners to design experiments in structured manner and thereby receive trustworthy data for analysis. Design for Six Sigma is one such tool.

**Analysis phase:**
Analysis phase is considered to be one of most challenging phases in any LSS project. From the data collected in Measure phase, ZadePack project team identified base line performance and made multiple hypotheses on possible reasons behind failures in production process. They conducted comprehensive statistical analysis of the data using such tools as regression analysis, Gage R&R study on variables, Analysis of Variation (ANOVA) etc. Everything was done in accordance with methodical steps within LSS methodology.

At the end of this phase, the project team had three hypotheses on how to eliminate the problems identified at the first phase of the project. The hypotheses were following:
- Employees need more in-depth and frequent training to decrease the number human driven mistakes. Their analysis revealed that majority of mistakes was done by human causing variation in final product.
- Materials used in production needed better tagging. Analysis revealed that proper tagging process was missing; as a result old and new materials were used in combination.
- The tagging of production materials needed to be more accurate and properly visible. This will help the employees to find the necessary right material in right time, thus increasing the speed of production.

**Improve phase:**
Improve phase consists of implementation of changes and viewing change in performance. The project team suggested the use of 5S technology to make changes to the workplace. 5S is a Lean tool which stands for Sorting, Storing, Shining, Standardizing and Sustaining. It is a five step improvement method that can be used to improve production process. Since the Analysis phase identified the problems with sorting and tagging of production materials, the project team created a plan for implementation of 5S.

The management was convinced and a pilot implementation was launched. The entire implementation was done within one week. Measurements of process performance were taken before implementation and after. They showed that the process capability, i.e. production capacity, doubled after the implementation was done.

**Control phase:**
The last phase of the LSS project is called Control. In this stage the project members work on sustaining the result that they have achieved. Once again, ZadePack project team decided to use some Lean concepts such as Poka Yoke (also known as mistake proofing). Using Poka Yoke, faults can be identified early enough so that they wouldn’t affect the production process.
They also implemented a 4 step control plan, known as PDSA: Plan, Do, Study, Act. This is also one of fundamental tools used in Lean. PDSA provides a quick way of eliminating problems.

**Results**

In the result of the described above LSS project, ZadePack benefited with more 100 000 USD in annual savings on raw materials, decreased number of defects, increased quality of the end products, production capacity and improved customer satisfaction.

### 4.2.2 Case 2: Financial Service Improvement in City Government

This case study describes the implementation of Lean Six Sigma in the financial administration department of State of Ohio city government. The case study was performed by Furterer (2009). The case study displays systematic step by step usage of various LSS disciplines to reach a goal of strategic importance. The main problems addressed were inefficient processes in a financial service department. The process problems resulted in inaccuracies in payments, delays in financial transactions and too many errors in financial statements. Main goals of the projects have been to streamline the financial process, reduce the cycle time by implementing Lean Six Sigma practices. The results of the project were tangible and sustainable.

The City Government has a complex structure. The city is managed by a city manager who reports to mayor and implements mayors instructions. Finance director reports to city manager and is responsible for budgeting and maintaining financial processes. Finance processes include following:

- Accounts payable
- Accounts receivable
- Monthly reconciliation
- Budgeting

The mentioned above processes were inefficient, error-prone, ineffective and contained large amount of non-value added activities. Considering all the factors, financial director decided to implement Lean Six Sigma project and use its problem solving methodology to eliminate the process inefficiencies.

**Major aspects of LSS implementation**

**Define Phase:**

The goal of this phase was to define the need for improvement of current financial processes, identify all stakeholders and create a project charter. LSS uses project charters early in the projects to identify some key factors describing the project. This is done by using a simple structure for easy understanding. Project charter stays unchanged until the end of the project. The project team had identified the following:

- Problem statement: need for streamlining of existing processes. This need is strengthened by complaints from line organization requesting more personnel. Vendors have complained that they received payments too late. Revenue receipts were not processed in time causing volatility in financial figures. Payroll processing time ranged between 13 and 70 hours, and contained errors highlighted by employees. Monthly reconciliations were not done regularly.
- Customers and stakeholders: Financial departments, city department, vendors and other governmental agencies.
- Critical to Satisfaction (CTS) for customers: Accuracy and timeliness.
- Goal of the project: to streamline process, reduce the cycle time, improve quality and accuracy.

An important aspect of Define phase is conduction of stakeholder analysis. It describes who is affected by LSS implementation and how are they affected. According to LSS, it is crucial to conduct this at the early stages of the project in order to make sure that right individuals are used in the project.
The goal of the project was closely tied with improvement of processes, and LSS suggests having high level process description at early stages of project. The tool used for this purpose is called SIPOC (Supplier, Input, Process, Output, Customer). SIPOC helps to identify high-level process steps affecting the scope of the project and also highlights how the identified stakeholders are affected by inputs/outputs of the processes. A diagram below shows the SIPOC map identified by the project team.

<table>
<thead>
<tr>
<th>Suppliers</th>
<th>Inputs</th>
<th>Process</th>
<th>Output</th>
<th>Customers</th>
</tr>
</thead>
<tbody>
<tr>
<td>City employees</td>
<td>Time reports</td>
<td>Payroll</td>
<td>Checks, pension reports, taxes paid</td>
<td>City employees, taxing authorities, state, county</td>
</tr>
<tr>
<td>Vendors, city employees</td>
<td>Invoices, requests</td>
<td>Accounts payable</td>
<td>POs, checks</td>
<td>Vendors</td>
</tr>
<tr>
<td>State, county</td>
<td>Checks, direct deposits</td>
<td>Accounts receivable</td>
<td>Funds available or invested</td>
<td>City departments</td>
</tr>
<tr>
<td>City departments</td>
<td>Financial transactions, receipts, checks, invoices, bank statements</td>
<td>Monthly reconciliation</td>
<td>Balanced accounts, adjustments, financial reports</td>
<td>Finance director, council</td>
</tr>
<tr>
<td>City departments</td>
<td>Budgeting needs</td>
<td>Budgeting</td>
<td>Budget, appropriations</td>
<td>Council and citizens</td>
</tr>
</tbody>
</table>

Table 4-f SIPOC map (Furterer , 2009)

The SIPOC map has strengthened the need for process improvement. The project members also created a project plan and some ground rules to be followed during the project.

**Measure phase:**
The goal of the Measure phase was to get better understanding of the current status. Project members worked on understanding and documenting of the processes that required improvement. While doing so, they also identified the problems, errors and possible root causes. As any other phase of the DMAIC methodology, it contains various tools and procedures that the project members followed.

The first step in this phase was identification of the current state of the processes. Therefore the project team used standard flow chart analysis to map how the processes were implemented. These flow charts depicted steps in various activities done within the financial department processes.

LSS suggests that every process has to have some metrics. When processes were drawn by the team, it was realized that no metrics existed at that time. This was a crucial finding, because this meant that it would be extremely difficult to assess the implications of process improvements done by the project. Therefore, the quality expert within the project team decided to estimate current process performances as next best solution to process metrics.

At the measure phase, it is also essential to identify what the customers want. The tool used for this is called Critical to Satisfaction (CTS) tree. It helps to identify all the customer needs and which are the most critical. The project team identified three CTS: Cycle time, Accuracy of the process, Customer satisfaction.

Identification of CTS raised the question of how the data for CTS will be collected. Each of the CTS had relation with various processes and had multiple metrics attached to them. Therefore the team created a Data Collection Plan. For example, in order to identify customer satisfaction, the team devised a survey done on regular basis. Data collection plan is crucial at this stage because it provides data required at the
later stages of project for analysis and projections on problems. Closely related to the data collection plan was the question of what type of data to collect. Two key LSS tools were used:

- Voice of Customer (VOC), describes what customers want
- Voice of Processes (VOP), describes what processes want

By knowing what customers and processes need allowed the team to identify what data to collect. Most of the data for VOC and VOP was collected through surveys. For example, one result of VOC revealed that customers (citizens of the city and vendors) were unsatisfied with too many transactions between them and city financial departments. Various other data were also highlighted as important, and sorted in descending order by importance to customers (citizens or vendors), for example:

- 80% of vendors didn’t receive payments in time
- 80% of vendors complained on customer service
- 88% of city employees had negative experience finance department

Through extensive process analysis, the project team identified what the processes needed to function so as they were designed. They found immediate relationships between CTS and process factors. It also allowed the project team to set a target on the CTS. For example, accuracy of processes was mainly affected by training of personnel and required at least 95% accuracy to meet the customer expectation.

**Analyze phase:**
The aims of this phase were following:

- Analyze the problems and collected data
- Conduct cost and benefit analysis of the improvements suggested at the end of this phase

One of the most used Lean tools for analysis and depiction of process problems is called “cause and effect diagram”. There are many ways to create a cause and effect diagram. The project team used combination of the earlier created process diagrams and various other Lean tools (such as waste identification, 5S, 5 Whys) to identify process problems. And to identify root causes they used cause and effect analysis.

Cause and effect analysis revealed four categories of defects causing process inefficiencies: people, hardware, methods and information technology. Each category had various subcategories. For example, the team identified that lack of training and computer skills amongst the people working at financial department added inefficiency to the processes. This analysis helped the project team to identify where to put their efforts. Through a prioritization matrix, they realized that bureaucratic culture and lack of training were the top contributors towards inefficient processes. These two factors were followed by antiquated technology and lack of standard procedures. Now the team was aware of the root causes and also the priority on each cause.

Another part of the analysis phase was Process analysis. The project team conducted in depth process analysis for accounts payable, accounts receivable and monthly reconciliation processes. The findings were following:

<table>
<thead>
<tr>
<th>Process</th>
<th>Value added percentage of activities</th>
<th>Nonvalue added percentage of activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounts payable</td>
<td>39%</td>
<td>61%</td>
</tr>
<tr>
<td>Accounts receivable</td>
<td>14%</td>
<td>86%</td>
</tr>
<tr>
<td>Monthly reconciliation</td>
<td>7%</td>
<td>93%</td>
</tr>
<tr>
<td>Payroll</td>
<td>17%</td>
<td>83%</td>
</tr>
</tbody>
</table>

**Figure 4-a Value analysis of processes (Furterer, 2009)**
Monthly reconciliation process was the worst one with only 7% of activities adding real value to the process. The analysis above just stressed the immense need and possibility for improvement.

Improve phase:
The aim of improve phase is to implement improvements and track changes. If the improvements were successful, then it would be necessary to educate personnel with the changes. The project team made following suggestions for process improvement:

- Standardization of Processes and Procedures: prior to start of the project, no standard processes or procedures existed.
- Kanban and Visual control: Kanban is a Lean tool, which helps to improve of how to do something and when to do it. For example, before the project all files sent to finance director were sent together. By implementing Kanban, different kinds of documents had different colors and colored boxes for storage. This made it easier to find and sort.
- Waste elimination: massive amount of work time was wasted by employees in printing documents that were never used.
- One piece flow: one piece flow is a Lean concept which suggests reduction of batch size to one piece or very small units to make process flow faster. By applying one piece flow, the account receivables department did not need to wait for large amount of invoices to be ready and then send them out. They could send them out immediately when ready.

Additionally, the project has identified need for information system. It was evident that more automation was necessary. There were suggested four alternative scenarios for development of IT systems.

The team has also provided a future state process map. The initial map that was drawn in Measure phase was redesigned by removing wasteful activities.

Control phase:
The aim of control phase is to measure process performances and sustain developments done in Improve phase. The project team made a measurement of process after all improvements were implemented. Below is what they discovered:

<table>
<thead>
<tr>
<th>Process</th>
<th>Average estimated processing time prior to improvements</th>
<th>Average estimated processing time after improvements</th>
<th>Percentage reduction of processing times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payroll and pension reporting</td>
<td>60 hours</td>
<td>24 hours</td>
<td>60%</td>
</tr>
<tr>
<td>Purchasing/accounts payable</td>
<td>40 hours</td>
<td>24 hours</td>
<td>40%</td>
</tr>
<tr>
<td>Accounts receivable</td>
<td>60 hours</td>
<td>6 hours</td>
<td>90%</td>
</tr>
<tr>
<td>Monthly reconciliation</td>
<td>60 hours</td>
<td>8 hours</td>
<td>87%</td>
</tr>
</tbody>
</table>

Table 4-g Improved processing times (Furterer, 2009)

Results
The improvement in process time ranged between 40% and 90%. On top of this, it was found that all the process could be performed by fewer personnel, i.e. one person working 40 hours per week. These measurements were done on regular basis to sustain similar level of performance.

All deviations were analyzed by root cause analysis. Several manual steps were automated, which improved mistake proofing and control of human errors.
4.2.3 Analysis of LSS studies

The two case studies presented above describe implementation of LSS from two points of view: industrial and service. Despite different industries and variations in the steps of implementation, it was remarkable, how strictly both companies followed the DMAIC schema.

The first company had origin in Brazil, and was rather small, with less than 100 persons employed. The problem that it faced was bad quality of its production, film of plastic. When the project was started, the team took sample of 12 rolls, and each of them, i.e. 100%, had variations in thickness. The second company, local government’s financial administration, had problems with quality of their service, and long cycle time. Prior to implementation, 80% of vendors didn’t receive payments in time and 80% customers complained on customer service.

During the first, Define phase, it was necessary to define the need for improvement. The first company was trying to find out which process needs improvement. This was identified as “elimination of wasteful activities”. Therefore LSS implementation was more lean-oriented. During this phase company used SIPOC analysis and VOC (Voice Of Customer). The second company had already known which processes it wanted to improve, therefore the team focused on process analysis, stakeholder analysis, project charters and SIPOC.

In the Measure phase, both companies were working on understanding and measuring current processes. The first company has done it through experiments. Second company was more methodological, the team mapped processes into flow chart analysis and implemented Critical To Satisfaction (CTS) tree. The latter gave measure on key performance indicators: Cycle time, Accuracy of the processes, Customer satisfaction. In this phase they used the same VOC for measurement of customer satisfaction, as the first company used for analysis. This indicates that phases are important, but tools can be used in different order.

In the Analyse phase both companies analyzed data gathered in the previous step. The first company used statistical analysis: regression analysis, Gage R&R study, ANOVA. After the analysis it identified 2 possible ways to improve: better training of employees to decrease human-driven mistakes and better tagging of materials. The second company used cause and effect diagrams, Lean tools (5S, 5 Whys, waste identification). It has revealed five possible ways to improve: better training and computer skills among personal, elimination of wasteful activities, standardization of procedures, changing bureaucratic culture, and modernization of IT systems.

In the Improve phase both companies implemented the changes as decided in the previous step. The first company made it with help of 5S tool. The second company used Kanban and visual control, waste elimination and one-piece-flow. For example, one improvement was to use different colours for different types of the documents, and keep them in coloured boxes to make it easier to find and sort the documents. The company has also implemented an IT system, which eliminated many human-made errors.

In the final, Control phase, the companies were working on sustaining the developments achieved in the previous phases. In the first case, Lean tools Poka Yoke and PDSA were used. In the second, the project teams made measurements of the new processes and followed their improvements.

Prior to implementation, both companies lacked formal data collection processes. After that they have got steady-state framework for control and improvement. Both had the same goals: quality improvement, reduction of waste and resources. As the result, quality was improved and stabilized, wasteful activities eliminated, production capacity was doubled. The first company has gained 100 000 USD in annual savings. The second company achieved decrease in process time up to 90%. After all the improvements, it was realised that one person could perform all the tasks.
4.3 Business Process Management (BPM)

4.3.1 Case 1: BPM in financial industry.

The study describes application of BPM at the Swiss bank Credit Suisse, operating in 50 countries (Kung and Hagen, 2007). Globalization has increased competition in financial services, and in the era of internet and mobile connections, customers demand better and faster services. Therefore to survive in such conditions, outsourcing has become the most popular trend in the recent times. Another approach is improvement of processes and streamlining services with IT approach. As it is often the case with banking processes, many of them are still performed in a manual manner and are time-consuming. In this study it was demonstrated how the processes could be automated through reengineering combined with implementation of IT systems. Namely, it describes BPM implementation for the four processes: trade finance process, closing account process, settlement of securities process, processing of special customers’ orders.

Major aspects of BPM implementation

The problem with the first process, “direct trade finance”, was that it included too many manual steps. Basically it was quite simple process, meant to handle letter of credits. But it was cumbersome and inconvenient for the customers, because to submit this letter, customers had to come to the bank and submit it on paper. Detailed model of process activities revealed that most of them could be performed electronically. The process was reengineered into 4 sub-processes and 16 activities. Implemented IT solution allowed customers not only to submit orders at any time via web interface communicating with bank system, but also track their status.

In the second process, “closing accounts”, customers for different reasons wanted to terminate the accounts. The process consisted of many manual steps. Customers had to speak or write to relationship manager. The latter had to write a paper based form, send a special e-mail “flow mail” to the administration staff, which sent the order to accounting clerk, who finally implemented the request. If there was any error in the paper form, it was sent all the way back. Understanding of this process revealed that there was a possibility to use already existing banking systems. For example, customer data could be retrieved from the other banking systems.

Also, after reengineering the process consisted of 26 activities. New application was based on a process engine that controlled the activities and communicated with back-end systems. It was a boost in the process productivity. Everyday hundreds of accounts had to be closed, and the process was executed several hundred times a day. Cycle time was reduced by 50%. Partially due to automatic customer data retrieval, number of errors reduced to 1 in 10 000. Reduce in manual work resulted in 85% of cases handled without human intervention.

The third process “settlement of securities” was already partially automated. However, the process has undergone several changes and its old IT solutions were already outworn. The old processes and applications were analyzed in all the details by usage of process modeling software ARIS. The model was discussed and agreed with the working group. During reengineering those old software applications were roughly divided into many smaller applications, called services. Architectural solution of the final software application was such that process definitions were loaded into database. A special middle-layer interpreted process definition and executed necessary service.

As a result, the new system allows handling of 30 000-40 000 cases per day. Only 1 of 10 000 cases required human intervention, the rest was done automatically. The process cycle time has shortened. New solution was more flexible and extendible.

The difficulty with the fourth process, “special orders” was such that it could not be fully automated. This process had large variation compared to previous processes. Each customer request was special, and
needed special solution. Therefore during reengineering it was decided to implement a generic business process that was loosely suitable for handling of all the cases. It had a number of possible pre-defined process states. Although different special requests may involve different steps and states, this kind of setup simplified and standardized the way of handling special cases. It also allowed tracking of case status.

The problem with the old process was that it was taking too long time. Therefore the most significant improvement achieved by BPM implementation was reduction in cycle time. Average response time decreased from 2 days to 0.5 day.

**Results**

<table>
<thead>
<tr>
<th>Process</th>
<th>Cycle time</th>
<th>Total process time</th>
<th>Work automation</th>
<th>Introduced improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct trade finance</td>
<td>Reduced</td>
<td>Reduced</td>
<td>Significant</td>
<td>Web-interface for order submission</td>
</tr>
<tr>
<td>Closing accounts</td>
<td>Reduced by 50%</td>
<td>Reduced to 1 day</td>
<td>80-85%</td>
<td>New software application</td>
</tr>
<tr>
<td>Settlement of securities</td>
<td>Reduced</td>
<td>Reduced</td>
<td>99.99%</td>
<td>Old IT system was replaced by new</td>
</tr>
<tr>
<td>Special orders</td>
<td>Reduced by 30%</td>
<td>Reduced from 2 days to 0.5 day</td>
<td>Increased</td>
<td>New IT system</td>
</tr>
</tbody>
</table>

Table 4-h BPM implementation results

Also, BPM implementation made substantial improvements in each of the process. Cycle times were significantly reduced in all the processes. In some cases web applications allowed customers to submit data electronically, and this not only shortened cycle time, but led to higher level of customer satisfaction. Automated processes dramatically increased output, improved quality of services, and increased correctness of process execution. Decrease in manually performed processes made tangible benefits in savings: lower overhead costs, and reduced number of errors.

4.3.2 Case 2: Business process reengineering in healthcare management

This case study demonstrates the implementation of business process reengineering in the neurosurgical ward of Parma hospital in Italy (Bertollini, 2011). Deteriorating quality of medical service, long waiting queues, failure of healthcare providers to understand customer needs, has recently raised attention to the situation in this area. This study is performed in the healthcare service, which is certainly a very complex service industry. It has to deal with complex therapies and equipments. Work is performed by different type of workers, ranging from low-level cleaning personal to highly educated expert specialists. It involves communications and collaborations with different organizations, from laboratories to governmental regulatory affairs. And although healthcare is usually classified as a service, the problem it is facing is not so unlike the problems experienced in the typical industrial reality.

Aim of this case study was to find the possibilities to increase productivity of the ward in terms of number of operations performed, by having only limited number of resources. The reviewed here small neurosurgical ward had 38 beds, 2 operating rooms, only 3 or 4 operations were made daily. The novelty of this study was in that authors used Delphi panel of experts (this is explained later in this case) and simulation model techniques. This allowed them not only analyze the static models of processes, but perform dynamic simulations of the different possible combinations of inputs, scenarios, human and
technical resources. This made this study in particular interesting for our research, as a demonstration of modeling techniques and involvement of process users into the project.

**Major aspects of BPM implementation**
The study started with As-Is analysis. The questions asked were:
- How can scheduled and unscheduled operations coexist?
- How can they efficiently share existing resources and avoid deadlocks?

The BPR team started with modeling of the processes. They identified two main categories of resources:
- Physical resources. Beds = 38, Operating rooms = 2
- Human resources. Head physician, doctors, unit nursing officer, nurses

Activities at the ward were analyzed in great details, and subdivided into sub-processes. Diagram with the high-level processes is below. (Fig. 4.3.2-1).

**Figure 4-b Processes at the neurosurgery ward**

In the following step BPR team analyzed each process in all the details. For example, the first process on the Level 2 “Management of patients who need further investigation” was subdivided into steps:

- Inform the patient about the need of further investigation
- Start hospitalization procedure (separate sub-process)
- Perform tests and analysis (separate sub-process)
- Assess results of tests, which has two outcomes
  - Impossibility to formulate diagnosis based on the results of test
    - Need to carry out new analysis (separate sub-process)
  - Formulation of diagnosis which also results in 2 outcomes
    - Need for surgery
      - Operate immediately (separate sub-process)
      - Wait
    - No need for surgery
      - Discharge patient (separate sub-process)
      - Transfer to another ward (separate sub-process)
      - Keep for further investigation (separate sub-process)

The models were created using EPC (event-driven process chains) technique. EPC diagrams were used for setting up the simulation process. Simulation was performed by ARIS simulation software. The first
run of simulation provided information about As-Is parameters of the processes: throughput time for processes with certain resources, process delays, identification of bottlenecks, use of resources and number of processes completed in a certain period of time.

In the next step of simulation, models remained the same, but input parameters were changed:
- Frequency. Number of process instances started at regular intervals per day, week, month or year. Historical data were used to define the rates of Poisson functions which represented the expected number of “events” or “arrivals” that occur per unit time.
- Probability. The probability that an event or a certain type of connection will happen. These probabilities have been used when logical connectors are inserted into the models.
- Priority. Priority of each process instance that the event goes through.
- Shift calendar. Periods of time during which the daily work is carried out by the human resources and during which the material resources are available.

Outcomes from the simulation were validated against historical data. They were equivalent to those observed in reality. However it was not enough for correct assessment of the models. The BPR team needed real expert knowledge from healthcare professionals. Therefore the team built a panel of 7 experts, consisting of: two academics (whose research studies are mainly focused on BPR) one head physician, two doctors, one nurse and one representative from Health Authority Administration. This method of employing number of experts for taking decision is called Delphi technique.

The panel worked for two weeks in three sessions. Output of their work was:
- Requirements of ward processes (generated individually and anonymously by each expert)
- Panel participation in developing of models
- Defining critical points and “what-if” scenarios

**Results**

As a result of this work, the critical aspects that caused bottlenecks in the processes were outlined:
- (A) Operating rooms.
- (B) Beds in the reanimation room.
- (C) Bed in another ward, should it be needed
- (D) Number of operating sessions, essentially number of human resources

In light of these findings alternative new scenarios were created. During the next round of simulations the team found the parameters that had greatest influence on the number of operations. The simulations revealed that it was impossible to achieve improvements by changing one parameter only. The biggest increase of 23.86% was achieved by increase of operating rooms (A) and number of personal (D).

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Average increase (in the number of operations, %)</th>
<th>SD (%)</th>
<th>Upper 95% CI (%)</th>
<th>Lower 95% CI (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>14.02</td>
<td>1.14</td>
<td>14.38</td>
<td>13.66</td>
</tr>
<tr>
<td>B</td>
<td>6.83</td>
<td>0.75</td>
<td>7.07</td>
<td>6.59</td>
</tr>
<tr>
<td>C</td>
<td>3.03</td>
<td>0.51</td>
<td>3.19</td>
<td>2.87</td>
</tr>
<tr>
<td>D</td>
<td>15.04</td>
<td>1.88</td>
<td>15.63</td>
<td>14.45</td>
</tr>
<tr>
<td>AB</td>
<td>19.11</td>
<td>1.76</td>
<td>19.87</td>
<td>18.55</td>
</tr>
<tr>
<td>AC</td>
<td>16.39</td>
<td>0.99</td>
<td>16.70</td>
<td>16.08</td>
</tr>
<tr>
<td>AD</td>
<td>23.86</td>
<td>2.13</td>
<td>24.53</td>
<td>23.19</td>
</tr>
<tr>
<td>BC</td>
<td>7.13</td>
<td>1.03</td>
<td>7.46</td>
<td>6.80</td>
</tr>
<tr>
<td>BD</td>
<td>16.10</td>
<td>1.22</td>
<td>16.49</td>
<td>15.71</td>
</tr>
<tr>
<td>CD</td>
<td>15.81</td>
<td>2.01</td>
<td>16.45</td>
<td>15.17</td>
</tr>
</tbody>
</table>

Table 4-i BPM implementation results on case study II
4.3.3 Analysis of BPM case studies

Similarly to LSS, the reviewed above two BPM case studies belong to different industries. One is from banking sector and another from healthcare. Seemingly they have little in common. Bank had standardized processes of handling documents. Processes at the hospital had more variations.

In the first case, Swiss bank had pressure of increased global competition, customers demanded internet and mobile services. The case study describes four processes, which were old-fashioned, cumbersome and inconvenient. These processes were thoroughly analyzed and automated through re-engineering. Some of them were embedded into web solutions, while others were simply reorganized and modernized. It was not really necessary to change them, because the standard procedures existed and were important for financial operations.

The second case described processes in a small Italian hospital. Situation there was more undefined. The hospital had limited amount of resources: 38 beds, 2 operating rooms and limited number of personal. The problem it faced was: how to efficiently share existing resources for performing both scheduled and emergency operations. To find this out, the BPM team performed simulation of the processes by use of ARIS simulation software. The team didn’t have enough of knowledge about hospital work. Therefore they invited panel of experts, consisting of the healthcare experts, doctors, nurses, etc. As the result of this work, the team found that combination of increased operating rooms and number of personnel would provide maximum (24%) of increase in operations number. The least increase (3%) would be achieved by increase of number of beds in another ward. The findings above are quite logical.

These two case studies demonstrated that although BPM always involves use of computer, the result of implementation is not always a computer solution. In the second case the processes were only analyzed by use of special software, but not really embedded into any IT system. However, the most typical BPM implementation was presented in the first case, when the final result was the software solution.
## 4.4 Cross-case study examination and analysis

While trying to identify causal relationships between these three methodologies, we found that they have addresses quite similar problems. Two tables below give an overview of the case studies analyzed above:

<table>
<thead>
<tr>
<th>Case study</th>
<th>Organization</th>
<th>Country</th>
<th>Industry</th>
<th>Company size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sona Koyo Steering Systems(SKSS) Limited</td>
<td>India</td>
<td>Automotive parts manufacturing</td>
<td>&gt;100 employees</td>
</tr>
<tr>
<td>2</td>
<td>Four auto part manufacturing SME</td>
<td>UK</td>
<td>Automotive parts manufacturing</td>
<td>90 – 160 employees</td>
</tr>
<tr>
<td>3</td>
<td>ZadePack</td>
<td>Brazil</td>
<td>Packaging materials manufacturing</td>
<td>50-99 employees</td>
</tr>
<tr>
<td>4</td>
<td>City government in State of Ohio</td>
<td>USA</td>
<td>Financial services</td>
<td>&gt;1000 employees</td>
</tr>
<tr>
<td>5</td>
<td>Credit Suisse</td>
<td>Switzerland</td>
<td>Financial services</td>
<td>&gt;60 000 employees</td>
</tr>
<tr>
<td>6</td>
<td>Neurosurgery ward of Parma Hospital</td>
<td>Italy</td>
<td>Healthcare</td>
<td>&lt; 100 employees</td>
</tr>
</tbody>
</table>

Table 4-j Overview of case studies

<table>
<thead>
<tr>
<th>No</th>
<th>Industry</th>
<th>Addressed problem</th>
<th>Methods used</th>
<th>Process</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Automotive parts manufacturing</td>
<td>• Low net profit • High supplier returns • Lack of new products</td>
<td>TQM</td>
<td>• Automotive parts manufacturing processes</td>
<td>• 100% increase of production and sales • 50% reduction of product defects • 44% sales came from new products</td>
</tr>
<tr>
<td>2</td>
<td>Automotive parts manufacturing</td>
<td>• Non existence of a quality framework • Inefficient processes • High defects in products</td>
<td>TQM</td>
<td>• Automotive parts manufacturing processes</td>
<td>• TQM implemented as quality framework • Reduction of product defects by 20 to 90%</td>
</tr>
<tr>
<td>3</td>
<td>Packaging materials manufacturing</td>
<td>• Process failures, dissatisfied customers • Wasted production material • Defected end products</td>
<td>LSS DMAIC</td>
<td>• Production processes</td>
<td>• &gt; 100 000 USD of annual year-to-year savings • Soft benefits as improved customer satisfaction and better vendor relationship</td>
</tr>
</tbody>
</table>
Cases where LSS was used showed strict usage of a step by step methodology with clear deliverables and actions at each stage. Inversely, TQM and BPM cases showed some kind of flexibility in this matter. This can be considered as flexibility, but also can be considered as lack of structure.

All these methodologies addressed process related issues. However it is clear from case studies that BPM has an IT focused approach. TQM and LSS cases understood the need for IT, but it was not in center of their agenda. LSS and TQM included a lot of human and motivational factors instead. The focus on IT and ERP systems by BPM had been highlighted in our problem discussion. The case studies strengthen this statement. Below we will provide analysis of four different aspects of the methods.

**Quality improvement**

Although implementations of the methods differ, they all have quality improvement as a goal. The first 4 case studies show that TQM and Six Sigma are the most effective in this aspect. Andersson et al.(2006) means that “companies that have received a quality award outperform the control companies concerning operating income-based measures and other indicators during a period that follows the announcement”. Six Sigma has a goal of 3.4 defects per million. In the BPM implementations quality improvements are obvious but not so stressed out.

The first TQM case study describes Indian auto parts manufacturing company that experienced crisis due to low net profit and massive supplier returns. As quality strategy and implementation, the company used “simple techniques like exactness, visualization and a suggestion scheme in 1997, moving forward to
applying gap analysis, deep analysis, why-why analysis, and 7QC tools, it has taken some unique initiatives like “quality gate 20”. These programs gave excellent results, and already in 2003 customer returns decreased in 10 times from 1,579 parts per million to 112 parts per million.

The second case study also presented four auto parts manufacturing companies in UK. The companies implemented TQM in a range of different ways. All of them had basis in the older quality systems ISO9000 and QS9000. Apart from that they used Advanced Quality Planning, Statistical Process Control, Customer Needs Identification System, Customer Satisfaction Measures, and other quality techniques including statistical tools, organizational re-structuring such as cell manufacturing, motivational, people-oriented and cultural aspects initiatives such as communication, monthly meetings, reward scheme, multi-skilling, etc. The case study does not present financial results, but only mentions that the company that had least mature TQM culture made the worst impression: “The first impressions of the company were quite displeasing”. As it was described in the theory, TQM suffers from difficulties to assess tangible results. But the more mature is TQM in the company, the more effective it becomes.

The Lean Six Sigma case studies are the most illustrative about quality aspect. The first company belonged to manufacturing and had problems with variation in the thickness of the plastic film it produced. The second belonged to financial service sector, and pursued improvements in performing financial operations. Both used DMAIC framework and standard Six Sigma statistical tools: regression analysis, correlation analysis, ANOVA. In both cases the quality was significantly improved after implementation of Lean Six Sigma, because number of defects decreased by more than 100%.

The BPM case studies do not directly describe quality improvements. They are rather process oriented, where quality improvement is not considered as a goal, but as a natural outcome. But nevertheless, in the first case from Swiss bank, quality improvements and error reduction were achieved through automation of the processes. In the second case quality aspect was not really an issue.

This analysis demonstrates that quality aspects are most inherent in the TQM and LSS, and that actually they share most of the same techniques. But this also shows how the techniques evolved, from more general all-around TQM techniques to robust statistical Six Sigma methods. In chapter 2.4.1 we presented criticism of TQM because of its too vague definition. Shift to Six Sigma was characterized by the fact that some of TQM techniques are very similar to those of Six Sigma. Six Sigma contributed by exact statistical methods that could get the root cause of the problem.

**Process orientation**

As the case studies demonstrated, process orientation was the most important characteristics that all methods have shared. TQM, Lean part of LSS, and BPM have biggest degree of process orientation. And even another part of LSS, Six Sigma, is going through process analysis during DMAIC implementation.

The first two TQM cases didn’t provide many details of work on the process improvement. It was mentioned the first company had implemented 5S, kaizen, poka yoke, and just-in-time (JIT). The second case study describes that all the companies implemented 5S and 3M (mura, muda, muri).

Both LSS cases had strong focus on implementation of Lean principles and process orientation. To identify process problems they also used waste elimination and 5S techniques: Sorting, Storing, Shining, Standardizing, Sustaining. The second case demonstrated usage of more advanced tools as Kanban, SIPOC (Supplier, Input, Process, Output, Customer) used for identification of high-level process steps, VOP (Voice of Process) used for identification of what the processes want. One particularly powerful Lean tool was “Cause and Effect diagram”, used during process analysis.
BPM cases are clearly showing that this methodology has the deepest engraved process orientation. In the first case the 4 bank processes were being analyzed in all the details and automated through computer systems. The second healthcare case study shows how the processes were analyzed and improved by use of a special process analysis software and collaboration with domain experts.

The findings above demonstrate that process improvement is particularly important part of all the methods. And that process tools have developed from simple techniques, such as 5S and waste elimination to the computer based process analysis. It was influenced by the development of technologies and strengthening of service-oriented industry. In chapter 2.4.4 we presented future challenges of LSS, where it was stated that LSS is extremely data driven and would benefit of using ERP solutions. This was exactly the situation with bank processes. Implementation of LSS would not bring as big benefits as automating the processes through BPM. However, both BPM cases indicate complexity of the processes, and that implementation of BPM should be enhanced by involvement of process users.

**Problems addressed**

The problems that TQM addressed can be subdivided into two categories:
- quality (high supplier returns in the first case and high level of defects in the second)
- organizational improvements (need for new products in one case and inefficient processes together with uncertain quality framework)

Then LSS dealt with the following three issues:
- quality(defects in the products was the problem only in the first manufacturing case)
- process errors(process failures and wasted material in first and inefficient processes in the second)
- process time(high lead-time in the second financial case)

Finally, BPM attempted to resolve such issues as:
- process time(faster service in the first financial case and minimization of waiting time for patient in a queue in the second case)
- low process capability(financial case: number of documents, hospital case: number of operations)
- computer-based service(web-based service demanded by customers)

From the findings above evolution of the problems becomes clear. When TQM was mainstream in 80-s, manufacturing was very developed in western countries. Quality of the products was major problems. The methodology was so broad that it even embraced cultural changes at the company. It was mentioned in the theory part that TQM was a profound and all inclusive philosophy. But this was its weakness too, the methodology was not concrete. LSS learned some lessons out of this and addressed more exact and narrow problems. This still remains probably the most popular approach nowadays, suitable for solving problems in both industrial and service companies. However, if this is not enough and requirements involve automation of manual operations, software creation, large amounts of data, and more technical improvements in general, then BPM is more suitable.

**Implementation**

The first two cases demonstrated that in TQM approach the responsibility for quality is undertaken by everyone from the simple workers to the managers. It was quite a change for that time, because previously only quality department was responsible for the quality aspects. A typical implementation team, as described for one of the companies in the second case study:
“...The company has a quality steering committee at company level, which comprises senior management, and a few selected members from the shop floor including supervisors and team leaders. A continuous
improvement structure exists in the company since it is a requirement of QS 9000. It centers mainly on a cell manufacturing system in which there are related process and quality engineers in each team. Other forms of improvement activities are the product improvement groups who hold weekly meetings to resolve problems and find better ways of performing tasks.”

None of the companies had exact implementation framework. Instead of that various quality improvement tools were used, from ISO9000 to Statistical process control.

LSS had special tools for measurement of the metrics and DMAIC, step-by-step instructions for implementation. LSS was implemented by a team of dedicated practitioners, certified Black or Green Belts. The techniques were very exact, and embraced both quality and process aspects.

BPM didn’t have exact implementation framework, and in this it was closer to TQM. In the first BPM case study it was described how the processes were reorganized in more optimal way. Although case studies did not mention this, it would have been possible to use Lean process analysis techniques for this purpose. In the second case study the techniques were more exactly defined, but they were not as specific as DMAIC.
5 Summary

The aim of this thesis was to find relations amongst three particular BPQM methodologies. Specifically we chose to study and compare TQM, LSS and BPM. Whilst LSS turned out to be a well structured methodology with rigid yet robust structure, TQM and BPM turned out to be vague and ambiguous at times. In order to keep right aspects in view for comparison and analysis of these methods, we focused on four aspects of BPQM which were identified by theoretical and data research.

These methods in general have some similarities. Main aspect addressed by TQM is Quality. Entire TQM concept is focused around quality and processes. LSS also focuses on end results with high quality; however more emphasis is made on how the end result is achieved. This makes LSS more process oriented methodology. Processes describe how you work. Business performance can always be reviewed by looking at end results which are dependent on what has been done. This sets a relationship between business performance and processes in any business organization. The outcome of any business is therefore dependent on how the processes interact and improve over time. LSS and TQM are methods that allow continuous process improvement with a combination of tools, business management framework, philosophy and continuous assessment of operational status. Both TQM and LSS focus on institutionalizing continuous improvement. When done appropriately, it can lead to dramatic improvements in quality of products and services, competitiveness and end value to customer.

Despite the widespread believe that TQM focuses on quality, it fails to define explicitly what quality is. It only states that quality must be perceived by customer/end-user. In reality, TQM implementations were focused around quality of various aspects. Quality in products, processes, operations, personnel or bottom line performance has different reasons and levels of importance depending on maturity of any organization. This ambiguity is perhaps the reason why methods that succeeded TQM were more focused into certain aspects. LSS for instance provided very specific metric for measurement of successful LSS implementation as a quality measure, i.e. 3 defects per million opportunities. BPM didn’t provide such criteria, however continuously stressed importance of information systems infrastructure for quality in data and information.

In all the methodologies investigated in this thesis, the term “process” has been prominent. However, there seems to be a lack in definition of processes that is commonly accepted. Much have been discussed about this topic by Armistead et al(1999). Common understanding is that processes define everything that happens from any input to any output. In the case studies that were presented in this thesis, a lot of focus had been made on processes. There has been description of processes that span throughout the organization and also processes that were localized within the organization. Processes can either create a service or facilitate smoother operations.

LSS tried to fill gaps that existed within methods that proceeded by being more focused, structured and at the same time agile to various needs of organizations. It continuously stressed on importance of data, however failed to incorporate aspects of information technology into the methodology. People and processes have always been the key focus areas of improvement for any LSS implementation. This has been evident in cases described in this thesis. This gap was rightfully filled by BPM, however with a cost. Initial ambiguity that existed within TQM can be seen within BPM as well. High focus on automation and dependency on ever changing information systems creates preconditions for successful BPM implementations. This is visible in the BPM case studies described earlier. The improvements achieved during BPM implementation were possible because of good process understanding and modelling. If the models were incorrect, then automation would not help. Partial explanation of decrease in cycle time is that automation of process steps eliminated waiting time. Output per employee improved, and work satisfaction too. Employees did not have to waste time on error-prone routine paper work. Instead of that they could rely on automatic systems, and dedicate their time to more creative tasks. Their roles, duties
and responsibilities were better defined. Quality of work increased. After reengineering, processes became clearer and more visible.

The diagram below shows the evolution of BPQM methodologies that has been discussed in this thesis with respect to time and aspects.

![Diagram showing the evolution of BPQM methodologies](image)

**Figure 5-a Evolution of BPQM, authors view.**

A limitation of this research has been the pursuit of breadth of research and not depth of BPQM aspects. Our discussion and analysis of chosen aspects provides a valuable panoramic overview and extensive bibliography, however we do encourage keen readers to delve deeper for aspects beyond the coverage provided in this thesis.

### 5.1 Future Research

The case studies analyzed in this thesis were from various parts of the world. During literature review and search for appropriate case studies, most BPM case studies were found from more developed countries. TQM as a method seems to fade away from western business, however soundly present in eastern countries. A comparative study of choice of BPQM methods amongst various countries may provide insights into evolution of these methodologies and different business cultures.

The methodologies discussed are of strategic importance for many organizations. The implications of successful or unsuccessful implementations are very tangible. During our case study analysis and literature review, we found that a lot of emphasis is placed on how these methodologies fit into overall strategy of the organization. During our analysis phase, we realised that this topic by itself can be elaborated to another complete thesis.


6 Conclusions

This study has been focused on critical evaluation of some aspects of BPQM methodologies. The research aimed to identify relations between the chosen methodologies and suggest possible solutions to be used in future for organizations while contemplating on BPQM implementations.

It was found that BPQM methodologies evolved over time either through increasing focuses in a particular direction or through better integration of people and Information Systems. A clear line of evolution were visible in the methodologies, going from quality to processes and then turning to IT to leverage quicker results. Processes were identified to be the aspect that glued everything together. Independent of other developments, process centricity increased with time. This is important to note that recent BPQM trends circle around processes. When comparing the evolutionary aspects and real life case studies, it is not surprising why process centricity is important.

Quality improvement also remains to be an important aspect. It has been identified as end results of process oriented thinking. Any improvement in process performance eventually affected the end quality in some way or other. Process centricity allows companies to keep an eye on end results while working on various paths to reach end results.

BPQM methodologies inherently focus on creating change in organizations. Creating change is always difficult and challenging unless steered by top executives. Jack Welch, renowned CEO of General Electric, considered Six Sigma to be a management culture and not just a problem solving methodology. The purpose behind this statement was to buy-in all top managers and direct them into one direction. This has not changed with time. Any BPQM implementation must be implemented with support from top executives. Inabilities to establish this will in most cases fail the BPQM implementation or provide variable results.

The theoretical framework provided earlier narrowed our research to some key aspects of BPQM methods. With respect to these aspects, we can conclude that in all cases the theory matches what is being practised within various industries. The table below relates aspects of our theoretical framework to our theoretical findings.

<table>
<thead>
<tr>
<th>BPQM Aspects</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality improvement</td>
<td>It is a valid aspect to consider for BPQM choice. It is evident in all three methodologies and case studies. However more evident in TQM and LSS. If quality is the main goal, these two methodologies have better framework to deliver results.</td>
</tr>
<tr>
<td>Process orientation</td>
<td>Either process improvement or automation is fundamental in all three methodologies and case studies. However BPM tackles complexity in far better manner and therefore delivers better process improvements.</td>
</tr>
<tr>
<td>Problems addressed</td>
<td>There is slight variation between the methodologies. Whilst TQM and LSS may address same problems, however their results are limited. Once human-computer-process interaction is desired, both TQM and LSS fail and BPM succeeds.</td>
</tr>
<tr>
<td>Implementation characteristics</td>
<td>Management and leadership support is always relevant for any new implementation; however it is especially important for TQM. A bottom-up approach will not succeed for TQM implementation. LSS addresses this by providing a strict framework for step by step implementation. BPM on the other hand relies too much on automation. Therefore, for quick implementation and obtainment of results LSS is more appropriate.</td>
</tr>
</tbody>
</table>
These findings provide a panoramic understanding on which potential problems can be tackled by use of specific BPQM methodologies. We can deduce that process and quality problems are mostly addressed by TQM and LSS, while BPM can be used for IT improvements. In cases where quick results are necessary, LSS is more suitable. For TQM to be effective, major steps need to be taken to create a cultural change.

In conclusion the authors wish to stress that choice of BPQM methodologies is just a beginning of journey. Organizations need to learn over time to build a pragmatic approach to reap the benefits from BPQM implementations. There is no evidence to suggest organizations to follow any specific methodologies like TQM, LSS or BPM. The need for BPQM methodologies varies. However, an understanding needs to exist regarding importance of processes and quality. It is imperative to understand that existence of consistent and high quality processes can lead to high quality products and services. This in turn leads to financial benefits and long term sustainability of any organization. It is very unlikely that a method will exist that will meet requirements from all organizations. Organizations in 21st century need to be agile and adapt to changing environment; and BPQM methodologies can be helpful only if they are chosen for the right reason.
Reference list


Busch P. and Fettke P. 2011, Business Process Management under microscope. 44th Hawaii International Conference on System Sciences Pages: 1-10


Appendix A

Principles of TQM:

Exploring the literature, following factors were identified as main principles of TQM (Psomas and Fotopoulos, 2010).

- Leadership
- Strategic quality planning
- Employee management and involvement
- Supplier management
- Customer focus
- Process management
- Continuous improvement
- Information and analysis
- Knowledge and education
- Quality management tools and techniques.

Another stream of literature identified following as main principles of TQM.

- Management Commitment
- Employee Empowerment
- Fact Based Decision Making
- Continuous Improvement
- Customer Focus

For every principle, TQM provided a set of methodologies to be used. For example for Fact Based Decision Making, TQM suggested to Statistical Process Control and various other statistical tools. The basis of TQM is to reduce the errors produced during the manufacturing process, increase customer satisfaction, streamline supply chain management, aim for modernization of equipment and ensure workers having highest level of training. TQM led the foundation for management strategies on quality and processes.
Appendix B

Table below summarizes the lean implementation steps and Six Sigma tools that can be used.

<table>
<thead>
<tr>
<th>Lean</th>
<th>Six Sigma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establish methodology for improvement</td>
<td>Policy deployment methodology</td>
</tr>
<tr>
<td>Focus on customer value stream</td>
<td>Customer requirements measurement, cross-functional management</td>
</tr>
<tr>
<td>Use a project-based implementation</td>
<td>Project management skills</td>
</tr>
<tr>
<td>Understand current conditions</td>
<td>Knowledge discovery</td>
</tr>
<tr>
<td>Collect product and production data</td>
<td>Data collection and analysis tools</td>
</tr>
<tr>
<td>Document current layout and flow</td>
<td>Process mapping and flowcharting</td>
</tr>
<tr>
<td>Time the process</td>
<td>Data collection tools and techniques, SPC</td>
</tr>
<tr>
<td>Calculate process capacity and Takt time</td>
<td>Data collection tools and techniques, SPC</td>
</tr>
<tr>
<td>Create standard work combination sheets</td>
<td>Process control planning</td>
</tr>
<tr>
<td>Evaluate the options</td>
<td>Cause-and-effect, FMEA</td>
</tr>
<tr>
<td>Plan new layouts</td>
<td>Team skills, project management</td>
</tr>
<tr>
<td>Test to confirm improvement</td>
<td>Statistical methods for valid comparison, SPC</td>
</tr>
<tr>
<td>Reduce cycle times, product defects, changeover time, equipment failures, etc.</td>
<td>Seven management tools, seven quality control tools, design of experiments</td>
</tr>
</tbody>
</table>

**Table 7-a Lean Implementation steps and Six Sigma Tools** *Source: Pyzdek (2000)*

The Integration of these methodologies has resulted in following:

![Service Lean Sigma DMAIC Diagram](image)

**Figure 7-a DMAIC**

*The DMAIC method:*

The acronym DMAIC comes mainly from Six Sigma but also includes lean management techniques. It stands for Define, Analyse, Measure, Improve and Control. The DMAIC process involves taking a business problem, translating it into a statistical problem, resolving the statistical problem, and returning a practical solution that can be controlled (Watson, 2004). Each stage consists of specific activities that are described below.
**Define**

This stage marks the beginning of an improvement work. This is the phase where the business problem is translated into LSS improvement project, members of the team are selected, project schedule and resources are identified, business problem from high level perspective is defined and critical success factors for customers is identified.

**Measure**

This stage marks the beginning of work with processes. The project members identify the AS-IS situation of the product/process that is under investigation whilst always concentrating on components critical to customer satisfaction. At the end of this stage, the business problem is translated into a statistical problem.

**Analyze**

This stage is filled with maximum amount of statistical and lean analysis. The project members analyze the process/product performance using sophisticated statistical tools and lean tools. Main aim is to identify the sources of variation and waste. At the end of this stage, all project members agree on improvement objectives based on the statistical analysis.

**Improve**

The improvement objectives identified at analyze phase are put to test at this stage. Along with the implementation of changes, a continuous analysis using statistical and lean management tools are carried on to identify results of implemented changes. At the end of this stage; project members are either convinced that the proposed recommendations solve the earlier identified business problem, or they revert back to analyze phase for deeper analysis.

**Control**

At the control phase, the solutions are integrated with day to day business processes and their performance is checked on regular basis.
# Appendix C

<table>
<thead>
<tr>
<th>Phase</th>
<th>Time</th>
<th>Focus</th>
<th>Business</th>
<th>Technology</th>
<th>Tools/Enablers</th>
</tr>
</thead>
</table>
| **Industrial Age**    | 1750 – 1960s | - Specialization of Labor  
- Task Productivity  
- Cost Reduction | - Functional Hierarchies  
- Command & Control  
- Assembly Line | - Mechanization  
- Standardization  
- Record-keeping | - Scientific Management  
- PDCA Improvement Cycle  
- Financial Modeling |
| **Information Age**   |           | Quality Management  
- Continuous Flow  
- Task Efficiency | Multi-Industry Enterprises  
- Line of Business Organization  
- Mergers & Acquisitions | Computerized Automation  
- Management Information Systems  
- MRP | TQM  
Statistical Process Control  
Process Improvement Methods |
| **1st Wave**          | 70s - 80s  | Process Innovation  
- “Best Practices”  
Better, Faster, Cheaper  
Business via the Internet | Flat Organization  
- End-to-end Processes  
Value Propositions – Speed to Market, Customer Intimacy, Operational Excellence | Enterprise Architecture  
ERP  
CRM  
Supply Chain Mgt | Activity Based Costing  
Six Sigma  
Buy vs. build  
Process Re-design/Reengineering Methods |
| **2nd Wave - Process Reengineering** | 1980s | | | |
| **3rd Wave**          | 2000+     | Assessment, Adaptability, & Agility  
24X7 Global Business  
Continual Transformation | Networked Organization  
Hyper Competition  
Market Growth Driven  
Process Effectiveness over Resource Efficiency  
Organizational Effectiveness over Operational Efficiency | Enterprise Application Integration  
Service Oriented Architecture  
Performance Management software  
BPM Systems | Balanced Scorecard  
Self Service & Personalization  
Outsourcing, Co-Sourcing, In-sourcing  
BPM Methods |

**Table 7-b** Historical evolution of Business Process Management methodologies (Lusk, 2005)
The main idea behind BPM is optimization and automation of business processes. This implementation also includes their alignment with the strategy. Here strategy is a backbone, a central and defining concept. Ideally, amalgamation of the right customer oriented strategy together with corresponding effective processes will bring maximum benefits. Opposite is also true, and automation will not improve the situation. Jeston and Nelis (2006) suggested a following framework for BPM implementation.

1. **Organization strategy**
   In the first phase the main focus is on working with the strategy. This step should give understanding of how the processes within the company contribute to achievement of strategic objectives.

2. **Process architecture**
   This phase brings together the first and the third phases. To start with the changes, it is necessary to understand how the processes work today. The meaning of this phase is to obtain a full architecture of the processes. They will be analyzed in all the details, and models of the processes will be created. Usually it is a high-level representation of organizational processes.

3. **Launch pad**
   Beginning of the redesign of business processes. Launch Pad prepares platform for the coming work. The process models, created in the previous stage are handed over to IT department. All the stakeholders are communicated, project teams and roles within them established. Clearly it is not possible to redesign all business processes. Therefore scope of the project must be defined, by this establishing prioritization of the processes with the biggest impact on the business. Another important aspect is degree of change, or agreement on how radically the business processes will be redesigned.
4. **Understand**
   As its name suggests, this phase brings in-depth understanding of current business processes. Usually it is conducted in form of workshops, where project members gather together with the experts and process owners. Some of the questions that need to be clarified:
   - is performance level satisfactory?
   - do we have enough of information?
   - what works well?
   - what needs to be improved?
   - what is the root cause of the problem?
   - is it enough human resources and time to implement the changes?

5. **Innovate**
   If successfully conducted, the previous phases will provide enough of information about the processes. In this phase they will be planned for improvements and enhancements that will make them more efficient and effective. If re-engineering needs to be performed, then it includes redesign of the whole business process architecture.

6. **People**
   In this phase people are prepared for the changes. It involves changing assignments and tasks and alignment to the new processes. Might be together with redesign of organization structure.

7. **Develop**
   This is a transitional phase from Innovate to Implement. The changes that were planned in the Innovation phase are implemented in practice. It involves all the work on process automation, development (purchase) of software and hardware. If software is going to be implemented in-house, whole process of development must be completed by the end of this phase.

8. **Implement**
   In this phase the changes will go live. The new software is in use, and new improved processes are being executed. Users are trained and introduced into the system. After the first roll-out and feedback, it becomes clear if the re-engineering process went successfully.

9. **Realize value**
   In this stage it is checked if the implemented improvements helped to realize business value, follow the strategy and bring maximum of benefits. If everything was well planned and conducted, the benefits will be such as increase in profit, more smoothly running processes, significant savings in time and money. In contrast to that, flawed, incomplete BPM will only magnify the problems.

10. **Sustainable performance**
    Because business processes never stop, they need constant review and improvement. Therefore sustainable development and improvement programs should be incorporated into the business culture.
Appendix E

Example of BPM implementation for a car renting service

In the first step there will be defined all the users, suppliers and stakeholders of the process.

![Stakeholder Diagram](image)

**Figure 7-c** A stakeholder diagram for the Rent Car process. Each stakeholder gets something from the process and must give something back (Harmon, 2010)

Further process modeling involves mapping of different processes, that occur between customer, car rental company, internal and external stakeholders. By applying Value Chain approach (Porter, 1985), processes can be categorized into different groups: core, support, management, etc.

![Value Chain Diagram](image)

**Figure 7-d** A value chain, some of the processes that make it up, and some stakeholders (Harmon, 2010)

This and the next step look very similar to Lean analysis, it finds out value adding activities and waste. Each process can be drilled down to its roots, and its variation/quality/efficiency can be examined with the tools of Six Sigma.
After analysis and definition of all the processes, they will form the ground for the next step - software development. A new car-rental web service will enable customer to book a car conveniently from home via Internet. Additional internal software will enable to monitor status of cars in-house and rented-out. Another software will simplify invoicing and payments. Finally, the whole system can evolve as on the diagram below:

![Diagram of the Rent Car process. Customer activities are at the top, Rent Car process in the center (the yellow area). Support process is below. (Harmon, 2010)](http://enterprisearchitecture.nih.gov/ArchLib/AT/TA/WorkflowServicePattern.htm)

**Figure 7-e**

**Figure 7-f** Business Process Management (BPM) Service Pattern

(http://enterprisearchitecture.nih.gov/ArchLib/AT/TA/WorkflowServicePattern.htm)